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Negative investment in China: financing constraints and restructuring versus growth

by

Sai Ding, Alessandra Guariglia, and John Knight

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Abstract

This paper addresses a puzzle in China's investment pattern: despite high aggregate investment and remarkable economic growth, negative investment is commonly found at the microeconomic level. Using a large firm-level dataset, we show that private firms divest in order to raise capital. We also find that, owing to over-investment and mis-investment in the past, state-owned firms have had to restructure by getting rid of obsolete capital in the face of increasing competition and hardening budget constraints. Finally, rapid economic growth counterweighs both effects for all types of firms, with a larger impact in the private and foreign sectors.

JEL classification: G3; O16; O53

Keywords: Negative investment; Financial constraints; Industrial restructuring; Economic transition; China

Outline

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Non-technical abstract

This paper investigates firms' divestment behavior in China. The issue is of particular interest because it presents a puzzle: China is an international outlier on account of its high rate of industrial investment, but it is also characterized by a high frequency of negative investment in its industrial sector. Specifically, our comprehensive nationwide annual dataset of about 60,000 Chinese manufacturing firms covering the period 2000-07 shows that, on the one hand, annual investment averaged 22% of value added and 9% of fixed capital stock but, on the other hand, 32% of the firm-year observations in the sample actually divested. This paper attempts to provide answers to two broad research questions. First, why do Chinese firms divest, i.e., what variables determine the probability of negative investment? Second, why do some firms divest more than others, i.e., what are the determinants of the amount of negative investment among divesting firms

Our descriptive statistics show dramatic structural changes over the decade, with the share of the state sector declining and that of the non-state sector expanding. SOEs remain the poor performers of the economy: they have the highest divestment rate, lowest profitability, lowest efficiency, slowest growth rate, and the highest leverage rate. This suggests that the state sector has been cushioned by favorable access to credit and state subsidies. By contrast, the private and foreign sectors, which contain the most efficient, profitable, and fast-growing firms, have less access to the formal financial system. Collective firms exhibit good financial performance and improvements in productivity, but their growth prospects are not comparable to those of private and foreign firms.

Given this huge heterogeneity in firms owned by different agents, our study of divestment in China required separate analysis of the different ownership groups. We find that negative investment by private firms is mainly due to external financial constraints: they need to obtain funds in order to survive and grow. State-owned enterprises (SOEs) divest mainly for inefficiency or restructuring reasons: they need to eliminate obsolete capital in the face of rising competition or other pressures to become efficient. The fact that firms are growing fast offsets both of these incentives for negative investment, particularly so in the case of the - most dynamic - private and foreign firms.

Our findings have an important policy implication: the limited access to external finance of the non-state sector is the most likely source of negative investment for private firms. This suggests the need for further reform of the financial system, which has lagged behind most other economic reforms in China.

1. Introduction

During the last three decades, China's investment rate has been remarkably high. Gross capital formation has averaged a fairly steady 39 percent of GDP over the entire reform period, the fixed capital formation component of which has risen, from an average of 29 percent between 1978 and 1992 to an average of 37 percent between 1993 and 2009 (World Development Indicators, 2011). The high aggregate investment rate and dramatic investment-generated improvements in productivity and technology have been viewed as the main driving forces behind China's remarkable growth over the reform period. Investment accounts for about two-thirds of the growth differences between China and Sub-Saharan Africa (Ding and Knight, 2009). It appears that high investment has been a necessary condition for China's growth success.

Nevertheless, at the micro level, China has also experienced much negative investment. Our comprehensive nationwide annual dataset of about 60,000 Chinese manufacturing firms covering the period 2000-2007 shows that, on the one hand, annual investment averaged 22% of value added and 9% of fixed capital stock but, on the other hand, 32% of the firm-year observations in the sample actually divested! The combination of high investment for firms in aggregate and divestment among individual firms presents a puzzle which, to our knowledge, has been ignored in the literature. In this paper we attempt to solve it.

China is not alone in having a high rate of negative investment. Using firm-level data from Amadeus (Bureau Van Dijk) and the same variable definition, we observe extensive divestment among many transition economies over similar time periods: 9% in Poland, 9% in the Czech Republic, 13% in Bulgaria, and 33% in Romania. Much negative investment can also be observed in the UK FAME dataset (Bureau Van Dijk), according to which 22% of firm-year observations are characterized by negative investment. The phenomenon deserves to be understood, particularly in the case of China. On the one hand, China's fast economic growth should reduce the frequency of negative investment below that of slower-growing economies. On the other hand, the transitional status of the Chinese economy should raise the frequency above that of market economies.

Using the firm-level dataset referred to above, we attempt to provide answers to two broad research questions. First, why do Chinese firms divest, i.e., what variables determine the probability of negative investment? Second, why do some firms divest more than others, i.e., what are the determinants of the amount of negative investment among divesting firms? To answer these questions, random-effects probit and tobit models are respectively estimated.

We find that negative investment by private firms is mainly due to external financial constraints: they need to obtain funds in order to survive and grow. State-owned enterprises (SOEs) divest mainly for inefficiency or restructuring reasons: they need to eliminate obsolete capital in the face of rising competition or other pressures to become efficient. The fact that firms are growing fast offsets both of these incentives for negative investment, particularly so in the case of the - most dynamic - private and foreign firms.

The remainder of the paper is organized as follows. Section 2 briefly reviews the relevant theories and empirical evidence on negative investment. Section 3 describes China's institutional context, and Section 4 specifies and explains the hypotheses that we test. Section 5 sets out our baseline specifications and empirical methodology. Section 6 describes our data and sample, and presents some descriptive statistics. Section 7 reports and interprets the estimation results of both our random-effects probit and tobit models. Section 8 provides a number of robustness tests for each hypothesis. Section 9 draws conclusions.

2. Literature review

Compared with the enormous literature on positive investment by firms, negative investment (or divestment) is under-researched. Moreover, the negative investment literature focuses largely on developed countries characterized by mature financial markets. According to Gadad *et al*. (2004), divestment can take many forms: sell-off, spin-off, equity carve-out, and management buyout[1]. Given that most firms in our sample are not listed in the stock market, our survey focuses on the first form of divestment, the sell-off.

The finance literature has identified several reasons for negative investment, among which the following five are most prominent: the *financing* explanation, whereby divestment can raise capital without recourse to the capital market; the *efficiency* explanation, whereby assets are transferred to firms which can operate them more productively; the *focus* explanation, according to which divestment may permit concentration on core activities; the *liquidity* explanation, which stresses the need for assets to be liquid if divestment is to occur; and the *defensive restructuring* explanation, according to which asset divestment is a response to rapid economic transition. This explanation may well be intertwined with the financing explanation. Each of these hypotheses is potentially important for understanding

[1] A sell-off occurs when a firm sells a part of its assets to another firm. A spin-off takes place when ownership of the divested asset is transferred to a new company formed by a pro-rata distribution of equity shares in the new company to current shareholders. An equity carve-out occurs when ownership of the divested assets is transferred to a new company formed by the issue of equity shares in the new company to the public. A management buyout means that the incumbent management team buys all the equity shares of either a firm or a subsidiary from current shareholders.

the coexistence of widespread negative investment and huge positive investment among Chinese firms.

2.1 The financing explanation

Shleifer and Vishny (1992) link asset sales to the firm's debt capacity. They argue that selling assets can be more attractive and cheaper than debt rescheduling and issuing new securities as a way of raising funds to meet debt obligations. Asset sales can reduce conflicts between creditors, control agency costs, and alleviate the problem of informational asymmetry between the firm and outsiders. However, the process may be hindered if assets are illiquid.

Lang *et al*. (1995) argue that managers may sell assets to obtain funds when alternative funding is either more expensive or unavailable. Highly-leveraged or poorly-performing firms may find it expensive to use capital markets owing to adverse selection costs (Myers and Majluf, 1984) or agency costs of managerial discretion (Jensen, 1988; Stulz, 1990). Based on a sample of US asset sales, Lang *et al.* (1995) find that firms selling assets are characterized by high leverage or poor performance. The typical firm selling assets appears to be motivated by its financial situation.

Using a US dataset, Hovakimian and Titman (2006) examine the relationship between proceeds from voluntary asset sales and investment expenditure. Their regressions show that cash obtained from asset sales is an important determinant of corporate investment and that the sensitivity of investment to proceeds from asset sales is significantly stronger for firms that are likely to be financially constrained. Thus, funds from voluntary divestment provide an important financing source for financially constrained firms.

2.2 The efficiency explanation

Hite *et al*. (1987) argue that managers retain only assets for which they have a comparative advantage, and that they sell assets if another party can manage them more efficiently. Investigating cases for both partial or total sell-offs in the US[2], they find that asset sales are associated with the movement of resources to higher-valued uses and that sellers capture some of the resulting gains.

Using a US firm-level database, Maksimovic and Phillips (2001) analyze the market for corporate assets (plants, divisions, and whole firms) in manufacturing industries and examine how seller characteristics and firm organization influence asset sales. They find that

[2] A partial sell-off is the sale of a subsidiary, division, or other operating assets; a total sell-off (or liquidation) occurs when a firm sells all its assets.

assets are more likely to be sold when they are less productive than their industry benchmarks, when the selling division is less productive, when the selling firm has more productive divisions in other industries, and when the economy is undergoing positive demand shocks. The timing of sales and the pattern of efficiency gains suggest that divestments tend to improve the allocation of resources.

Warusawitharana (2008) presents a model in which asset sales and purchases enable the transfer of capital from less to more productive firms. His empirical analysis concludes that both return on assets and firm size influence asset transactions, i.e., more profitable firms purchase assets whereas less profitable firms choose to downsize and sell assets, and large firms engage more than small firms in asset transactions.

2.3 The focus explanation

Berger and Ofek (1995) adopt segment-level US data to estimate the valuation effect of diversification and to examine the potential sources of value gains or losses. They find that the value of diversified firms is on average about 14% lower than the sum of the imputed values of their segments, implying that diversification reduces value. Overinvestment is associated with diversification, and segments of diversified firms overinvest more than single-line firms. Reducing diversification by selling assets may help to increase focus, thus reducing overinvestment, and increasing efficiency.

John and Ofek (1995) also emphasize focus as a motive for divestment: selling an unrelated asset leads to an increase in focus and to more efficient operation of the core business. The improvement in performance may have various causes, including elimination of negative synergies and better allocation of management time and other resources. Using a US sample, they find that asset sales improve the performance of the remaining assets in each of the three years following the asset sale, but only if the firm increases focus. The results support their hypothesis that divestment may be undertaken to achieve a more focused operation.

2.4 The liquidity explanation

Schlingemann *et al*. (2002) emphasize the role of asset liquidity in determining which assets are divested in the pursuit of firm objectives. They argue that more liquid assets are more likely to be divested. They control for the factors that initiate the divestment process by examining only firms that cut out segments with the aim of achieving a more focused operation. The probability that a segment is divested is found to be higher if the asset is in an

industry with a liquid market for assets[3]. Their empirical findings are in line with the theoretical prediction of Shleifer and Vishny (1992), according to which asset illiquidity impedes asset sales and worsens firms' financial situation.

2.5 The defensive restructuring explanation

Negative investment can arise for different reasons in transition economies. Asset divestment can be forced on a firm when its survival is threatened. According to Carlin *et al*. (2001), divestment may indicate restructuring and downsizing by firms that have difficulties in adapting to a new market environment. Using a World Bank survey covering 25 transition countries, they examine the determinants of firm restructuring and performance. They find that SOEs and old firms are significantly more likely to engage in defensive restructuring through labor shedding and plant closures, and that firms with market power are less likely to do so.

This defensive restructuring argument is closely linked to the financing explanation for divestment. Using a survey of large private Hungarian and Polish companies, Filatotchev *et al*. (2007) investigate managers' choice of financing sources. They hypothesize that divestment may be a means of raising funds if firms become financially distressed during economic transition. Yet, they find a negative relationship between divestment and bank finance. Their interpretation is that if firms are undergoing restructuring and seeking access to fresh finance, funders may view divestment as a negative signal and thus a deterrent to lending.

2.6 Summary

In brief, the literature provides various motivations for firms to divest. Asset sales may permit financially constrained firms to raise capital if debt and equity markets are unattractive or unavailable. In addition, asset sales may enable financially healthy firms to restructure and to improve efficiency by selling assets to more productive users or by selling assets unrelated to the core business. Asset liquidity plays a role in determining which assets are divested. Finally, in transition economies, asset divestment may assist defensive restructuring or relieve financial constraints.

[3] Schlingemann *et al*. (2002) measure the liquidity of an industry by taking the ratio of the value of the industry's corporate transactions to the value of the industry's total assets.

3. China's institutional context

Our hypotheses must take into account the Chinese context. China had a centrally planned economy until economic reform began in 1978. The reform process has been described by Deng Xiaoping as 'crossing the river by groping for the stones'. The reforms were incremental but hardly slow: huge changes have occurred in only three decades, as China has moved towards a market economy.

A distinguishing feature of China's institutional reform is the emergence of new forms of ownership. The Chinese industrial sector was initially dominated by SOEs, whose directive was to fulfil production quotas, to transfer profits to government, and to provide life-long employment. In the 1980s and early 1990s, the collectively-owned 'township and village enterprise' (TVE) sector grew rapidly and played a catalytic role in pushing China towards a market economy. Unlike SOEs, TVEs faced relatively harder budget constraints, so generating profit incentives. The entry of TVEs also provided competition for SOEs. However, when restrictions on the private sector were gradually relaxed and when the urban reforms created more incentives for SOEs to seek out profitable opportunities and to compete successfully against them, TVEs began to lose their ground; after the mid-1990s, many were transformed into private businesses.

Deng Xiaoping's 'southern tour' of 1992 formally gave the green light to capitalist development. The Company Law adopted in 1994 provided a uniform legal framework into which all of the ownership forms fit, signalling the introduction of more clearly defined property rights and the start of the dramatic institutional change involved in the rapid downsizing of the state sector. Many SOEs and urban collective enterprises (UCEs) were shut down, and employment in SOEs and UCEs shrank by over 40 percent and 75 percent respectively between 1995 and 2006 (China Statistical Yearbook, 2007: 128). A large number of SOEs and UCEs were either privatized or turned into shareholding entities that are increasingly dominated by private owners (Lin and Zhu, 2001; Garnaut *et al*., 2005). However, SOEs remain dominant in energy, natural resources and a few strategic or monopolistic sectors that are controlled and protected by central and local governments.

Figure 1 shows the shares of firms owned by different agents in investment in fixed assets over the period 1980-2008. SOEs accounted for the bulk of fixed investment until the early 1990s, after which the structure of investment altered dramatically. Between 1992 and 2008, the investment share of SOEs fell from two-thirds to one-third, whereas the share of private enterprises climbed to two-thirds. This has been viewed as a positive development,

given that the average return on capital in SOEs was well below that in the private sector and many SOEs continued to make losses (Dougherty and Herd, 2005; Knight and Ding, 2010). There is evidence that the profitability of the state sector improved after 1998: the measures taken from the mid-1990s onwards to make SOEs more accountable for their profits and losses seem to have been effective (Lu *et al*., 2008; Knight and Ding, 2010). Although still less efficient than non-state firms, the SOEs that survived the massive downsizing and reform are assumed to be more efficient and profitable on average.

Another important dimension of China's institutional context is its financial system, which is inefficient and 'repressed'. The government has intervened, and continues to intervene, in bank lending to favor the state sector (Riedel *et al*., 2007). Despite the gradual reform of the banking sector, bank loans constitute a major share of investment financing only for SOEs, while private firms are generally discriminated against by the formal financial system and have to rely predominantly on internal funds for investment (Allen *et al*., 2005; Guariglia *et al*., 2011; Knight and Ding, 2010). Although these problems have become less severe since 2000 (Guariglia and Poncet, 2008), private investment has remained constrained (Haggard and Huang, 2008).

4. Development of hypotheses

According to our first hypothesis (the *financing* hypothesis), given the inefficient nature of the Chinese financial system, some firms may need to divest in order to generate the funds required to pursue their objectives when other sources of finance are limited or costly. This hypothesis is likely to be particularly relevant to private firms, which are typically disciminated against by the banking sector. We test this hypothesis by examining the link between two financial variables (cash fow and leverage) and the probability of divestment and, if it occurs at all, the amount of divestment.

Models of capital market imperfections imply that external finance is more costly than internal finance (Myers, 1984; Hubbard, 1998). For given levels of investment opportunities, information costs, and market interest rates, firms with higher cash flow (or, more in general, higher net worth) should invest more, and therefore have a lower probability, or lower amount, of negative investment. We therefore expect to observe a negative relationship between cash flow and divestment.

Leverage can be seen as a measure of the amount of external finance used by the firm. High leverage might be interpreted as indicating high debt capacity or low external financial

constraints (Fazzari et al., 2000; Hovakimian, 2009)[4]. In these circumstances, we expect to observe a negative relationship between the probability or the amount of negative investment and leverage. This relationship should be stronger for private firms which have limited access to formal bank credit and may have to divest for financing purpose.

According to our second hypothesis (the *efficiency* hypothesis), firms may divest for efficiency reasons. This hypothesis is likely to be particularly relevant to SOEs compared to non-state firms, as the former are typically less efficient, and hence more likely to divest and downsize for efficiency reasons. We test this hypothesis by examining the link between firm productivity and divestment. We expect the relationship to be negative and larger in absolute value for SOEs.

A distinguishing feature of the Chinese economy is its rapid growth: the growth rate of GDP per capita averaged 8.6% per annum over the three decades of economic reform. Moreover, the growth of real sales in our sample averaged 11.6% per annum over the period 2000-2007. This remarkable growth performance creates vast opportunities for investment. In the investment literature, Blomström *et al*. (1996) argue that growth induces subsequent capital formation more than capital formation induces subsequent growth. Thus, our third hypothesis (the *growth* hypothesis) predicts a negative relationship between growth and negative investment. We expect the effect to be greater for non-state firms than for SOEs given the widespread evidence that the former are much more dynamic than the latter. The role of firm growth has not been explored in the literature on negative investment.

In summary, to understand why Chinese firms divest, we investigate how firm financing, efficiency, and growth influence negative investment within each ownership group. Our lack of segment-level data prevents an assessment of the focus and liquidity explanations for divestment.

5. Baseline specification and estimation methodology

5.1 Baseline specification

In order to test our hypotheses, we start by estimating the following regression:

[4] Other authors consider high leverage as an indicator of a firm's poor financial health (Lang et al., 1995; Kaplan and Zingales, 1997). We believe that this interpretation is less likely to hold in the Chinese context, where, especially for private firms, it is particularly difficult for to obtain bank loans.

$$divestment_{i,t} = \alpha_0 + \alpha_1 cash\ flow_{i,t-1} + \alpha_2 leverage_{i,t-1} + \alpha_3 TFP_{i,t-1} + \alpha_4 sales\ growth_{i,t-1} + \alpha_5 firm\ size_{i,t-1} + \alpha_6 firm\ age_{i,t} + \alpha_7 tangibility_{i,t-1} + \alpha_8 export_{i,t} + v_t + v_j + v_{tj} + \varepsilon_{i,t}\ , \quad (1)$$

where the dependent variable represents divestment. Unlike other studies in the literature, our dataset does not contain any information on asset sales. We therefore follow Liu and Siu (2011) and define investment at year t (I_t) as the book value of tangible fixed assets at time t (K_t) minus the book value of tangible fixed assets at time $t-1$ (K_{t-1}) plus depreciation at time t (Dep_t), i.e. $I_t = K_t - K_{t-1} + Dep_t$[5]. Negative investment or divestment occurs when $I_t < 0$.

When testing for the probability of negative investment, the dependent variable is a binary variable taking value of one if the firm divests, and zero otherwise. When examining the determinants of the amount of negative investment, the dependent variable is a censored variable which is equal to zero if the firm does not divest, and takes the value of the actual amount divested otherwise.

The independent variables in equation (1) include proxies aimed at testing the financing, efficiency, and growth hypotheses, as well as some control variables. Specifically, $cash\ flow_{i,t-1}$ and $leverage_{i,t-1}$ are included to test for the financing hypothesis. $cash\ flow_{i,t-1}$, is the lagged cash flow to tangible fixed assets ratio. It is included as a proxy for changes in net worth. It should be noted that cash flow is an imperfect proxy for changes in net worth, as it might also contain information about expected future profitability or, more in general, demand factors, which may be relevant to investment decisions even in the absence of capital market imperfections. Thus the finding of a significant coefficient on cash flow cannot be interpreted as necessarily indicating financial constraints (Cummins *et al*., 2006; Kaplan and Zingales, 1997; 2000). This is especially the case when investment opportunities are omitted or mis-measured by standard measures such as Tobin's *Q* (Bond *et al*., 2003; Carpenter and Guariglia, 2008). To deal with this problem, we follow Brown and Peterson (2009), Brown *et al.* (2009), Duchin *et al*. (2010), and Guariglia *et al*. (2011) and include in our model time dummies interacted with industry dummies to capture investment opportunities or, more specifically, time-varying demand shocks at the industry level [6].

[5] Definitions of all variables are presented in Table A1 in Appendix 1.

[6] As most of the firms in our dataset are unlisted, we are unable to include Tobin's *Q* in our model. However, our baseline model includes sales growth among the explanatory variables, which can be seen as an alternative measure of investment opportunities (Guariglia *et al.*, 2011). Our inclusion of both sales growth and industry-specific time dummies should ensure that investment opportunities are properly accounted for.

The second financial variable included in equation (1), $leverage_{i,t-1}$, is the lagged ratio of total debt over total assets. Both financial variables are lagged once to alleviate the potential endogeneity problem in the divestment regressions. According to the financing hypothesis formulated in section 4, we expect that $\alpha_1<0$ and $\alpha_2<0$.

To test the efficiency hypothesis, we compute firm-level total factor productivity ($TFP_{i,t-1}$) using the Levinsohn and Petrin (2003) method[7]. Similar to the two financing variables, we lag our TFP measure once. According to the efficiency hypothesis, we expect that $\alpha_3<0$. $sales\ growth_{i,t-1}$ is a proxy for the output growth of the firm, and is used to test for the growth hypothesis, which suggests that $\alpha_4<0$.

As for the control variables, we include firm size, firm age, the asset tangibility ratio, and an export dummy in our baseline model. $firm\ size_{i,t-1}$ is defined as the lagged value of the natural logarithm of real total assets. It can be important in explaining financing choices for corporate investment. According to Myers and Majluf (1984), size may serve as an inverse proxy for the extent of informational asymmetries between the firm's insiders and external finance providers: smaller firms are expected to face higher hurdles when raising external capital, whereas large firms, which are assumed to be more diversified and less prone to bankruptcy, can borrow more easily. We predict that firm size does not play an important role in SOEs' divestment decisions owing to their soft budget constraints, but might be important for non-state firms.

Firm age may also serve as a proxy for the wedge between the costs of external and internal capital (Oliner and Rudebusch, 1992). Moreover, younger firms are more likely to face problems of asymmetric information and may therefore be more financially constrained compared to their older counterparts. On the other hand, younger firms are generally more dynamic and efficient than old ones. In the Chinese context, old firms may be less efficient and more likely to divest for restructuring reasons, whereas younger firms may be more likely to divest for funding reasons.

$tangibility_{i,t-1}$ is defined as the lagged ratio of tangible fixed assets to total assets. Firms with higher asset tangibility are more likely to operate in less dynamic industries with

[7] A key issue in estimation is the correlation between unobservable productivity shocks and input levels. Profit-maximizing firms respond to positive shocks by expanding output, which requires additional inputs; and to negative shocks, by decreasing output and input usage. Olley and Pakes' (1996) estimator uses fixed investment as a proxy for these shocks. This could cause problems as any observation with zero or negative fixed investment would have to be dropped. Levinsohn and Petrin (2003), by contrast, introduce an estimator which uses intermediate inputs as proxies, arguing that these (which are generally positive) are likely to respond more smoothly to productivity shocks. See Appendix 2 for details on how exactly we calculate TFP.

lower growth potential (Hovakimian, 2009). We therefore expect to observe a positive relationship between asset tangibility and divestment.

We use an export dummy to capture the expected performance-enhancing effects of export activities among Chinese firms. Consistent with widespread evidence that efficiency and exports are positively correlated in China (Kraay, 1999; Park *et al*., 2010), we expect that firms conducting export business are more likely not to divest or to divest less.

Lastly, we include time dummies (v_t) to account for macroeconomic fluctuations or business cycle effects, industry dummies (v_j) to capture industry-specific effects, and the interactions of time and industry dummies (v_{tj}) to account for industry-specific shifts in investment demand or expectations.

5.2 Estimation methodology

We first estimate a random-effects probit model to examine the factors that determine the probability of negative investment for each ownership group. We then use a random-effects tobit model to estimate the determinants of the amount of negative investment in the divesting firms[8].

To control for the potential endogeneity of our regressors, all variables except firm age and dummies are lagged once in our regression, the aim being to alleviate simultaneity bias. As a robustness test, we also estimate our equations using an Instrumental Variable (IV) approach.

6. Data and descriptive statistics

6.1 Data

Firm-level data offer several advantages for the study of investment or divestment behavior: the problem of aggregation over firms is eliminated in estimation, and the heterogeneity among various types of firms can be taken into account (Bond and Van Reenen, 2007). This is particularly important for China owing to the institutional differences between state and non-state enterprises.

We use data drawn from the annual accounting reports filed with the National Bureau of Statistics (NBS) by industrial firms over the period 2000-2007. The original sample contains more than 300,000 firms, including all SOEs and other types of enterprises with

[8] Our results were generally robust to using pooled probit and tobit estimators, controlling for unobserved heterogeneity by using cluster-robust standard errors, clustered by firm.

annual sales of five million yuan (about $750,000) or more. These firms operate in the manufacturing and mining sectors and are located in all 31 Chinese provinces or province-equivalent municipal cities. We deleted observations with negative sales; as well as observations with negative total assets minus total fixed assets; total assets minus liquid assets; and accumulated depreciation minus current depreciation. Firms that lacked complete records on our main regression variables were also dropped. To control for the potential influence of outliers, we excluded observations in the one percent tails of each of the regression variables. Finally, we removed all firms with fewer than five years of consecutive observations.

The NBS data contain a continuous measure of ownership, which is based on the fraction of paid-in-capital contributed by six different types of investors, namely the state; foreign investors (excluding those from Hong Kong, Macao, and Taiwan); investors from Hong Kong, Macao, and Taiwan[9]; legal entities[10]; individuals; and collective investors[11]. We group all foreign firms (from Hong Kong, Macao, Taiwan, and other parts of the world) into a single category (which are labeled *foreign*); and all firms owned by legal entities and individuals into a single category (labeled *private*)[12]. Thus our firms fall into four broad categories - state-owned, collective, private, and foreign - based on the shares of paid-in-capital contributed by the four types of investors each year.

As in Guariglia *et al*. (2011), we group firms according to the majority average ownership shares. For instance, if the average share of capital paid-in by private investors over the period 2000-2007 is greater than 50%, then the firm is classified as privately owned. Table A2 in Appendix 1 presents the distribution of observations by ownership. Our sample is dominated by private firms: 62% of firms are classified as privately-owned. SOEs, collective firms and foreign firms represent respectively 8%, 8% and 18% of our sample.

[9] The rationale for dividing foreign investors into those from Hong Kong, Macao, and Taiwan, and those from other parts of the world is that the former capture the so-called 'round-tripping' foreign direct investment, whereby domestic firms may register as foreign invested firms from nearby regions to take advantage of the benefits (such as tax and legal benefits) granted to foreign invested firms (Huang, 2003).

[10] Legal entities represent a mix of various domestic institutions, such as industrial enterprises, construction and real estate development companies, transportation and power companies, security companies, trust and investment companies, foundations and funds, banks, technology and research institutions etc.

[11] Collective firms are typically owned collectively by communities in urban or rural areas. The latter are known as township and village enterprises (TVEs).

[12] Within this category, firms owned by individuals represent about two thirds of the total. As firms owned by legal entities include firms owned by state legal entities, one could question their inclusion in the *private* category. One reason for including them is that while the state's primary interest is political (i.e. aimed at maintaining employment levels or control over certain strategic industries), legal entities are profit-oriented (Wei *et al*., 2005). Since our dataset does not allow us to discriminate between state and non-state legal entities, we are unable to exclude the former from our *private* category. However, our results were generally robust to excluding firms owned by legal entities from the *private* category.

Table A2 shows an interesting pattern of the evolution of ownership over the eight-year period. The proportion of SOEs in our sample declined dramatically, from 12% in 2000 to 5% in 2007. A similar pattern holds for collective firms, whose share declines from 11% to 7%. In contrast, the share of private firms climbed from 52% to 66%. The share of foreign firms remained roughly stable at between 17 and 19%. Privatization of small SOEs and TVEs became significant after 1998 (Haggard and Huang, 2008). Our dataset reflects the restructuring process involved in the shrinkage of the state and collective sectors and the expansion of the private sector.

Considering that the year 2000 is used to construct lagged variables, the final dataset that we use in estimation covers 63,069 (mainly unlisted) firms, which yield 270,691 firm-year observations over the period 2001-2007[13]. The sample is unbalanced: the structure of the panel can be seen in Table A3 in Appendix 1. The number of observations ranges from a minimum of 17,744 in 2001 to a maximum of 51,877 in 2005. Entry and exit of firms take place during our sample period: fewer than 30 percent of firms have the full 8-year accounting information. The active entry and exit of firms are the consequence of the enterprise restructuring that began in the mid-1990s, and can be viewed as a source of dynamism (see, for instance, Brandt *et al*., 2011).

6.2 Descriptive statistics

Table 1 presents descriptive statistics for some key variables. We focus this discussion on means. Fixed asset investment as a proportion of tangible fixed assets averages 8.8% in our sample. The investment rate is lowest for SOEs (2.5%) and highest for private firms (10%), followed by foreign firms (8.8%). The proportion of firms that have negative fixed asset investment is 32.1% for the full sample: it is highest for SOEs (43.4%) and lowest for foreign firms (29.7%) and private firms (31%). Negative investment is a widespread phenomenon among all types of firms in China. The high divestment in the case of SOEs suggests that there may be dramatic structural changes in this sector.

Turning to the financial variables included in our baseline model, SOEs have the lowest cash flow ratio (15.1%), and the highest leverage ratio (63.3%). In contrast, foreign firms have the highest cash flow ratio (41.2%) and the lowest leverage ratio (47.7%). The ratios of private firms lie between those of SOEs and foreign firms. The co-existence of high

[13] The NBS dataset does not allow separate identification of publicly listed companies. It is in fact difficult to track these companies as their legal identification numbers were changed as they went public (Liu and Xiao, 2004). Over the period considered, there were slightly more than 1,000 listed companies operating in the manufacturing and mining sectors. This amounts to less than 0.3% of the total number of firms in our sample.

leverage and low cash flow in the state sector is initial evidence in favor of easy credit and soft budget constraints enjoyed by SOEs. The descriptive statistics for collective firms are consistent with Naughton's (2007) view that, after reform and transformation, these firms operate effectively as private enterprises.

SOEs have the lowest TFP (3.1) and foreign firms the highest (5.0), followed by private firms (3.4) and then collective firms (3.2). It is apparent that SOEs remain the least efficient. SOEs also have the lowest rate of sales growth (3.8%), whereas private firms have the highest (11.2%). Foreign firms also have a high growth rate (8.4%). The growth rate of collective firms (7.2%) is higher than SOEs' but lower than that of private and foreign firms. Thus private and foreign firms are the faster growing groups, whereas SOEs are, relatively speaking, stagnating.

SOEs are generally older and larger than enterprises in the non-state sectors, and they have a higher asset tangibility ratio. Collective firms and SOEs are least involved in the exporting business: respectively only 14.8% and 16.1% of these firms export, compared to 72.9% and 29.5%, respectively for foreign and private firms.

In sum, the descriptive statistics show that over our sample period, SOEs were the least financially constrained, the least efficient, and the slowest growing. Given their easy access to credit, reflected in their high leverage ratio, the poor performance of SOEs reflects inefficiencies in capital allocation and a sluggish response to market forces. It is therefore not surprising to observe that SOEs had the highest negative investment rate. In contrast, private and foreign firms were the most profitable, efficient, and dynamic sectors. Collective firms had good financial performance but fewer growth opportunities. These differences make it plausible to hypothesize that firms owned by different agents divest for different reasons. In the sub-section that follows, we aim to test whether this is indeed the case.

7. Empirical results

7.1 Random-effects probit results

Table 2 reports random-effects probit estimates of our baseline model, estimated separately for SOEs, collective, private, and foreign firms. The cash flow coefficient is negative and significant for all four ownership groups, which accords with the financing hypothesis. Focusing on the marginal effects, a 10 percentage point drop in the cash flow ratio increases the probability of negative investment by 0.79 percentage points for SOEs, 0.55 percentage

points for collective firms, 0.38 percentage points for private firms, and 0.26 percentage points for foreign firms.

The leverage ratio displays an interesting pattern across ownership groups. Its coefficient is significantly positive for SOEs, significantly negative for private firms, and insignificant for collective and foreign firms. For SOEs, a 10 percentage point increase in the leverage ratio is associated with a 0.52 percentage point increase in the probability of divestment. Taking into account the fact that SOEs have the highest leverage ratio, this finding suggests that easy credit and soft budget constraints impair SOEs' investment capability. On the contrary, for private firms, the probability of having negative investment declines by 0.58 percentage points in the presence of a 10 percentage point rise in the leverage ratio. This supports the financing hypothesis. External finance does not affect the divestment decisions of collective and foreign firms, perhaps because of their links with local governments and international financial markets respectively, which may help them to obtain alternative sources of finance.

The firm-level TFP measure has a significantly negative coefficient for all ownership groups: firms are more likely to divest when they are less productive. This is in line with the efficiency hypothesis. The marginal effect is greatest for SOEs: a 10 percentage point increase in TFP reduces their probability of negative investment by 0.20 percentage points. The corresponding figures for collective, private, and foreign firms are 0.14, 0.11, and 0.06 percentage points, respectively. Owing to over-investment or mis-investment in the past, less productive SOEs have a higher incentive to divest in order to eliminate obsolete capital in the face of increasing competition and other incentives to make profits and avoid losses.

The growth rate of real sales significantly reduces the probability of divestment for all types of firms, with the largest marginal effects for private and foreign firms: in the presence of a 10 percentage point increase in sales growth, the probability of negative investment drops by 0.9 and 1.0 percentage points respectively for these two groups of firms. This supports our hypothesis that firm growth protects against negative investment. In their divestment decisions, private and foreign firms are more responsive to growth opportunities than state and collective firms.

Turning to the control variables, the coefficient on firm size is insignificant for the divestment decisions of SOEs and foreign firms, but it is significantly positive for collective and private firms. This is consistent with our prediction that their easy access to external finance insulates the divestment decisions of SOEs from the influences of firm size. A similar argument applies to foreign firms who may access external finance through their parent

companies (Manova et al., 2011). By contrast, smaller collective and private firms are more likely to exhibit higher financial flexibility than their larger couterparts (Chow and Fung, 2000), and are therefore less likely to divest.

The coefficient on firm age is positive and significant in the divestment regression for all firms. In China, firm age does not perform an efficient role in alleviating informational asymmetry, as it does in many developed financial markets. Instead, younger firms, being generally more dynamic and efficient, are less likely to divest.

Asset tangibility displays a positive and significant ciefficient for all firms: Hovakimian's (2009) argument that firms with lower asset tangibility are usually found to operate in industries with higher growth potential and are therefore less likely to divest is strongly supported.

The export dummy has a poorly determined coefficient for SOEs and collective firms but a significantly negative coefficient for private and foreign firms. The probability of negative investment declines when private and foreign firms have the opportunity to export. This is in line with the view of Park *et al.*'s (2010) argument that exporting is a cause of superior performance.

In summary, our random-effects probit results suggest that negative investment can be mainly explained by financial constraints in the case of private firms, and by inefficiency in the case of SOEs. Rapid growth of the firm counterweighs both effects for all types of firms. Moreover, a high probability of negative investment in the non-state sectors is associated with certain firm characteristics: being old, large, having a high asset tangibility ratio, and lacking access to overseas markets.

7.2 Random-effects tobit results

We next question which factors determine the amount of negative investment for those firms that actually divest. To answer this question, equation (1) is estimated using a random-effects tobit model. The results are shown in Table 3.

In line with the findings in the random-effects probit model, lower cash flow is associated with a higher level of negative investment for all firms. The leverage term is significantly negative for collective and private firms, but insignificant for SOEs and foreign firms. The largest effect is found for private firms: for these, a 10 percentage point decrease in the leverage ratio raises the amount of negative investment by 1.3 percentage points. The finding that lower levels of external finance produce more divestment confirms our hypothesis that the need for funds may explain divestment by private firms.

Once again, the coefficient of TFP is significantly negative for all firms, with the largest effect for SOEs: for these firms, a 10 percentage point decrease in TFP raises the amount of negative investment by 1.9 percentage points. This is consistent with our prediction that inefficiency is most important in explaining the massive divestment in the state sector.

The growth rate of sales also has a negative and significant coefficient for all firms: a higher sales growth is associated with less divestment. Larger marginal effects are found for private and foreign firms: a 10 percentage point rise in sales growth decreases the amount of negative investment by 1.2 and 1.4 percentage points respectively for these two groups of firms. This suggests that the growth hypothesis holds most for the fastest-growing firms.

Several additional factors affect the amount of negative investment of the non-state firms. For instance, older firms with higher asset tangibility, and those which do not export, tend to have more negative investment. Overall the findings are consistent with our random-effects probit results.

8. Robustness tests

8.1 Alternative tests of the hypotheses

To test the robustness of our results in the baseline model, we use some alternative measures of our main right-hand-side variables. We first introduce an alternative proxy for firms' net worth in place of cash flow. One important component of the cash flow measure is depreciation. However there is no consensus as to whether depreciation is a source of funds, i.e. whether depreciation is a source of capital replacement or just one of the adjustments needed to convert the accrual net income to the cash provided from operating activities. As a robustness check for the financing hypothesis, we therefore deduct deprecation from cash flow, which gives a measure of net profit, and replace the lagged cash flow to tangible fixed assets ratio in equation (1) with the lagged net income to tangible fixed assets ratio.

Next, in order to test the robustness of the efficiency hypothesis, we replace TFP with two widely-used alternative proxies for firm-level productivity. First, following McGuckin and Nguyen (1995) and Maksimovic and Phillips (2001), we calculate lagged value added per worker ($value\ added\ per\ worker_{i,t-1}$), which is defined as the lagged value of total real value added divided by the number of workers. Second, we construct lagged average labor productivity ($productivity_{i,t-1}$), which is given by lagged total real sales divided by number

of workers. Neither of these measures has the desirable theoretical properties of TFP, but they may have desirable statistical properties since they are not computed from a regression.

Lastly, to test the robustness of the growth hypothesis, we replace sales growth with three different measures of growth. The first is the growth rate of value added ($value\ added\ growth_{i,t-1}$). We are also interested in various sources of output growth, i.e., the rate of factor accumulation (proxied by the growth rates of total assets, $asset\ growth_{i,t-1}$, and of employment, $employment\ growth_{i,t-1}$), and the rate of improvement in firm productivity (the growth rate of TFP, $TFP\ growth_{i,t-1}$).

We present summary statistics of these new variables in Table 4. Focusing on means, the net profit ratio is lowest for SOEs (6.3%), whereas for all non-state sectors, it is above 24%. There is a sharp contrast in productivity between the state and non-state firms. SOEs have the lowest efficiency as measured by value added per worker and average labor productivity, and private and foreign firms are the most efficient. SOEs also have the lowest rates of all four growth measures, i.e. value added growth (-0.1%), total asset growth (0.8%), employment growth (-4.0%), and TFP growth (3.6%). On the other hand, private firms have the highest rates of value added growth (10.8%), total assets growth (9.7%), and TFP growth (8.9%). Foreign firms have the highest growth in employment (3.8%). In brief, these statistics confirm our previous findings that SOEs are the worst performers in terms of profitability, efficiency and growth, whereas private and foreign firms are the best performers.

Table 5 reports the random-effects probit estimation results for the models including these new variables. To save space, we only report the coefficients associated with the new variables. Net profit displays a very similar pattern to that of cash flow: for all firms, the probability of divestment declines as internal finance becomes abundant. Replacing cash flow with net profit does not change the features of the leverage term (not reported): excess leverage in the state sector still worsens firms' performance and increases the probability of negative investment, whereas, for private firms, limited access to external finance creates incentives for divestment.

The coefficient on value added per worker is significantly negative for SOEs, insignificant for collective firms, and significantly positive for private and foreign firms. This indicates, more clearly than in the baseline model that the efficiency explanation of negative investment holds only for the state sector: for SOEs, a 10 percentage point decline in value added per worker is associated with an increase in the probability of divestment by 0.23 percentage points. For private and foreign firms, the probability of negative investment increases as efficiency improves, implying that it is not because they are inefficient that they

divest. The use of average labor productivity tells the same story, except that collective firms also have a significantly positive coefficient. Thus these robustness tests not only confirm that the efficiency explanation applies to SOEs, but also provide evidence that it does not apply to non-state firms.

Growth of value added and TFP do not affect the divestment decisions of state and collective firms but reduce the probability of divestment by private and foreign firms. In the case of real asset growth and employment growth, the coefficient is significantly negative for all firms. Although there are minor differences according to the measure being used, our main finding of the growth explanation is robust: growth generally reduces the chances of negative investment, but tends to do so more for private and foreign firms than for state and collective firms.

We also find that the baseline results for the control variables are robust when alternative financing, efficiency, and growth measures are used. Finally, our results also hold when the random-effects tobit estimation method is employed. To save space we do not report these results.

8.2 Instrumental variable methods

Our method of lagging the right-hand-side variables once might not be sufficient to alleviate potential endogeneity. As a further robustness test, we therefore use the instrumental variable (IV) method to test our baseline model specification. We instrument all financing, efficiency, growth, asset tangibility, export, and firm size variables using their own values lagged twice. Both random-effects probit and tobit IV models are estimated. To save space, we only report the results of the former in Table 6.

The results relative to the variables representing our three hypotheses are generally consistent with those of our baseline model. One minor difference lies in the control variables of firm age and size. After being instrumented, the coefficient of firm size becomes significantly positive only for private firms, suggesting that firm size is not important in determining the divestment decisions of the other types of firms. A similar story holds for firm age, which is significant and positive only for private and foreign firms. These results strengthen our argument that the easy access of SOEs to external finance makes size and age irrelevant to their divestment decisions. Only in the private and foreign sectors are smaller and younger firms more likely to outperform their counterparts, and therefore less likely to divest. In brief, the instrumental variable results provide evidence that the baseline model findings are robust.

8.3 Interaction terms

This section aims at testing the possibility that the response of negative investment to changes in certain variables may be non-linear. For instance, we found that in the baseline model, the relationship between cash flow and divestment is negative for all firms. However, the effect might be different for firms with abundant and scarce cash flow. We test whether this is the case by estimating the following model:

$$\begin{aligned} divestment_{i,t} = \alpha_0 + \alpha_{11} cash\ flow_{i,t-1} * LOWCF_{i,t-1} + \alpha_{12} cash\ flow_{i,t-1} * HIGHCF_{i,t-1} \\ + \alpha_2 leverage_{i,t-1} + \alpha_3 TFP_{i,t-1} + \alpha_4 sales\ growth_{i,t-1} \\ + \alpha_5 firm\ size_{i,t-1} + \alpha_6 firm\ age_{i,t} + \alpha_7 tangibility_{i,t-1} + \alpha_8 export_{i,t} v_j + \\ + v_t + v_{tj} + \varepsilon_{i,t}\ , \end{aligned} \quad (2)$$

where $LOWCF_{i,t-1}$ ($HIGHCF_{i,t-1}$) is a dummy equal to 1 if firm i's cash flow at time $t-1$ is in the bottom (top) half of the distribution of the cash flow of all firms operating in the same industry as firm i in the same year, and 0 otherwise. Subsequently, we compute similar interaction terms for leverage, TFP, and sales growth to examine the differential effects of these variables on the divestment decisions of firms with low/high leverage, low/high TFP, and low/high sales growth, respectively.

Table 7 reports the random-effects probit estimation results of the models which include these interactions terms. To save space, we report only the results of the new interactions terms and a χ^2 test for the equality of the coefficients between each group of firms. We find that, *ceteris paribus,* the impact of cash flow on negative investment is greater for firms with lower cash flow, and the difference between low and high cash flow groups is significant for SOEs, collective, and private firms. For instance, in the private sector, a 10 percentage point decrease in the cash flow ratio increases the probability of negative investment by 1.66 percentage points for firms with scarce cash flow, but merely by 0.31 percentage points for firms with abundant cash flow. In other words, in the presence of a drop in cash flow, it is firms that do not have much cash flow to start with, which find it more necessary to divest. This provides additional evidence in favor of the financing hypothesis of negative investment.

A significant difference between lower and higher leverage groups is found only for private firms. For these, a decline in leverage is associated with a rise in the probability of negative investment, the effect being greater for firms with lower external borrowing: a 10

percentage point drop in leverage induces a rise in the probability of divestment by 0.87 percentage points for firms with limited access to external funds, and by 0.65 percentage points for those with higher borrowing capacity. On the contrary, the coefficient on leverage is positive and significant for SOEs with higher leverage ratio, but insignificant for those with lower leverage: the adverse impact of soft budget constraint is, understandably, more severe for the state firms with high leverage. This interesting contradiction, i.e. a larger negative effect for low-leverage private firms and a significantly positive effect for high-leverage state firms, further strengthens our conclusion that the financing explanation of divestment holds for private firms in general, more externally-financially-constrained private firms in particular; and that the easy access to external funds induces negative investment in the state sector.

TFP displays an interesting pattern between low and high TFP groups. For all ownership groups, the coefficient is negative and significant for firms with high TFP, and larger marginal effects are found for SOEs and collective firms than for private and foreign firms, suggesting that the former groups of firms are more likely to divest for efficiency reasons. Yet, among private and foreign firms, the coefficient of TFP is significantly positive for firms in the low TFP group: contrary to their counterparts with high TFP, private and foreign firms with low TFP do not divest for efficiency purposes.

Lastly, for all ownership groups, the impact of sales growth on divestment is greater for firms with high growth rates. Growth reduces the chances of negative investment, and this is particularly the case for firms with high growth rates. This result helps to explain why divestment is more sensitive to growth for foreign and private firms: these are the faster growing ownership groups.

9. Conclusion

To the best of our knowledge, this paper represents a first attempt to investigate firms' divestment behavior in China. The issue is of particular interest because it presents a puzzle: China is an international outlier on account of its high rate of industrial investment, but it is also characterized by a high frequency of negative investment in its industrial sector. We have tried to explain this puzzle using a large and comprehensive panel data set of industrial firms over the period 2000-2007.

Our descriptive statistics show dramatic structural changes over the decade, with the share of the state sector declining and that of the non-state sector expanding. SOEs remain the poor performers of the economy: they have the highest divestment rate, lowest profitability,

lowest efficiency, slowest growth rate, and the highest leverage rate. This suggests that the state sector has been cushioned by favorable access to credit and state subsidies. By contrast, the private and foreign sectors, which contain the most efficient, profitable, and fast-growing firms, have less access to the formal financial system. Collective firms exhibit good financial performance and improvements in productivity, but their growth prospects are not comparable to those of private and foreign firms.

Given this huge heterogeneity in firms owned by different agents, our study of divestment in China required separate analysis of the different ownership groups. We tested whether firms owned by different agents divest for different reasons. Our results support the hypothesis that private firms divest in order to raise capital, whereas negative investment by SOEs can be explained largely by inefficiency. Rapid economic growth counterweighs both effects, especially in the private and foreign sectors, which are the most dynamic.

Our findings have an important policy implication: the limited access to external finance of the non-state sector is the most likely source of negative investment for private firms. This suggests the need for further reform of the financial system, which has lagged behind most other economic reforms in China.

Our study suffers from a number of limitations. The dataset does not allow us to observe the exact timing and amount of asset sales or divestment by firms, making interpretations difficult. The extent to which our findings can be generalized to all sectors of the Chinese economy may also be questioned, due to the fact that only manufacturing and mining enterprises are covered in the NBS dataset. Ideally, future research should be extended to those less mature, faster growing sectors of the economy such as the dynamic service sector, which have fuelled China's economic growth over the last few years. Finally, the lack of segment-level data makes it impossible to test hypotheses of divestment such as the focus hypothesis and liquidity hypothesis, which may also be important in determining firms' divestment behavior.

Appendix 1: Data

Table A1 provides definitions of all variables used in the paper. Table A2 presents the distribution of observations by ownership over time. Table A3 describes the structure of our panel.

Appendix 2: Procedure to construct TFP

A key issue in the estimation of production functions is the correlation between unobservable productivity shocks and input levels (Levinsohn and Petrin, 2003). Profit-maximizing firms respond to positive productivity shocks by expanding output, which requires additional inputs. Negative shocks lead firms to pare back output, decreasing their input usage. Methods that ignore this endogeneity, such as OLS and the fixed-effects estimator, will provide inconsistent estimates of the parameters of the production function. In this paper, we follow the approach by Levinsohn and Petrin (2003), which uses intermediate inputs as a proxy for unobservable shocks. We assume a simple two-factor production function of the form:

$$Y_{it} = A_{it} L_{it}^{\beta} K_{it}^{\gamma} \quad , \qquad \text{(A1)}$$

where Y_{it} is a measure of output such as gross revenue or value added, and L_{it} and K_{it} represent the usage of labor and capital, respectively. A_{it} is total factor productivity (TFP) which increases all factors' marginal products simultaneously. Transforming equation (A1) into logarithms allows linear estimation. The production function then takes the following form, where small letters denote logarithms:

$$y_{it} = \beta . l_{it} + \gamma . k_{it} + u_{it} \, . \qquad \text{(A2)}$$

The residual of this equation is the logarithm of plant-specific TFP, namely A_{it}.The simultaneity problem is that at least a part of TFP will be observed by the firm at a sufficiently early point in time to allow the firm to change the factor input decision. For any profit-maximizing firm, the realization of the error term of the production function is expected to influence the choice of factor inputs. To deal with the correlation between the regressors and the error term, Levinsohn and Petrin (2003) estimate the following production function:

$$y_{it} = \beta_0 + \beta_l . l_{it} + \beta_k . k_{it} + \beta_m . m_{it} + \omega_{it} + \eta_{it} \quad , \qquad \text{(A3)}$$

where y_{it} is the logarithm of the firm's output; l_{it} and m_{it} are the logarithms of the freely variable labor and intermediate inputs; and k_{it} is the logarithm of the state variable capital. The error term has two components: the transmitted productivity component given by ω_{it}, and an independent and identically-distributed component, which is uncorrelated with input choice, η_{it}. The key difference between ω_{it} and η_{it} is that the former is a state variable and hence impacts the firm's decision rules, while the latter has no impact on the firm's decisions. Demand for the intermediate input m_{it} is assumed to depend on the firm's state variables k_{it} and ω_{it}, i.e. $m_{it} = m_{it}(k_{it}, \omega_{it})$. Making mild assumptions about the firm's production technology, Levinsohn and Petrin (2003) show that this demand function is monotonically increasing in ω_{it}. This allows the inversion of the intermediate demand function, which leads

to: $\omega_{it} = \omega_{it}\,(k_{it}, m_{it})$. The unobservable productivity term is now expressed solely as a function of two observed inputs. In addition, Levinsohn and Petrin (2003) assume that productivity is governed by a first-order Markov process, i.e. $\omega_{it} = E[\omega_{it}|\omega_{i,t-1}] + \varepsilon_{it}$, where ε_{it} is an innovation to productivity that is uncorrelated with k_{it}, but not necessarily with l_{it}. This is part of the source of the simultaneity problem. Equation (A3) can therefore be expressed as

$$y_{it} = \beta_l . l_{it} + \phi_t(k_{it}, m_{it}) + \eta_{it} \quad , \qquad \text{(A4)}$$

where $\phi_{it}(k_{it}, m_{it}) = \beta_0 + \beta_k . k_{it} + \beta_m . m_{it} + \omega_{it}(k_{it}, m_{it})$. Levinsohn and Petrin (2003) approximate $\phi_t(k_{it}, m_{it})$ by a third-order polynomial in k and m, $\sum_{j=0}^{3}\sum_{s}^{3} \delta_{js} k_{it}^{j}\, m_{it}^{s}$, and obtain an estimate of β_l and $\phi_t$via OLS. This constitutes the first stage of their estimation procedure.

In the second stage, the elasticity of capital β_k is defined as the solution to the following problem: $\min_{\beta_k^*} \sum_i \sum_t (y_{it} - \widehat{\beta_l} . l_{it} - \beta_k{}^* . k_{it} - \varpi_{it})^2$, where ϖ_{it} is a nonparametric approximation of $E[\omega_{it}|\omega_{i,t-1}]$. Since the estimator involves two stages, the calculation of the covariance matrix of the parameters is quite involved. Levinsohn and Petrin (2003) suggest therefore the use of a bootstrapping procedure to estimate standard errors. Once consistent estimates of the input elasticities are derived, the logarithm of productivity can be obtained as $\widehat{\omega_{it}} = y_{it} - \widehat{\beta_l} . l_{it} - \widehat{\beta_k} . k_{it}$. TFP estimates based on the Levinsohn and Petrin (2003) method can be obtained in STATA by using the *levpet* command.

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Table 1. Descriptive statistics of key variables

	Full sample	*SOEs*	*Collective firms*	*Private firms*	*Foreign firms*
Investment vs divestment					
fixed investment/tangible fixed assets	0.088	0.025	0.062	0.100	0.088
	(0.064)	(0.012)	(0.044)	(0.079)	(0.064)
negative investment ratio	0.321	0.434	0.355	0.310	0.297
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Independent variables in the baseline model					
cash flow	0.364	0.151	0.408	0.364	0.412
	(0.209)	(0.076)	(0.218)	(0.211)	(0.244)
leverage	0.572	0.633	0.591	0.598	0.477
	(0.584)	(0.645)	(0.602)	(0.616)	(0.472)
TFP	3.773	3.062	3.179	3.439	4.969
	(2.536)	(1.916)	(2.228)	(2.379)	(3.308)
sales growth	0.096	0.038	0.072	0.112	0.084
	(0.094)	(0.044)	(0.069)	(0.108)	(0.086)
Control variables in the baseline model					
firm size	5.544	5.879	5.236	5.370	5.951
	(5.432)	(5.917)	(5.151)	(5.237)	(5.888)
firm age	2.274	3.137	2.685	2.152	2.142
	(2.197)	(3.465)	(2.639)	(2.079)	(2.197)
tangibility	0.322	0.399	0.314	0.322	0.302
	(0.294)	(0.381)	(0.276)	(0.295)	(0.280)
export	0.377	0.161	0.148	0.295	0.729
	(0.000)	(0.000)	(0.000)	(0.000)	(1.000)
Observations	270,691	19,264	21,139	157,606	61,229

Notes: mean and median (in parentheses) values of each variable are reported. All variables are defined in Table A1 in Appendix 1.

Table 2. Baseline model -- random-effects probit estimation

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*
Independent variables				
$cash\ flow_{i,t-1}$	-0.221**	-0.156**	-0.114**	-0.081**
	(0.050)	(0.026)	(0.012)	(0.015)
	[-0.079]	[-0.055]	[-0.038]	[-0.026]
$leverage_{i,t-1}$	0.145**	-0.023	-0.175**	0.037
	(0.046)	(0.046)	(0.017)	(0.028)
	[0.052]		[-0.058]	
$TFP_{i,t-1}$	-0.057**	-0.039**	-0.032**	-0.019**
	(0.006)	(0.006)	(0.002)	(0.002)
	[-0.020]	[-0.014]	[-0.011]	[-0.006]
$sales\ growth_{i,t-1}$	-0.188**	-0.202**	-0.267**	-0.307**
	(0.027)	(0.028)	(0.009)	(0.016)
	[-0.067]	[-0.070]	[-0.089]	[-0.100]
Control variables				
$firm\ size_{i,t-1}$	-0.012	0.026**	0.012**	-0.008
	(0.010)	(0.012)	(0.004)	(0.007)
		[0.009]	[0.003]	
$firm\ age_{i,t}$	0.027**	0.032*	0.088**	0.171**
	(0.014)	(0.017)	(0.006)	(0.016)
	[0.010]	[0.011]	[0.029]	[0.055]
$tangibility_{i,t-1}$	0.931**	0.773**	0.890**	0.765**
	(0.062)	(0.063)	(0.023)	(0.042)
	[0.335]	[0.271]	[0.299]	[0.249]
$export_{i,t}$	-0.007	-0.038	-0.123**	-0.155**
	(0.030)	(0.029)	(0.009)	(0.014)
			[-0.041]	[-0.051]
Observations	19,264	21,139	157,606	61,229

Notes: the dependent variable is a binary variable which takes value of one if the firm divests, and zero otherwise. Heteroskedasticity-consistent standard errors are reported in parentheses. ** and * indicate significance at the 5 and 10 percent level respectively. Marginal effects are in square brackets for those variables that are statistically significant. Time dummies, industry dummies and their interactions are included in estimation but not reported. Also see Notes to Table 1.

Table 3. Baseline model -- random-effects tobit estimation

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*
Independent variables				
$cash\ flow_{i,t-1}$	-0.082**	-0.099**	-0.065**	-0.043**
	(0.018)	(0.014)	(0.006)	(0.008)
	[-0.082]	[-0.099]	[-0.065]	[-0.043]
$leverage_{i,t-1}$	0.016	-0.068**	-0.126**	0.013
	(0.017)	(0.025)	(0.010)	(0.015)
		[-0.068]	[-0.126]	
$TFP_{i,t-1}$	-0.019**	-0.018**	-0.017**	-0.010**
	(0.002)	(0.004)	(0.001)	(0.001)
	[-0.019]	[-0.018]	[-0.017]	[-0.010]
$sales\ growth_{i,t-1}$	-0.044**	-0.064**	-0.118**	-0.136**
	(0.010)	(0.017)	(0.007)	(0.011)
	[-0.044]	[-0.064]	[-0.118]	[-0.136]
Control variables				
$firm\ size_{i,t-1}$	-0.003	0.016**	0.008**	-0.015**
	(0.004)	(0.007)	(0.003)	(0.003)
		[0.016]	[0.008]	[-0.015]
$firm\ age_{i,t}$	0.003	0.013	0.044**	0.104**
	(0.005)	(0.009)	(0.003)	(0.009)
			[0.044]	[0.104]
$tangibility_{i,t-1}$	0.294**	0.450**	0.574**	0.481**
	(0.026)	(0.038)	(0.015)	(0.026)
	[0.294]	[0.450]	[0.574]	[0.481]
$export_{i,t}$	0.007	-0.005	-0.061**	-0.079**
	(0.012)	(0.018)	(0.005)	(0.008)
			[-0.061]	[-0.079]
Observations	19,264	21,139	157,606	61,229

Notes: the dependent variable is a censored variable which is equal to zero if the firm does not divest, and takes the value of the actual amount divested otherwise. Also see Notes to Tables 1 and 2.

Table 4. Descriptive statistics of alternative variables used in the robustness tests

	Full sample	*SOEs*	*Collective firms*	*Private firms*	*Foreign firms*
Financing variable					
net profit	0.238	0.063	0.283	0.244	0.261
	(0.086)	(0.009)	(0.092)	(0.095)	(0.100)
Efficiency variables					
value added per worker	0.777	0.477	0.692	0.781	0.882
	(0.471)	(0.277)	(0.415)	(0.494)	(0.498)
productivity	2.856	1.504	2.514	2.914	3.223
	(1.854)	(0.868)	(1.558)	(1.960)	(2.051)
Growth variables					
value added growth	0.089	-0.001	0.042	0.108	0.094
	(0.086)	(0.026)	(0.047)	(0.099)	(0.091)
asset growth	0.077	0.008	0.044	0.097	0.065
	(0.042)	(-0.005)	(0.014)	(0.058)	(0.041)
employment growth	0.015	-0.040	-0.012	0.017	0.038
	(0.000)	(-0.015)	(0.000)	(0.000)	(0.000)
TFP growth	0.079	0.036	0.049	0.089	0.082
	(0.073)	(0.044)	(0.051)	(0.081)	(0.074)
Observations	270,691	19,264	21,139	157,606	61,229

Notes: mean and median (in parentheses) values of each variable are reported. All variables are defined in Table A1 in Appendix 1.

Table 5. Robustness test: alternative measures of hypotheses (random-effects probit estimation)

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*
Alternative financing variable				
$net\ profit_{i,t-1}$	-0.190**	-0.109**	-0.071**	-0.057**
	(0.051)	(0.026)	(0.011)	(0.015)
	[-0.069]	[-0.038]	[-0.024]	[-0.018]
Observations	19,264	21,139	157,606	61,229
Alternative efficiency variables				
$value\ added\ per\ worker_{i,t-1}$	-0.065**	-0.003	0.018**	0.017**
	(0.017)	(0.015)	(0.004)	(0.006)
	[-0.023]		[0.006]	[0.005]
Observations	23,739	21,709	163,095	65,815
$productivity_{i,t-1}$	-0.015**	0.008*	0.013**	0.017**
	(0.006)	(0.005)	(0.002)	(0.002)
	[-0.005]	[0.003]	[0.004]	[0.006]
Observations	23,739	21,709	163,095	65,815
Alternative growth variables				
$value\ added\ growth_{i,t-1}$	-0.001	-0.022	-0.101**	-0.082**
	(0.016)	(0.019)	(0.007)	(0.010)
			[-0.034]	[-0.027]
Observations	16,468	18,968	148,823	55,385
$asset\ growth_{i,t-1}$	-0.457**	-0.171**	-0.318**	-0.268**
	(0.050)	(0.040)	(0.013)	(0.022)
	[-0.164]	[-0.059]	[-0.107]	[-0.087]
Observations	19,277	21,142	157,632	61,220
$employment\ growth_{i,t-1}$	-0.209**	-0.272**	-0.322**	-0.396**
	(0.042)	(0.037)	(0.012)	(0.021)
	[-0.076]	[-0.095]	[-0.107]	[-0.129]
Observations	19,246	21,127	157,550	61,183
$TFP\ growth_{i,t-1}$	0.005	-0.009	-0.068**	-0.050**
	(0.019)	(0.020)	(0.007)	(0.010)
			[-0.023]	[-0.017]
Observations	15,500	18,186	142,208	51,665

Notes: For each model, we only report the coefficients associated with the new variables to save space. Also see Notes to Tables 2 and 4.

Table 6. Robustness test: instrumental variable method (random-effects probit estimation)

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*
Independent variables				
$cash\ flow_{i,t-1}$	-0.344**	-0.183**	-0.147**	-0.135**
	(0.117)	(0.062)	(0.035)	(0.048)
	[-0.344]	[-0.183]	[-0.147]	[-0.135]
$leverage_{i,t-1}$	0.222**	-0.026	-0.214**	0.052
	(0.061)	(0.062)	(0.025)	(0.038)
	[0.222]		[-0.214]	
$TFP_{i,t-1}$	-0.073**	-0.048**	-0.038**	-0.020**
	(0.008)	(0.010)	(0.004)	(0.004)
	[-0.073]	[-0.048]	[-0.038]	[-0.020]
$sales\ growth_{i,t-1}$	-0.201**	-0.193**	-0.276**	-0.324**
	(0.038)	(0.034)	(0.012)	(0.022)
	[-0.201]	[-0.193]	[-0.276]	[-0.324]
Control variables				
$firm\ size_{i,t-1}$	0.012	0.029	0.025**	-0.005
	(0.014)	(0.018)	(0.007)	(0.011)
			[0.025]	
$firm\ age_{i,t}$	0.014	0.016	0.073**	0.138**
	(0.017)	(0.019)	(0.006)	(0.019)
			[0.073]	[0.138]
$tangibility_{i,t-1}$	0.806**	0.622**	0.604**	0.536**
	(0.091)	(0.086)	(0.039)	(0.075)
	[0.806]	[0.622]	[0.604]	[0.536]
$export_{i,t}$	-0.033	0.005	-0.131**	-0.155**
	(0.034)	(0.032)	(0.009)	(0.015)
			[-0.131]	[-0.155]
Wald test of exogeneity	89.67	25.80	357.96	67.02
	{0.000}	{0.000}	{0.000}	{0.000}
Observations	12,483	14,654	112,695	42,614

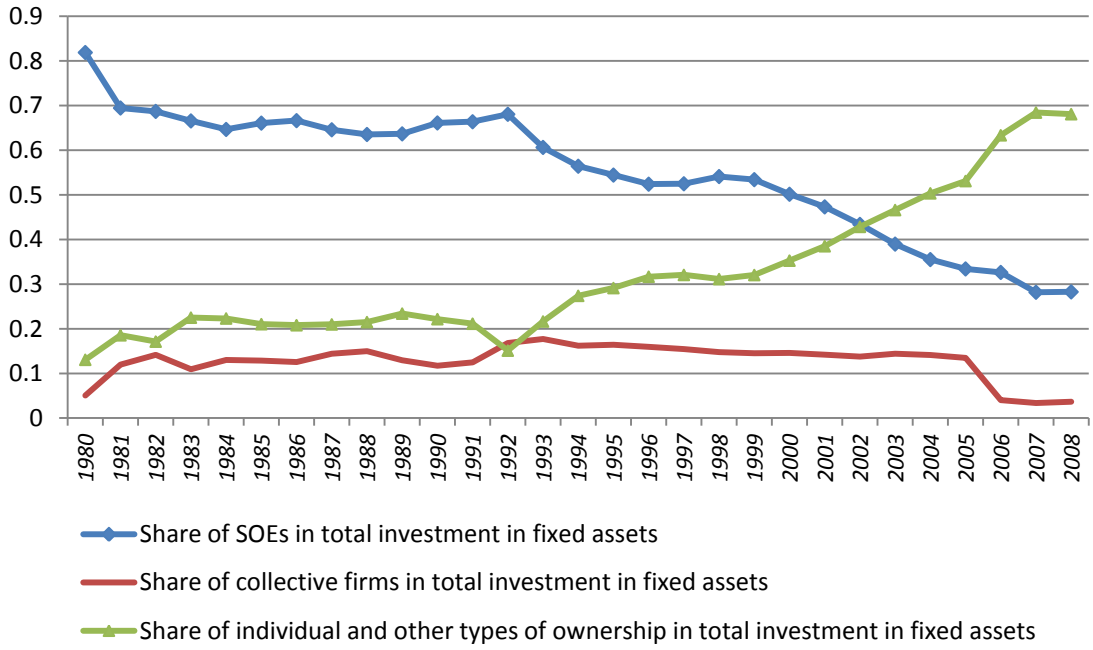
Notes: All financing, efficiency, growth, asset tangibility, export, and firm size variables are instrumented using their own values lagged twice. This explains the smaller number of observations in this Table compared to the previous ones. *p*-values of the Wald test of exogeneity of the instruments are shown in curly brackets. Also see Notes to Tables 1 and 2.

Table 7. Robustness test: interactions (random-effects probit estimation)

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*
Cash flow				
$cash\ flow_{i,t-1} * LOWCF_{i,t-1}$	-0.428**	-0.320**	-0.496**	-0.114**
	(0.084)	(0.074)	(0.035)	(0.029)
	[-0.154]	[-0.112]	[-0.166]	[-0.037]
$cash\ flow_{i,t-1} * HIGHCF_{i,t-1}$	-0.174**	-0.149**	-0.094**	-0.077**
	(0.051)	(0.026)	(0.011)	(0.016)
	[-0.063]	[-0.052]	[-0.031]	[-0.025]
χ^2 test for $H_0: \beta_1 = \beta_2$	8.84	6.27	155.57	1.81
	{0.003}	{0.012}	{0.000}	{0.178}
Leverage				
$leverage_{i,t-1} * LOWLEVERAGE_{i,t-1}$	0.082	-0.069	-0.260**	-0.034
	(0.079)	(0.071)	(0.026)	(0.039)
			[-0.087]	
$leverage_{i,t-1} * HIGHLEVERAGE_{i,t-1}$	0.127**	-0.035	-0.195**	0.032
	(0.049)	(0.048)	(0.018)	(0.028)
	[0.046]		[-0.065]	
χ^2 test for $H_0: \beta_1 = \beta_2$	0.95	0.71	19.11	6.71
	{0.329}	{0.401}	{0.000}	{0.010}
TFP				
$TFP_{i,t-1} * LOWTFP_{i,t-1}$	0.008	-0.002	0.017**	0.053**
	(0.010)	(0.011)	(0.004)	(0.005)
			[0.006]	[0.017]
$TFP_{i,t-1} * HIGHTFP_{i,t-1}$	-0.046**	-0.039**	-0.028**	-0.014**
	(0.006)	(0.006)	(0.002)	(0.002)
	[-0.016]	[-0.013]	[-0.009]	[-0.005]
χ^2 test for $H_0: \beta_1 = \beta_2$	45.00	20.85	226.20	218.97
	{0.000}	{0.000}	{0.000}	{0.000}
Sales growth				
$sale\ growth_{i,t-1} * LOWSALESGROWTH_{i,t-1}$	-0.129**	-0.121**	-0.104**	-0.170**
	(0.037)	(0.038)	(0.014)	(0.022)
	[-0.046]	[-0.042]	[-0.035]	[-0.055]
$sale\ growth_{i,t-1} * HIGHSALESGROWTH_{i,t-1}$	-0.263**	-0.286**	-0.407**	-0.436**
	(0.041)	(0.039)	(0.013)	(0.022)
	[-0.094]	[-0.100]	[-0.136]	[-0.142]
χ^2 test for $H_0: \beta_1 = \beta_2$	6.12	9.82	289.66	76.75
	{0.013}	{0.002}	{0.000}	{0.000}
Observations	19,264	21,139	157,606	61,229

Notes: $LOWX_{i,t}$ ($HIGHX_{i,t}$) is a dummy variable equal to 1 if firm *i*'s variable *X* at time *t* is in the bottom (top) half of the distribution of the *X*s of all firms operating in the same industry as firm *i* in year *t*, and 0 otherwise. For each model, we only report the coefficients associated with the new variables to save space. *p*-values of the χ^2 test for the hypothesis that the coefficients of the two variables are the same are in curly brackets. Also see Notes to Tables 1and 2.

Figure 1. Share of firms owned by different agents in total investment in fixed assets



Data source: NBS *Statistical Yearbook* (Various issues).
Note: individual firms include family firms and small private businesses; other types of ownership consist of joint-ownership enterprises, shareholding companies, joint-venture enterprises, and foreign firms.

Table A1. Variable definitions

Variables	*Definitions*
Dependent variable in the random-effects probit model	
Divestment	Binary variable which takes value of one if the firm divests at time *t* (I_t <0), and zero otherwise. I_t represents fixed investment at time *t* and is defined as the book value of tangible fixed assets at time *t* (K_t) minus the book value of tangible fixed assets at time *t*-1 (K_{t-1}) plus depreciation at time *t* (Dep_t), i.e. $I_t=K_t - K_{t-1}+Dep_t$.
Dependent variable in the random-effects tobit model	
Divestment	Censored variable equal to zero if the firm does not divest (I_t >=0), and equal to the actual amount divested, otherwise.
Independent variables (in both the baseline model and robustness tests)	
Financial variables	
cash flow	Ratio of cash flow (defined as the sum of the firm's net income and depreciation) to total tangible fixed assets.
Leverage	Ratio of total debt to total assets.
net profit	Ratio of net income to total tangible fixed assets.
Efficiency variables	
TFP	Total Factor Productivity calculated using the Levinsohn and Petrin (2003) method (see Appendix 2 for details on how this variable is calculated).
value added per worker	Ratio of real value added to number of employees.
Productivity	Average labor productivity: ratio of real sales to number of employees.
Growth variables	
sales growth	Growth rate of real sales
value added growth	Growth rate of real value added
asset growth	Growth rate of total real assets
employment growth	Growth rate of number of employees
TFP growth	Growth rate of TFP
Control variables	
firm size	Natural logarithm of the book value of total real assets (expressed in thousands of RMB *yuan*)
firm age	Natural logarithm of firm age
tangibility	Ratio of tangible fixed assets to total assets.
export	Dummy variable equal to one if the firm exports, and zero otherwise

Notes: all variables (except dummy variables) are deflated using provincial ex-factory producer price indices taken from various issues of the *China Statistical Yearbook*.

Table A2. Distribution of observations by ownership

	SOEs	*Collective firms*	*Private firms*	*Foreign firms*	*Mixed ownership*	*Total*
2000	11.80	11.06	52.04	19.49	5.61	100.00
2001	9.49	9.62	58.00	18.20	4.69	100.00
2002	8.65	8.90	60.89	17.23	4.33	100.00
2003	7.57	8.04	63.36	17.25	3.77	100.00
2004	7.36	7.83	63.56	17.53	3.71	100.00
2005	6.75	7.62	64.42	17.47	3.73	100.00
2006	6.27	7.21	65.18	17.69	3.65	100.00
2007	5.28	6.93	66.25	17.99	3.55	100.00
Average	7.62	8.20	62.42	17.75	4.02	100.00

Notes: all numbers in this table are in percentage terms. The ownership classification is based on the majority rule.

Table A3. Structure of the unbalanced panel used in estimation

Year	*Number of observations*	*Percent*	*Cumulative*
2001	17,744	6.56	6.56
2002	24,830	9.17	15.73
2003	35,178	13.00	28.72
2004	43,031	15.90	44.62
2005	51,877	19.16	63.78
2006	50,514	18.66	82.45
2007	47,517	17.55	100.00
Total	270,691	100.00	