Estimating Corporate Investment Inefficiency: Evidence from an Implied Return on Capital in China*

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This Draft: May 23, 2007

Abstract

In this paper we infer the return on capital from firms' actual capital expenditures and study how institutions affect corporate investment efficiency through an examination of various cross-sections of the inferred return on capital. We apply the Generalized Method of Moments (GMM) estimator derived from a structural investment model to a large sample of Chinese industrial firms. Based on the estimated structural parameters, we compute the stochastic discount rate perceived by managers to decide investment spending. We document robust evidence that ownership is the primary institutional factor affecting the firm-level return on capital in China. The results from our benchmark estimation show that return on capital for a non-state firm is approximately 10 percentage points higher than that of an otherwise similar state firm. We also find that privatization leads to improvement in corporate investment efficiency. Applying the same estimation to the universe of China's listed firms, we further identify that firms with better corporate governance have higher returns on capital. Our estimates show that redirecting the capital from less efficient state sector to more efficient private sector can unleash a 4.4% GDP growth in China every year, and that the deadweight loss due to capital mis-allocation is about 4% of China's GDP.

JEL Classification: G3; D21; O16
Keywords: Ownership, institutions and financial development, implied return on capital, investment Euler equation model, Chinese economy

*We thank Toni Whited for kindly sharing programming code and offering computation suggestions. We also thank Hongbin Cai, Qiang Kang, Hongbin Li, Wing Suen, Chenggang Xu, Charles Leung, Yong Wang and seminar participants at the University of Hong Kong, the Chinese University of Hong Kong, and the City University of Hong Kong for various useful comments, and Yong Wei for excellent research assistance. Financial supports from the University Grants Committee of the Hong Kong Special Administrative Region, China (Projects No. AOE/H-05/99 and HKU7474/06H) are gratefully acknowledged. All errors remain our own responsibility.

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Abstract

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1 Introduction

Much of the empirical work studying the effect of institutions and financial development on economic performance is based on cross-country studies (see, e.g., Acemoglu et al., 2001; Claessens and Laeven, 2003; Levine and Zervos, 1998; Rajan and Zingales, 1998; and Bekaert, Harvey, and Lundblad, 2005), and is likely subject to contamination due to country differences in accounting standards, taxation, and bankruptcy laws. The empirical findings based on cross-country studies also fail to account for obvious outliers such as China — the unprecedented economic growth over the past quarter century in China has been largely based on weak institutions and inefficient financial intermediation (Allen et al., 2005). In addition, a broader review of the literature reports that most studies on this subject use indirect approaches.[1] Direct empirical evidence at micro-level that maps out the dynamics between corporate investment efficiency and institution measures is scant, partly due to the difficulty in computing firm-level return on capital, and partly due to the difficulty in measuring institutions.

This study presents a new approach to estimate an investment-implied return on capital for a large sample of Chinese industrial firms. We then document the cross-sectional relation between the "implied" return on capital and measures of institutions and financial development, especially ownership. Our empirical strategy is built on a simple economic intuition that in equilibrium the managerial required rate of investment return should equal the discount rate (cost of capital) they perceive. The intuition can be more rigorously modeled in a firm's dynamic value optimization problem, with the resulting first-order condition labeled the investment Euler equation in the literature. The investment Euler equation describes the intertemporal substitution relation of investment spending at firm level, and has been tested in a variety of contexts.[2] In this paper, we apply the Generalized Method of Moments (GMM) estimations to the investment Euler equation models. Based on the estimated parameters, we infer the stochastic discount rate ("implied" return

[1] E.g., Demirguc-Kunt and Maksimovic (1998) document that the proportion of firms in countries that were growing fast than they could have using only internally generated funds is positively related to financial development and to legal system indicators; Rajan and Zingales (1998) use industry-level data to show that industries that require more external finance grow faster in more developed capital markets; Wurgler (2000) finds that financial development improves capital allocation by increasing the industry-level sensitivity of investment growth to value-added growth.

[2] A large literature has used either the Q-theory or the investment Euler equation model (the two are just different ways of expressing the first order conditions) to examine corporate investment behavior. Recent examples include Whited (1992); Gilchrist and Himmelberg (1999); Chirinko and Schaller (2004); Love (2003); and Whited and Wu (2006) among others. See Hubbard (1998) for a survey of the literature.

on capital) perceived by the managers to decide investment spending.

The "implied" return on capital derived from actual investment has several appealing features. First, this implied return on capital is derived from the actual capital expenditures, and reveals the managerial investment propensity — it is the required rate of return actually used by the manager to make investment decision. Second, the conventional methods rely on various asset pricing models to estimate return on capital or cost of capital (see e.g., Fama and French, 1997; Gebhardt et al., 2001). Those methods are subject to several potential problems: (1) difficulty in identifying the right models, and (2) imprecision in the estimates of factor loadings and in the estimates of risk premia. Furthermore, even though those methods generate precise estimates, they at best reflect the discount rate perceived by investors but not managers.[3] Our approach relies on a structural investment model but not asset pricing models, it is thus not subject to the criticism on using asset pricing models to estimate cost of capital. Third, using operating performance variables such as return on asset (ROA) or return on equity (ROE) to measure investment efficiency is also problematic. Operating results (e.g., net incomes) are subject to managerial manipulations especially in emerging markets like China, where many components of institutions are still missing and law enforcement is relatively weak (see e.g., Cai and Liu, 2007). Investment data and their "implied" returns on capital are arguably less subject to managerial discretion. Last but not least, our approach allows for the estimation of the "implied" return on capital for any firms with investment data available. It is not confined to publicly listed firms and also imposes minimal requirement for capital market information. The approach is thus more appropriate for research on emerging markets, where capital markets are under-developed and financial disclosures are less transparent.

This paper differs from pervious papers on corporate investment and institutions (i.e., Love, 2003; and Wurgler, 2000) in several aspects. First, we focus on a single country and use firm-level data, which allows us to construct a richer set of variables to examine the determinants of corporate investment and to better control the contamination due to cross-country differences. Second, we study China. China is an outlier in most cross-country studies of the relation between insinuations and economic performance. Investment in fixed assets, which amounts to nearly

[3]The gap between the two could be caused by various imperfections in the capital markets, such as information asymmetry, market irrationalities, and agency problems (See, e.g., Stein, 1996; and Chirinko and Schaller, 2004).

50% of China's GDP in recent years (see Table A1), has been the primary engine of China's economic growth. However, China's high investment rate, especially its ever-increasing pattern, has raised the concern that China might have over-invested. Deriving the firm-level return on capital from the actual investment data and mapping out their various cross-sections may help us better understand the concerns alike.[4] Third, China's rich institutional context also allow us to conduct various cross-sectional and time-series analysis. Although China has continued to build up institutional infrastructure since its economic reform and economic transition kicked off about a quarter century ago, significant disparities in institutional and financial development exist cross sectionally (e.g., state owned firms vs. privately owned firms; and coastal provinces vs. inland provinces). Meanwhile, the ongoing reforms in the corporate sector of China see improvements in institutions and governance among many Chinese firms, which makes possible the time-series analysis.

We mainly focus on how ownership affects corporate investment efficiency in this paper. All else equal, the investment–implied return on capital for state owned enterprises (SOEs hereafter) would be lower given SOEs' soft budget constraint nature, and preferential treatments received. We assume SOEs' "implied" return on capital to be r^{SOE}, and the "implied" return on capital for other types of firms to be r. We conjecture that in equilibrium, $r = r^{SOE} + \theta$, where θ reflects the premiums accrued to other types of firms, and is presumably larger than 0 due to two institutional factors: first, unlike SOEs, non-state firms are more likely to face market interest rate because they are not favored by state-dominated financial system. They thus tend to perceive a higher level of cost of capital and ask to a higher hurdle rate; and second, non-state firms, especially private firms, are exposed to more institutional risks, therefore require an external finance premium to compensate those additional risks.[5] Our empirical strategy thus centers on exploring the magnitude of θ, and examining its cross-sectional and time-series patterns.[6]

[4]Bai et al. (2006) estimate China's aggregate return to capital to average at 20% since 1998. Although their estimations challenge the view that China invests too much, using aggregate data cannot directly measure the extent of capital mis-allocation, and link investment inefficiency to institutional deficiencies. Song et al. (2006) use the same data as we use in this paper. They use operating variables such as ROE and ROA to measure investment efficiency. However, improvement in operating performance does not necessarily imply that the investment efficiency would improve, especially during China's reform era — China is going through a wave of corporate restructuring; total assets or book values of equities in the formula for ROA or ROE likely do not measure the actual operating invested capital.

[5]Love (2003) specifically examines this aspect but focuses her discussions on external financing constraints.

[6]We note that θ may also capture the distortions in investment due to factors other than institutional deficiencies, e.g., irrationality in managers, managerial agency problems, etc. However, those factors are likely to be individualistic

Using the actual corporate investment data retrieved from a well-maintained dataset developed by the National Bureau of Statistics of China (NBS) (for studies based on earlier editions of this database, see Bai et al. (2006); Jefferson and Su, 2005; Hu, Jefferson, and Qian, 2004; and Li, Yue, Zhao 2006, among many others), we apply the GMM estimation to a panel of 36,103 industrial firms over the period 2000 – 2005. Based on the estimated structural parameter values, we compute the "implied" return on capital at firm level. Our analysis yields several findings. First, we document robust evidence that the derived return on capital varies significantly across ownership identifications. In our benchmark estimation, returns on capital for private firms, Hong Kong and Taiwan invested firm (HK/TW firms), foreign firms, mixed firms, and collective firms are respectively 11.9, 9.5, 11.0, 9.1, and 10.4 percentage points higher than that of an average SOE.

The finding is intuitive. Because the state-dominated financial system in China favors the state sector and directs a disproportionate amount of bank lending to the state sector (see, e.g., Brandt and Li, 2003; and Boyreau-Debray and Wei, 2005); also because SOEs are afflicted with investment hunger (see Kornai, 1980; and Huang, 2003, among many others), SOEs managers perceive a relatively lower cost of capital and set a lower investment hurdle rate. The fact that the local governments integrate government activities and business activities further worsens the 'investment hunger problem', because local governments now also actively invest as entrepreneurs do. Managers of private firms however are more likely to perceive a higher cost of capital. Access to bank lending by private firms in China has been plagued by the standard asymmetric information problem, by the poor protection of private properties and the resulting lack of collateral, and by the discriminatory lending policies practiced by the state-dominated banks (Brandt and Li, 2003; and Gordon and Li, 2003). The private firms, in order to obtain external finance, have to either bear higher costs in the formal financial system or resort to alternative informal financing channels by accepting a much higher interest rate.[7]

We also find that our ownership results are robust after we control for industry effect and measures of regional institutional and financial development, indicating that ownership is the primary institution factor in China. Furthermore, we find that after SOEs have privatized — one common route of privatization in China is to change a firm's ownership status from SOE to

and tend to average out when we aggregate their impact across ownership identifications.

[7] Allen et al. (2005) argue that the alternative financing channels play a major role in the private sector's external financing in China.

mixed — they tend to improve their investment return on capital by about 12.7 percentage points.

Besides using the NBS data,[8] we apply the same GMM estimation to the universe of China's listed firms from 1999 to 2005. Although this panel only covers slightly over 600 industrial firms each year and these firms are arguably not representative enough, our estimation results based on the listed firms are largely consistent with those from the NBS data. In the benchmark estimation, all else equal, a state-control listed firm's implied return on capital is about 13.3 percentage points lower than that of other listed firms. We also find that firms with a larger fraction of outside board members, a larger percentage of shares held by the controlling shareholder, and with H– or B– shares traded by foreign investors tend to have a higher estimated return on capital. The results from the alternative population of firms confirm our earlier finding that improvement in institutions helps enhance corporate investment efficiency.

Unlike Bai et al. (2006) and Song et al. (2006), we do not intend to answer whether China might have invested too much in aggregate. We take the actual investment level as given, argue, and provide empirical evidence that the institutional distortions in China unavoidably lead to mis-allocation of financial sources. One novel feature of our study is that we are able to quantify the economic magnitude of capital mis-allocation due to institutional constraints and ineffective financial intermediation. Based on the structural parameter values estimated from our benchmark estimation, we find that if the part of finance directed to the less efficient state sector can be reallocated to the more efficient private sectors, or if the state sector can improve their investment efficiency to the level of private sectors, a 4.4% of GDP growth can be unleashed in China every year. Furthermore, we compute the welfare loss due to mis-allocation of capital resources in the Chinese economy. We find that various institutional distortions cause a deadweight loss of RMB 694.2 billion, which is about four percent of China's GDP in 2005.

The rest of the paper proceeds as follows. Section 2 discusses the institutional background in China and related literature, and then suggests three conjectures that describe the potential effect of China-specific institutions on corporate investment efficiency. Section 3 provides an investment model and discusses our estimation strategy. Section 4 presents data and variables used in our

[8] One may concern that the NBS data, based on which China's GDP is estimated, are potentially inaccurate. In addition, when implementing the GMM estimations, we have to delete from our sample the firms that have changed their ownership identifications during our sample period 2000-2005, which potentially introduces a certain selection bias.

empirical analysis. The effect of ownership on corporate investment efficiency is discussed in Section 5. We estimate the investment efficiency of privatized firms and listed firms in Section 6. Section 7 computes the costs of having weak institutions and a failing financial system in China. We conclude the paper in Section 8.

2 Institutional Background and Corporate Investment in China

China's striking economic growth in the past quarter century has been largely driven by fixed asset investments. Three distinct features characterize the fixed asset investments during China's reform era. First, due to a high gross domestic savings rate and success in attracting FDI, the rate of China's fixed asset investments has hovered at a high level. As shown in Table A1, fixed asset investment accounts for nearly 50% of China's GDP in recent years, which from time to time raises the concern that China might have invested too much and the economy is over-heating. Second, more than 50% of fixed asset investment concentrates in the state or quasi-state sectors (Table A.2), where productivity and investment efficiency are believed to be considerably low. Third, because the capital markets in China, including both the equity markets and corporate bond markets, are poorly developed, bank lending has been the main funding source of China's investment boom.

The excessive amount of capital allocated to the state sector results in widespread inefficiency among SOEs, reduced overall productivity of the economy,[9] and a large amount of non-performing loans. Prior literature has identified several sources of inefficiency in corporate investment, and attributes them to insufficient institutions and a low level of financial development. The foremost one is a state-dominated financial system that systematically allocates capital away from more productive sectors/regions towards less effective sectors/regions (see, e.g., Brandt and Li, 2003; Cull and Xu, 2003; Young, 2001; and Boyreau-Debray and Wei, 2005). Due to soft budget constraint, SOEs are afflicted with an "investment hunger" problem and are prone to overinvesting regardless of the market demand for their products (Kornai, 1980). Legally and financially, inefficient SOEs are favored at the expense of more efficient non-state sectors (Huang, 2003).

Second, during the reform era, China can be described as the *de facto* federalism. Local

[9]During the first half of the 1990s, about $3.30 of investment was needed to produce $1.00 of GDP gorwth. Since 2001, however, each $1.00 of growth has required $4.90 of new investment — 40% more than that amount required in South Korea or Japan during their higher-growth periods (Farrell et al. 2006).

governments at the provincial and lower levels have significant autonomy in economic matters (Qian and Xu, 1993). Local bureaucrats are assessed and promoted mainly based on the local economic growth, which primarily comes through investment. Returns generated by their investments help pay for social spending on everything from education to health care — costs that are now their responsibility. The provincial and regional officials thus have strong incentives to approve new projects to stimulate economic growth. A large number of such investments are the so-called "image" projects (projects undertaken by local governments to boost the local image) or "political achievement" projects (projects undertaken to boost local bureaucrats' scores on key performance indicators), and inherently suffer from dim earnings prospects. From time to time, the central government has to take a slew of measures (e.g., raising bank lending rate or bank reserve requirement, sometimes outright administrative methods) to put the brakes on the investment boom because of fears that overheated investment could lead to inflation and a pileup of bad loans.[10]

Despite numerous anecdotes and sound economic intuitions, it remains empirically difficult to map out the dynamic relations between corporate investment behavior and institutions and financial development in China. Towards this goal, we need to first of all quantify the investment inefficiency at the firm-level, and then plot out its distribution against variables measuring institutions and financial development. Previous studies have used several indirect approaches to unravel such dynamics.[11] In the Chinese context, Cull and Xu (2005) provide empirical evidence that access to external finance in the form of bank loans, expropriation risk, contract enforcement, and ownership structure are significant predictors of firm reinvestment in China.[12] However, to argue that institutions and financial development do enhance investment efficiency at micro-level requires identifying firms that "should" be growing, given their investment opportunities. Few in the literature attempt to control for the growth opportunities available for each firm or each industry at each point in time.

[10]A recent episode however highlights the difficulty the central government faces to control the runaway investment at provincial level. In August 2006, the governor of Inner Mongolia and his two lieutenants were publicly criticized by the State Council for disobeying the central government's call to slow down investment by allowing hundreds of millions of dollars of investments in coal-burning power plants. Such investments boost local economic growth but are also held accountable for the ever-worsening environmental problems in the northern part of China, several fatal accidents, and low efficiency (source: the Wall Street Journal - Asia Edition, August 18, 2006).

[11]See footnote 1 for examples.

[12]For research on how institutions affect corporate investment, also see Besley (1995); Johnson et al. (2002); and McMillan and Woodruff (2002).

We propose in this paper a new empirical approach and provide direct evidence of corporate investment inefficiency at micro-level. Using the actual corporate investment data obtained from the National Bureau of Statistics of China (NBS), we estimate the investment Euler equation models that characterize the Chinese firms' investment behavior to derive the effective discount rate "perceived" by firm managers in deciding investment spending. The "implied" cost of capital is similar to the managerial hurdle rate, and is potentially a function of variables measuring institutions and financial development.

The soft budget constraint afflicting SOEs and local governments acting as investment decision makers all suggest that the SOE managers tend to perceive lower cost of capital.[13] SOEs are favored by the state, and are less subject to regulation burdens, insecure properties rights, and credit constraints. SOEs' soft budget constraint nature and cheap capital fueled by the state-dominated banking system together reduce the cost of capital SOEs managers perceive. Using the notations we introduced earlier, r^{SOE} is a distorted reflection of the market price of capital and it tends to be lower than the market rate.[14]

Non-state sectors, on the contrary, are more likely to perceive a relatively higher cost of capital (implied return on capital), r. The gap between r^{SOE} and r, θ, could be caused by two institutional factors in China. First, unlike SOEs, non-state firms are more likely to face market interest rate because they are not favored by state-dominated financial system. Therefore, they tend to perceive a higher level of cost of capital. Second, non-state sectors, especially private firms, are exposed to more institutional risks, therefore require an external finance premium to compensate those additional risks, which further pushes up managerial hurdle rates. To sum up, we have:

Conjecture 1: The "implied" return on capital derived from the investment Euler equation model is the lowest among SOEs; but much higher for non-state firms such as collective firms, private firms, HK/TW firms, and foreign firms.

The sign and magnitude of the gap between r^{SOE} and r, θ, capture corporate investment inefficiency caused by institutional deficiencies. One may wonder how θ would change once the

[13] A large literature has also provided evidence that state ownership is less efficient than private ownership (see e.g., Shleifer, 1998; and Dewenter and Malatesta, 2001).

[14] Although China's central bank has now partially deregulated the interest rates by removing the interest rate ceiling on loans and the floor on deposits. The large banks still price most of their loans, at or slightly below, the government-set benchmark rate because they lack loan-pricing skills. Based on the consulting firm McKinsey & Company's estimate, most Chinese listed firms in 2005 paid interest rates ranging from 3.8% to 6.1% (source: Farrell, et al. 2006).

institutions concerning firms have been improved. The ongoing privatization wave in China provides with an opportunity to examine how changes in institutions affect corporate investment decisions. Converting SOEs to joint stock companies (mixed-ownership companies) has been the common practice of privatization in China. Such conversion takes many forms, and initial public offerings (IPOs) normally are the final stop of "the SOEs ownership reform". We expect that an SOE's investment efficiency could be improved after it changes its ownership status to mixed ownership. We conjecture:

Conjecture 2: The SOEs' "implied" return on capital tend to increase after they are privatized.

Finally, we conjecture that the product market competition plays a role as well. Firms in a more competitive market likely face a larger pressure from their rivals and thus are more cautious in making investment decisions. Given significant cross-region variations in institutions and financial development, we expect the "implied" return on capital to be higher for firms located in regions with better institutions and market-prone financial system.[15] A caution has to be taken here because both the competition level in a given industry and the regional institutional level in China are highly correlated with the presence of state ownership in that industry and region. Therefore, the impact of competition and regional development on "implied" return on capital may be camouflaged by the ownership effect. It remains an empirical question to test whether it is the case. To sum up, we conjecture:

Conjecture 3: The "implied" return on capital derived from the investment Euler equation model is higher for firms operating in a more competitive market; the "implied" return on capital is higher for firms located in regions with better institutions and a market-prone financial system.

3 Investment and Testing Framework

Throughout our empirical analysis, we use a structural investment model to derive the cost of capital (return on capital) "perceived" by managers when making optimal investment decisions. Our model follows closely the literature on the Q-theory and Euler equation models, and explicitly control for future growth opportunities. More importantly, our model provides a theoretical framework for

[15] Using the Italian data, Guiso, Sapienza, and Zingales (2004) document empirical evidence that *local* financial development enhances the probability an individual starts his own business, favors entry of new firms, increases competition, and promote growth. Local financial development is an important determinant of economic success of an area.

the identification of the "implied" return on capital, which enables us to test the conjectures in Section 2.

3.1 The Model

We construct a dynamic model of firm value optimization. We start with a standard partial-equilibrium investment model to examine the Chinese firms' investment behavior. Our derivation follows closely the specifications in Whited (1992), Gilchrist and Himmelberg (1999), Love (2003), and Whited and Wu (2006). Although both the Q-theory and Euler equation models of investment are derived from the same dynamic optimization problem (the two models are just different ways of rearranging the firs-order conditions), the assumptions required to estimate the Q-model are more stringent.[16] Therefore, we choose to use the investment Euler equation methodology to test the factors that affect a firm's effective discount rate (return on capital).

Here, firm managers maximize the present value of the firm, which is equal to the expected present value of future dividends subject to the capital accumulation and external financing constraints. The firm value is given by

$$V_{it} = \max_{(I_{it+s})_{s=0}^{\infty}} D_{it} + E_{it}[\sum_{s=1}^{\infty} \beta_{it+s-1} D_{it+s}] \tag{1}$$

subject to

$$D_{it} = \Pi(K_{it}, \zeta_{it}) - C(I_{it}, K_{it}) - I_{it}, \tag{2}$$

$$K_{it+1} = (1-\delta_i)K_{it} + I_{it}, \tag{3}$$

$$D_{it} \geq 0. \tag{4}$$

Here, V_{it} is the time t value of firm i. E_{it} is the expectations operator conditional on firm i's time t information; β_{it+s-1} is a discount factor from the period $t+s$ to period t; D_{it} is the dividend paid to

[16]The testing frameworks based on the Q-model methodology have recently been subject to extensive criticism due to several concerns. First, since it is virtually impossible to measure marginal Q, most studies use average Q, which only equals marginal Q under very restrictive assumptions such as perfect competition in factor and product markets, perfect capital markets, and constant return to scale in production technology (see Hayashi 1982). Second, observed stock market valuations — a component of Q — may diverge from the manager's valuation of the marginal return on capital, if the stock markets are not efficient. Third, if marginal Q is mis-measured, then the estimated coefficients cannot be properly interpreted. Specially, it is difficult to tell whether the estimated coefficients of effective stochastic discount factor reflect shocks to production opportunities or financing costs.

shareholders and is given according to the specification in Equation (2); K_{it} is the beginning of the period capital stock; I_{it} is the investment expenditure during the period t, and δ_i is the deprecation rate. $\Pi(K_{it}, \zeta_{it})$ is the firm's profit function, with $\Pi_K \geq 0$; and ζ_{it} is a shock to the profit function that follows a Markov process and that is observed by the firm at time t. The adjustment cost of investment is given by the function $C(I_{it}, K_{it})$, and is assumed to result in a loss of a portion of investment.

The frictions in financial markets are introduced via a nonnegativity constraint on dividends (see Equation (4)). Let λ_{it} be the Lagrange multiplier associated with (4). This multiplier equals the shadow cost associated with raising new equity, which implies that external (equity) financing is costly relative to internal finance.

The first order conditions to the above maximization problem are rearranged to obtain the Euler equation for K_{it}

$$1 + (\frac{\partial C}{\partial I})_{it} = \beta_{it} E_{it} \left[\Theta_{it} \left\{ (\frac{\partial \Pi}{\partial K})_{it+1} - (\frac{\partial C}{\partial K})_{it+1} + (1 - \delta_{it})(1 + (\frac{\partial C}{\partial I})_{it+1}) \right\} \right]. \tag{5}$$

Here $\frac{\partial C}{\partial I}$ is the marginal adjustment cost of investment, which we will specify later. $\frac{\partial \Pi}{\partial K}$ is the marginal profit of capital. $\Theta_{it} = (\frac{1+\lambda_{it+1}}{1+\lambda_{it}})$ is the relative shadow cost of external finance in periods t and t+1. Note that in perfect capital markets, $\lambda_{it} = \lambda_{it+1}$, and β_{it} serves as the only discount factor in the investment equation.

Equation (5) has a simple interpretation. The left side represents the marginal adjustment and purchasing costs of capital goods. The right side represents the expected discounted cost of waiting to invest tomorrow, which consists of the marginal product of capital and the marginal reduction in adjustment costs from an increment to the capital stock. Optimal investment implies that on the margin the firm must be indifferent between investing today and transferring those resources to tomorrow, as long as appropriate *discount rate* is identified to discount the payoff in the next period.

The firm's intertemporal allocation of investment depends on its effective discount factor, which is given by the product of β_{it} (the internal discount factor), and Θ_{it} (the discount factor associated with the external finance premium). Let $\Gamma_{it} = \beta_{it}\Theta_{it}$. Then Γ_{it} measures the effective discount factor facing firm i in period t. Suppose that the investment decision is optimal, then the cost of capital "implied" or "perceived" by the firm managers, r_{it}, is given by

$$r_{it} = \frac{1}{\Gamma_{it}} - 1 \tag{6}$$

In (6), a high level of Γ_{it} corresponds to a low level of cost of capital for firm i in period t and vice versa. When Γ_{it} (r_{it}) is low (high), the firm may defer investment to next period.

Γ_{it} can be viewed as the effective stochastic discount factor that guides the managers' investment decision. Similarly, r_{it} derived from (6) is the "perceived" cost of capital by managers that corresponds to an optimal investment decision. Although we argue that Γ_{it} corresponds to the effective discount factor at optimality, we do not assume away frictions causes by institutional distortions and poor financial development. Those distortions could be incorporated and reflected in the specifications of Γ_{it}, and can be tested empirically.

3.2 Estimation

To estimate the model we replace the expectation operator in (5) with an expectational error, e_{it+1}, where we assume that $E_{it}(e_{it+1}) = 0$ and $E_{it}(e_{it+1}) = \sigma_{it}^2$. The former condition implies that e_{it+1} is uncorrelated with any time t information, and the latter suggests that the error can be heteroscedastic. We thus rewrite Equation (5) as follows:

$$\Gamma_{it} \left\{ \Pi_K(K_{it+1}, \zeta_{it+1}) - C_K(I_{it+1}, K_{i,t+1}) - (1-\delta_{it})(1 + C_I(I_{it+1}, K_{it+1}) \right\} = 1 + C_I(I_{it}, K_{it}) + e_{it+1}. \tag{7}$$

To parameterize the marginal product of capital, we assume that firms are imperfectly competitive and set out price as a constant mark-up, μ, over marginal cost. In this case constant return to scale implies:

$$\Pi_k(K_{it}, \zeta_{it}) = \frac{Y_{it} - \mu VC_{it}}{K_{it}}, \tag{8}$$

where Y_{it} is output and VC_{it} is variable cost, which is defined as the sum of "costs of goods sold" and "selling, general, and administrative expenses".

We parameterize the investment adjustment cost function, $C(i_{it}, K_{it})$ as follows:

$$C(I_{it}, K_{it}) = (\alpha_0 + \sum_{m=2}^{M} \frac{1}{m}\alpha_m(\frac{I_{it}}{K_{it}})^m)K_{it}, \tag{9}$$

where $\alpha_m, m = 2, ..., M$ are coefficients to be estimated, and M is a truncation parameter that sets the highest power of $\frac{I_{it}}{K_{it}}$ in the expansion. When $M = 2$, Equation (9) reduces to the standard quadratic adjustment cost function. We follow Whited and Wu (2006) and use the test developed in Newey and West (1987) to determine the value of M. We are able to achieve the best estimation results (the corresponding Chi-square values are minimal) for most of our model specifications when we set $M = 3$. In what follows we set $M = 3$ for all.[17]

We obtain the estimating equation by substituting (8) into (7), differentiating (9) with respect to I_{it} and K_{it} respectively, and substituting the derivatives into (7), which results in the following estimating equation:

$$\Gamma_{it}\left[\frac{Y_{it+1} - \mu VC_{it+1}}{K_{it+1}} - (\alpha_0 - \sum_{m=2}^{M}\frac{m-1}{m}\alpha_m(\frac{I_{it+1}}{K_{it+1}})^m) + (1-\delta_{it})(\sum_{m=2}^{M}\alpha_m(\frac{I_{it+1}}{K_{it+1}})^{m-1} + 1)\right] = \sum_{m=2}^{M}\alpha_m(\frac{I_{it}}{K_{it}})^{m-1} + 1 + e_{it+1}. \tag{10}$$

To estimate Equation (10), we need to specify the firm-level discount factor, Γ_{it}. In our model, Γ_{it} consists of two parts — the internal discount factor denoted by β_{it} and a part associated with external finance premium, Θ_{it}. Based on our empirical design, institutional distortions and inefficient financial intermediation, if any, will be reflected in Γ_{it}. Because the investment Euler equation models do not provide a formula for Γ_{it}, prior research relies mainly on ad hoc parameterization of the factor with observable firm-level indicators of a firm's financial health and other firm-specific variables (see, e.g., Love, 2003; Whited and Wu 2006; and Forbes, 2007). This approach, although ad hoc, does provide a certain empirical flexibility in specifying the firm-level discount factor function.

We adopt a reduced-form specification for the effective discount factor, Γ_{it}. Besides the usual

[17] As detailed in Newey and West (1987) and Whited and Wu (2006), the test can be described as a GMM analog to a standard likelihood-ratio test. We start with a "high" value for M and estimate the model. We then use the same optimal weighting matrix to estimate a sequence of restricted models for lower values of M, in which the corresponding coefficient, α_{M+1}, is set to be zero. The appropriate maximum value for M will be the highest one for which the exclusion restriction on the parameter α_{M+1} is not rejected.

firm-level variables, our specification of Γ_{it} also incorporates the variables measuring institutions and financial development. We assume:[18]

$$\begin{aligned} \Gamma_{it} &= l_0 + l_1 OWN_{it} + l_2 LNLABOR_{it} + l_3 HIND_{it} + l_4 NERI_{it} + l_5 SG_{it} \\ &\quad + l_6 TLTD + b OWN_{it} * LNLABOR_{it}, \end{aligned} \quad (11)$$

Here OWN_{it} is a set of dummy variables that specify a firm's ownership identification (private, collective, mixed firm, foreign invested firm, HW/TW firm, or SOE); $LNLABOR_{it}$ is the natural log of the number of employees, which captures firm size; $HIND_{it}$ is the industry Herfindahl index, which is the sum of squares of the market shares (by sales) by the ten largest firms in an given industry (based on the two-digit industry code designated by the NBS). It is designed to capture the level of competition in a given industry. $NERI_{it}$ measure the level of regional institutions and financial development, where the firm locates (see details in Section 4.3). SG_{it} is the sales growth rate for firm i in year t, which captures the growth opportunities facing the firm; and $TLTD$ is the ratio of long-term liabilities to total assets, and is constructed to capture the impact of financing decision on corporate investment. Besides the above variables, we also define various other firm-specific variables. We defer the discussion of their impact on the discount factor to Section 4.

The parameterization in Equation (11) does not allow for an explicit error term, which is a strong assumption. However, this assumption can be tested with the over-identification test, which provides an important check on the validity of the model. If the test does not indicate a rejection, the omitted error term is not empirically important.

In order to test the various conjectures laid out in Section 2, we need to know the signs and significance levels of the estimated coefficients of the ownership variables, competition variables, and regional variables. Note that in our benchmark specification (11), we do not include region dummies or industry dummies. This choice stems from the evidence that ownership dummies in our sample are significantly correlated with both industry and region dummies. Including the region

[18] One caveat of our specification is that it does not model traditional risk factors such as β, book-to-market ratio, momentum, etc. due to the data limitations. However, we are not much concerned here because (1) our estimations, as we will explain later, are based on a three-year investment data (2003 — 2005), our results thus are largely driven by cross-sectional variations rather than the time-series effects; and (2) we include in the specification a rich set of firm-specific variables, which likely pick up these traditional risk factors.

and industry dummies on the one hand greatly increases the number of parameters to be estimated; on the other hand, may only pick up the ownership effect. We devote Section 5.2 to analyzing how industry (region) affects the "implied" return on capital.

We estimate Equation (10) in first differences to eliminate possible fixed firm effects. That is, we use GMM to estimate conditional moments of the following form:

$$E_{t-1}(z_{it-1} \otimes (e_{it+1} - e_{it})), \tag{12}$$

where z_{it-1} are a set of instruments which use the two-period lags of all variables, including all variables appeared in the Euler equation model, plus inventories, income taxes, total liabilities, depreciation, current assets, and net income. All of these variables are scaled by total assets.

4 Sample Overview and Variable Definition

4.1 Data Sources

We use a database developed and maintained by the National Bureau of Statistics of China (NBS) to conduct our empirical analysis. The NBS data are in fact census data. NBS surveys all industrial firms in China with sales above RMB5 million (approximately US$600,000). The data cover close to 190,000 firms in thirty seven 2-digit manufacturing industries and from 31 provinces or province-equivalent municipal cities over the period from 2000 to 2005. The NBS database is quite representative and represents literally all of China's industrial value added and 22% of China's *urban* employment in 2005.[19]

The NBS database is constructed based on the annual accounting briefing reports filed by the industrial firms in China with NBS. The NBS designates every firm in the database a legal identification number and specifies its ownership type. Firms are classified into one of the following six primary categories: SOEs, collective firms, private firms, mixed-ownership firms (mainly joint stock companies), foreign invested firms, and Hong Kong, Macao, and Taiwan invested firms (HK/TW firms). The NBS does not treat publicly listed companies in China separately. It is

[19] In fact many previous studies on China have used various versions of this database, see, e.g., Bai et al. (2006); Jefferson and Su (2005); Hu, Jefferson, and Qian (2004); Li, Yue, Zhao (2006); and Cai and Liu (2007), among many others.

difficult to track them as their legal identification numbers were changed when they went public. But they all belong to the mixed category. By 2005, there are about 1,400 publicly listed companies in China's two stock exchanges. However, only slightly over 700 of them are industrial firms.

The NBS data contain detailed enough information that allow us to construct variables required for the GMM estimation of the investment Euler equation models. All monetary terms are in 2000 constant Renminbi (RMB) Yuan.

Besides the NBS data, we also conduct the same set of empirical analysis against another population of firms — the universe of China's listed companies — in Section 6.2. The listed firms' financial data are derived from the CSMAR Financial Databases developed by the Shenzhen GTA Information Technology Co. We study the universe of Chinese listed companies for the period from 1999 to 2005. The sample contains 5,977 firm year observations, and represents 1,009 unique listed firms in China.

4.2 Sampling

To conduct the GMM estimations, we need to have a balanced panel of firm-year observations. The NBS data have several built-in weaknesses. First, the firms included in the NBS survey each year are not always the same. About 20% of firms enter or exit the database each year as a result of changes in their size classification or changes in their identification numbers due to mergers and acquisitions, bankruptcies and restructuring. Although the original NBS database contains industrial firms with the numbers ranging from 162,883 to 279,092 from year to year, only 40,217 firms appear in all six years. Second, because the NBS chooses to include in the database any industrial firms with annual sales above RMB 5 million, many firms are fairly small. One may wonder whether those relatively small firms represent corporate China well. Third, the NBS data do not have information on capital expenditures or the firm-level fixed asset investments. We have to compute the fixed asset investment, I_{it}, based on the investment accounting identity. However, not all information required to calculate I_{it} is available for all firms in the data.

To obtain a balanced panel, we include in our sample firms with data entries in all six years. We delete firms with extreme variable values (one percent at both tails, the variables will be defined slightly later). Our final sample contains 36,103 firms from 2000 to 2005. In 2005, they account for about 55% of total industrial value added and 12% of urbane employment in China.

Table 1 reports the breakdown of our sample firms by ownership industry. As shown in Panel A, SOEs, collective firms, mixed firms, private firms, HK/TW firms, and foreign firms respectively account for 13.29%, 14.09%, 20.93%, 21.54%, 15.18%, and 14.97% of our sample. Panel B shows the distribution of the sample firms by industry. Textile (17), electrical machinery and equipment (39), ordinary machinery (35), nonmetal products (31), and raw chemical (26) are the top five two-digit industries with the most firms in our sample, while petroleum and natural gas extraction (7) and ferrous mining (8) are the least covered two-digit industries (numbers in the brackets are the two-digit industry codes designated by the NBS). Table A3 presents the breakdown of the sample by region. Not surprisingly, Guangdong, Zhejian, and Jiangsu are the three provinces with the largest numbers of firms, while Hainan, Tibet, Qinghai and Ningxia have the fewest firms.

We note that our sampling process unavoidably introduces 'selection bias' or 'survival bias'. Such concerns however can be mitigated because of the following considerations. First, most firms excluded from our sample are fairly small and young. Arguably, they do not capture the true picture of the Chinese firms. Second, the ownership, industry and regional distributions of our sample firms are largely in line with those of the original NBS data. During the sampling process, we do not observe any significant cross-ownership, cross-industry, or cross-region patterns in the probability of an observation being dropped. Third, we carry out several robustness checks and find results very similar to those based on our final sample.[20]

4.3 Variables

We first construct six dummy variables to capture a firm's ownership status — D^{SOE}, $D^{private}$, $D^{foreign}$, $D^{HK/TW}$, D^{mixed}, and $D^{collective}$. These binary variables take the value of one if a firm falls into a corresponding ownership category and zero otherwise.

We define $Sale_{it}$ as the sales in year t for firm i. Cost, VC_{it}, is the variable costs, which is defined as the sum of costs of good sold and administrative costs. We denote total assets as TA_{it}. The depreciation rate $DRATE_{it}$ is computed as the ratio of DEP_{it} (current year depreciations)

[20]We conduct the GMM estimations on several sub-samples. We first impose size restriction and only include in our sample large-sized firms (total assets and total sales are both above RMB 20 million). The estimation results based on this sub-sample are qualitatively similar. We then apply the estimation to another firm population — the publicly listed companies in China — and again find qualitatively similar results. Selection bias likely affects the economic magnitude of our results but not their directions.

to the beginning of year fixed assets K_{it-1}.[21] The cash flow CFK_{it} is defined as earnings before depreciations and amortizations plus depreciations. We retrieve total liabilities TL_{it} and current assets CA_{it} from the NBS data. Besides the above variables, we use $INVEN_{it}$ to denote firm i's total inventories in year t. The firm's after tax income is defined as $INCOME_{it}$ and its effective tax rate TAX_{it} is calculated as the ratio of total income tax to total before-tax profit. We use the natural log of the number of employees to measure firm size. It is labeled $LNLABOR_{it}$. Except for $INCOME_{it}$, $DRATE_{it}$, and TA_{it}, all of the variables are scaled by total assets (TA_{it}). We have defined firm age AGE_{it}, and the industry Herfindahl index, $HIND_{it}$, in Section 3.2.

China is a large and diversified country with significant cross-regional differences in the institutions and the levels of financial development(Demurger et al., 2002). China can be described as the *de facto* federalism, involving a decentralized economic system in which each region can be considered as autonomous economic entity (Qian and Xu, 1993). Domestic financial markets in China are severely segmented — compared with the developed markets, cross-regional bank lending has been relatively rare (Boyreau-Debray and Wei, 2005). To control for cross-regional differences in institutions, we use $NERI$ complied in Fan and Wang (2004) as the measure.[22]

The NBS data have information on fixed assets K_{it} and depreciations DEP_{it}, which allows us to compute I_{it} by the investment accounting identity as below:

$$I_{it} = K_{it} - K_{it-1} + DEP_{it}. \tag{13}$$

We have investment data available for the period from 2001 to 2005.[23] To apply the GMM estimations, we have to use variable values lagged by two periods as the instruments. We can only estimate the investment Euler equation models for 2003 – 2005. Panel A of Table 2 presents firms' investment rate (I_{it}/TA_{it}) by ownership from 2003 to 2005. Judged by investment rate, private firms in China invest more than other types of firms with average investment rate at 17.7%.

[21]We delete firms with $DRATE_{it}$ larger than one from our sample. About 0.4% of firms are thus dropped. Such a screening rule is consistent with our previously discussed guideline that firms with variables values either above the 99 percentile or below 1 percentile would be dropped.

[22]Fan and Wang examine the extent of marketization in each region by focusing on the following five aspects: (1) the relations between the local government and local markets; (2) the significance of non-state sector in the local economy; (3) the development level of product markets; (4) the development level of factor markets; and (5) legal environment, law enforcement, and the development of market intermediaries. The weighted average of scores on the five aspects is computed and used to capture the market and legal conditions of China's diverse regions.

[23]The investment data in 2000 cannot be derived since we do not have fixed assets information in 1999.

The numbers reported in Panel A might be misleading in the sense that they do not take into account the impact of firm size and investment opportunities — SOEs in China have longer history and are usually larger than private firms and collective firms; and they do not necessarily have better investment opportunities.

To provide a better motivation that corporate investment behavior in China varies across ownership, we regress the firm-level investment rate on ownership dummies and firm size. Panel B of Table 2 reports the OLS regression results. In Model 1, only ownership dummies are included as the explanatory variables. The results certify the findings in Panel A — compared to SOEs, non-state sectors in China invest more. In Model 2, we add the firm size (measured by $LNLABOR$), we find similar ownership result. Firm size enters the regression positively, implying that larger firms tend to invest more. One may wonder whether ownership influences corporate investment decision through firm size. We interact ownership dummies with $LNLABOR$ and add them into the regression (Column 3). After controlling for the interactions of ownership types and firm size, both statistical and economic magnitudes of ownership dummies are greatly attenuated. The result suggests that after controlling for firm size, non-state sectors in China do not necessarily invest more. Therefore, only using investment rate to understand Chinese firms' investment behavior is inappropriate.

Table 3 provide the summary statistics of the variables used in our analysis. During 2001 – 2005, the fixed investment on average accounts for 14.9% of total assets; the average depreciation rate is 17.2%; cash flow is about 3.4% of total asset. Surprisingly, the mean of ST (total sales/total assets) is 1.274, indicating that in our sample firms tend to have sales larger than total assets. The sales costs (VC) also amount to 109.4% of total assets, and the profit margin (INCOME) is 2.7%. The average firm age is 16.1 years. An average firm in our sample has 500 employees.

5 The Ownership Effect

5.1 The Baseline Models

We apply the GMM estimation to various Euler equation models. We start with the model specified in Equations (10) and (11). Although the NBS database contains firm-level information from 2000 to 2005, it does not have fixed asset investment data. We calculate I_{it} according to Equation (13), we therefore lose the data in 2000. Also, we need to use the values of firm-level variables lagged by two periods as the instrument variables (see Equation (12)) in order to conduct the GMM analysis. Thus we can only estimate the investment Euler equation models for 2003 – 2005.

We examine the ownership effect. As shown in Equation (11), the marginal impact of ownership on Γ_{it} is given by

$$\frac{\partial \Gamma_{it}}{\partial OWN_{it}} = l_1 + bLNLABOR_{it}. \tag{14}$$

In Equation (14), l_1 captures the standard impact of ownership on the discount factor, and the latter, $b \times LNLABOR$, measures ownership's impact through firm size. Plugging Γ_{it} as in Equation (11) into Equation (12) and using GMM to estimate the Euler investment equation models, we expect the estimated coefficients of l_1 and b to be negative and positive respectively — firm size effect offsets the ownership effect.

We start with the most general specification of the stochastic discount factor, in which ownership dummies, their interactions with firm size, and various firm–, industry–, and region– level variables are used to parameterize Γ_{it}. Together with three unknown parameters in the production function and investment adjustment function (μ, α_1, and α_2), we have in total 18 parameters to estimate (the coefficients of SOE dummy and its interaction with $LNLABOR$ are set to be zero). Our instruments include all of the Euler equation variables lagged by two periods such as $Sale_{it-2}$, VC_{it-2}, $DRATE_{it-2}$, and I_{it-2}, as well as inventories ($INVEN_{it-2}$), total liabilities (TL_{it-2}), current assets (CA_{it-2}), depreciations (DEP_{it-2}), tax rate (TAX_{it-2}), net income ($INCOME_{it-2}$), firm age (AGE_{it-2}), industry-level Hirfindahl index measure ($HIND_{it-2}$), ownership dummies, and finally the constant. There are in total 20 instrument variables.

Table 4 presents the investment Euler-equation estimation results. Column (1) contains estimates from the most general model, where the discount factor is specified according to Equation (11). We do not include time dummies here since we only estimate the models for 2003 – 2005, and adding time dummies does not change the results qualitatively.[24] Each subsequent column contains estimates from a model, in which we have dropped from the the discount factor equation the variable with the smallest t-statistic. We examine the difference in the minimized

[24] We in fact start with discount factor functions that contain more firm-level variables than Equation (11) does. The majority of those model specifications are not statistically significant at all. Including more variables to the discount factor function also increases the demand for more instrument variables and reduces the stability of estimating results.

GMM objective functions for the most general and for subsequently more parsimonious models. Each of these differences will have a χ-squared distribution with degree of freedom equal to the number of variables excluded from the model. That is, if a variable belongs in the Euler equation, its omission should produce a small p-value. Following Whited and Wu (2006), we call this test of exclusion restriction an "L-test".

For all of the models except the one in Column (5), the J-tests of over-identifying restrictions do not produce a rejection, suggesting that those models and corresponding assumptions are not misspecified. The model in Column (5) fails to pass the J-test, indicating that the interactions of ownership dummies and $LNLABOR$ belong in the discount factor function. That is, the ownership variables also affect the implied discount factor through firm size.

Sales growth (SG) and the measure of capital structure ($TLTD$) are not significant in Column (1). The p-value of L-test, as shown in Column (2), also suggest that dropping SG and $TLTD$ from the stochastic discount factor specification do not affect the model efficiency. Sales growth and firm-level leverage ratio thus are not significant determinants of the discount factor perceived by the managers.

The estimation results in Table 4 reveal several findings. The coefficients of $D^{private}$, $D^{collective}$, D^{mixed}, $D^{foreign}$, and $D^{HK/TW}$ are all negative, and the estimated coefficients of their interactions with $LNLABOR$ are all positive. Since the impact of ownership on the discount factors perceived by managers is given by Equation (14), we plug the sample mean of $LNLABOR$, 5.35, and estimated coefficients back into the equation to compute the ownership impact. We find that everything else equal, an average non-state firm has a discount factor *smaller* than that of an average SOE. That is, the managers of non-state firms tend to perceive lower "implied" discount factors. Equivalently, they face higher "implied" costs of capital and have higher "implied" returns on capital.

This result applies to all models in Columns (1) – (4). We use the L-test to check which model is more parsimonious. In Column (2), besides the ownership variables, both $NERI$ and $HIND$ are marginally significant. The negative sign of $NERI$ seems to suggest that firms in well-developed regions (high NERI) have lower (higher) "implied" discount factors (discount rates), which is consistent with our conjecture that institutions and financial development improve corporate investment efficiency. However, Model 2 fails to pass the L-test — dropping $NERI$ from the discount factor function does not affect the model efficiency. Comparing Models 3 shows that

$HIND$ belongs in the Euler equation model (the p-value of L-test is 0.051). Our discussions below thus center on results based on the model in Column (3).

$HIND$ is significantly negative in Column (3), implying that everything else equal, firms in more competitive industries (measured by lower $HIND$) have higher (lower) discount factors (discount rates). Competition does not improve corporate investment efficiency. We do not have a good explanation for the evidence. However, it is worth pointing out that in China a certain ownership type firms tend to concentrate in certain industries. $HIND$ thus may pick up some ownership effect.

The estimated coefficient of $LNLABOR$ — the proxy for firm size — is significantly negative in all models, implying that larger firms tend to have lower (higher) discount factor ("implied" return on capital) than smaller firms do. We can interpret the evidence as that in equilibrium larger firms tend to make more efficient investment decisions after controlling for investment opportunities, competition effect, and the impact of other firm-specific attributes.

We compute the impact of ownership on "implied" return on capital based on Equation (14). The mean of $LNLABOR$ in our sample is 5.35. All else equal, a private firm's effective discount factor is 11.9 percentage points lower than that a typical SOE.[25]

Similarly, we can compute the magnitude of the ownership effect for mixed firms, collective firms, foreign firms, and HK/TW firms. Our computation results indicate that the "perceived" or "implied" return on capital for collective firms, mixed firms, HK/TW firms, and foreign firms are approximately 10.4, 9.1, 9.5, and 11 percentage points higher than that of an average SOE.

We note that the "implied" return on capital for mixed firms is higher than SOEs, although almost all of the mixed firms in China are partly owned by the state, and can be viewed as *de facto* SOEs. The result is intuitive since mixed firms can be viewed as the end product of China's SOEs reforms. Their operating efficiency tends to improve after the reforms kick off — mixed firms are less subject to soft budget constraint.

As our baseline model (Column 3 in Table 4) shows, ownership, firm size and industrial concentration are the primary determinants of the "implied" return on capital perceived by managers. The effect of other variables have been camouflaged by these variables. To obtain

[25] The estimated coefficients of private firm dummy and its interaction with $LNLABOR$ are respectively –1.729 and 0.301. The aggregate impact of private firm dummy on effective discount factor is thus given by $-1.729 + 0.301 \times 5.35 = -0.119$.

a sense of how return on capital distributes across different types of firms, we apply the baseline model to all firms in our sample under the assumption that the discount factor function as specified in Column 3 of Table 4 holds for all firms during our sample period. There is one problem though — we cannot specify the constant (l_0) in the discount factor function. However, we impose a parsimonious assumption that the average discount rate for all firms in our sample is 10%, based on which we compute l_0 to be 1.929. Plugging it in the discount factor function, we compute the implied return on capital for each firm. Figure 1 plots the distribution of return on capital across the six ownership types over time. Clearly, SOEs on average have the lowest investment efficiency, while private firms and collective firms have relatively higher returns on capital.

5.2 The Ownership Effect Controlling for the Industrial Effect

Our analysis in Section 5.1 has one caveat — we do not fully control for the impact of industry. We use the Herfindahl index at the two-digit industry level ($HIND$) to capture the industry effect, but the sign of $HIND$ is counter-intuitive. Also, we assume that the firms from different industries face the same profit function and cost adjustment function, and that the cross-sectional variations in their investment behavior are totally driven by firm-level discount factors. Those assumptions are likely too strict. To check whether the empirical evidence reported in Section 5.1 is sensitive to those assumptions, we conduct additional empirical analysis below.

We first apply the GMM estimations to individual industries. We choose the top five largest industries (by number of firms) in our sample: Textile (2,738; 7.58%), Raw Chemical (2,646; 7.33%), Nonmetal Products (2,899; 8.03%), Ordinary Machinery (2,763; 7.65%), and Electrical Machinery (3,218; 8.91%).[26] The five industries cumulatively account for 40% of our sample. We apply the model as specified in Column (4) of Table 4 (we exclude $HIND$) to each industry and report the estimation results in Columns (1)–(5) of Table 5.

The results from Table 5 reveal several findings. First of all, for each individual industry, the estimated coefficients of ownership dummies and their interactions with $LNLABOR$ all have the expected signs and are in most cases statistically significant. We compute the ownership effects by plugging estimated coefficients and the means of $LNLABOR$ into Equation 14, and find that for all

[26] The first number in the brackets refers to the number of unique firms in each industry and the second number refers the its share in the full sample.

five industries the non-state firms have managerial "perceived" discount factors significantly greater than those of SOEs. These results are consistent with those reported in Table 4 and discussed in Section (5.1). Second, the estimated parameters of the profit and cost adjustment functions are different across the five industries suggesting that firms in different industries are indeed facing different investment opportunities.

In Column (6) of Table 5, we estimate the investment Euler equation model for the whole sample, in which we include the thirty-seven two-digit industry dummies into the discount factor function Γ_{it}. The specification directly controls for the industrial effect on the discount factors derived from corporate investment. It has one caveat as well — it assumes that firms from different industries are facing the same investment opportunities (they share the same profit and cost functions).

We use GMM to estimate this model. Besides the twenty instruments described before, we also use the industry dummies as the instruments. The degree of freedom thus is still 6. The result of J-test shows that we cannot reject the hypothesis that the model is correctly specified. Our interest however is on the signs and significance levels of the ownership dummies and their interactions with $LNLABOR$. After we include the industry dummies in Γ_{it}, private firms and foreign firms still demonstrate distinct investment patterns — the estimate coefficients of the two dummies and their interactions with $LNLABOR$ are both statistically significant. Plugging the estimated coefficient and the mean of $LNLABOR$ into Equation (14), we find that all else equal, an average private firm (foreign firm) has "implied" return on capital 8.0 (10.8) percentage points higher than that of a typical SOE. The magnitudes are consistent with those identified in Table 4 where industry dummies are not included. Overall, the results in Table 5 show that the ownership effect identified earlier are robust to the industrial effect.

5.3 Evidence from Domestic Firms

Foreign firms and Hong Kong/Taiwan invested firms operating in China use different financing channels. Plus, their investment decision making mechanisms might also be different from domestic firms. Pooling domestic firms and foreign and HK/TW firms thus might lead to spurious results. To better serve our goal of examining how institutions and financial development affect Chinese firms' investment decisions and also offer a robustness check, we apply the GMM estimations to a sub-sample that only contains the domestic firms. Deleting foreign firms and HK/TW firms, we obtain a smaller sample with 25,220 domestic firms in each year.

Applying the GMM estimation to the domestic firms only, we replicate the estimations in Table 4 and find that the ownership results do not change qualitatively. To save space, we choose not to report them. We draw the conclusion that our empirical results are not driven by foreign firms and HK/TW firms.

5.4 Caveats Of Our Empirical Approaches

Our empirical analysis is conducted based on the estimation of the investment Euler equation models. We examine the impact of institutions and financial development on corporate investment efficiency by studying the cross-ownership and cross-region distribution of the the "implied" return on capital derived from corporate investment data. Such a testing strategy however suffers from several shortcomings. First, it requires imposing a high degree of structure on the estimating equations, such as our various specifications of the effective discount factor equation (see Equation (11)). The estimation results thus can be sensitive to the model specification. A rejection of "no ownership effect" hypothesis can occur for reasons other than institutional deficiencies. To overcome this concern, we experiment with many different specifications of the discount factor function. Our results, especially the ones related to ownership identifications and regional disparities, turn out to be quite robust.

Second, the testing strategy based on the Euler equation models relies on period-by-period restrictions derived from the firm's first-order conditions, so that it may not capture the impact of institutions and financial development across periods. However, due to data limitations, we are only able to estimate the investment equations for 2003 – 2005. The changes in institutions and financial development cannot be that significant in these three years. Our identification is thus mainly driven by cross-sectional variations. Third, the tests based on the Euler-equation methodology have poor small sample properties. It is however not a big concern here since our sample is reasonably large.

6 Further Analysis

6.1 Estimating the Privatized Firms

Our empirical results so far are largely driven by cross-sectional variations. It is interesting to study whether a firm's investment decision becomes more efficient after the institutions surrounding the firm has been improved. Privatizing the Chinese SOEs provides us with a unique opportunity to study such an effect.

Since we can only estimate the investment Euler equations for the period from 2003 to 2005, we first examine the dynamic landscape of the SOE sector during this time period. In 2003, there are 4,799 SOEs in our sample. 500 of them changed their ownership status to mixed-ownership (i.e., joint stock company) — a common privatization practice in China. 98 firms even changed their ownership status to private firms. If our analysis in previous sections is correct, we expect those firms to improve their investment efficiency after they have been privatized.

For the 4,799 firms, we create two dummies MIX and $Private$. They take the value of 1 if an SOE becomes a mixed firm or a private firms in either 2004 or 2005, and 0 otherwise. We start with the most general model, in which the discount factor function is specified as below:

$$\begin{aligned}\Gamma_{it} &= l_0 + l_1 MIX_{it} + l_2 Private_{it} + l_3 LNLABOR_{it} + l_4 HIND_{it} + l_5 NERI_{it} + l_6 SG_{it} \\ &\quad + l_7 TLTD + b_1 MIX_{it} * LNLABOR_{it} + b_2 Private_{it} * LNLABOR_{it}.\end{aligned} \tag{15}$$

Applying the GMM estimation to Equations (10) and (15), we report the estimated coefficients of the Euler equation model in Column (1) of Table 6. The model passes the J-test and reveals several findings. First, the estimated coefficients of MIX and its interaction with $LNLABOR$ are statistically significant, while the estimated coefficients of $Private$ and its interaction with $LNLABOR$ are not so. This might be due to the fact that few firms changed their ownership status from SOE to private during 2003–2005. We thus exclude $Private$ and its interaction with $LNLABOR$ from the discount factor function Γ_{it} in Column (2) of Table 6. In Column (3), we further exclude $MIX \times LNLABOR$. The results from the L- tests show that the model in Column (2) is correctly specified. The mean of $LNLABOR$ for SOEs is 5.5, and the impact of MIX on the effective discount factor is thus given by $l_1 + b_1 LNLABOR$. Plugging the estimated values of

l_1 and b_1 and the mean of $LNLABOR$ into the formula, we find that all else equal, a privatized firm – from an SOE to a mixed firm – have its effective discount factor decreased by 0.127. Putting it another way, its effective discount rate (that is, the "implied" return on capital) increases by roughly 12.7 percentage points. This finding is consistent with those reported in Tables 4 and 5.

Results reported in Column (2) of Table 5 yield several other interesting findings. The measure of industrial competition $HIND$ is significantly positive, suggesting that firms in more competitive industry (i.e., firms with lower $HIND$) tend to have higher "implied" return on capital. Negative sign of SG and $TLTD$ suggests that all else equal firms with greater growing opportunities (measured by a high level of sales growth rate, SG) and levered firms (measured by a high $TLTD$) tend to make more efficient investment decisions. Moreover, we find that the measure of local insinuations and financial development $NERI$ is significantly negative. SOEs in regions with better institutions and a market-prone financial system make better investment decisions.

The empirical findings based on the estimated coefficients of $NERI$, SG, $TLTD$, and $HIND$ are largely disguised by the ownership effect in Tables 4 and 5, and only burst into scene in Table 6, in which we examine the within-ownership corporate investment behavior. The various findings as reported in Tables 4-6 thus imply that the cross-sectional variations in corporate investment efficiency are largely driven by the ownership variables and firm size variables, and that the impact of firm-specific variables and regional variables emerges within one specific ownership type. Cross-ownership differences have the first-order effect in explaining corporate investment behavior in China.

6.2 Estimating Another Population of Firms— Listed Firms in China

To offer a more direct cross-check on our empirical results, we apply the same testing strategy to another population of the Chinese firms — the universe of China's listed firms. Such analysis has several incremental advantages. First, the information on the listed firms is more transparent and plausibly more reliable; second, listed firms contain more publicly accessible information, we can construct more variables to capture the potential impact of institutions. Third, the listed firms allow us to carry out the GMM estimation over a relatively longer time period (1999–2005). The tradeoff however is also obvious. There are only slightly over 1000 listed firms in China, the representativeness is always a concern. Second, focusing on the listed firms makes both cross-industry and cross-region analysis less applicable because some industries and provinces hardly have any listed firms.

We study the universe of China's listed firms for the period from 1999 to 2005.[27] The listed firms' financial data are extracted from the CSMAR Financial Databases developed by the Shenzhen GTA Information Technology Co. We obtain a sample with 5,977 firm year observations for our sample period, which represents 1,009 unique listed firms in China. To conduct the GMM analysis, we need a balanced sample. To make the estimation results comparable, we also exclude firms in financial services sectors. We also delete firms with extreme variable values (one percent at both tails). We end up with a panel with 646 firms each year for the period 1999–2005.

We specify the discount factor function Γ_{it} as follows:

$$\begin{aligned} \Gamma_{it} \quad = \quad & l_0 + l_1 SOE_{it} + l_2 LNLABOR_{it} + l_3 OUTSIDE_{it} + l_4 CFK_{it} + l_5 HIND_{it} + l_6 \beta \\ & + l_7 HBSHARE_{it} + l_8 TOPSHARE + l_9 CEOCHAIR + l_{10} PARENT + l_{11} B/M, \end{aligned} \tag{16}$$

where SOE is a binary variable that takes the value of 1 if a listed firms is controlled by the government; $OUTSIDE$ is the ratio of outside board members to total board members; $PARENT$ is a binary variable with the value of 1 if a listed firm belongs to a group firm; $HBSHARE$ is a binary variable with value of 1 if a listed firm has either H– or B– shares traded by foreign investors; $TOPSHARE$ is the percentage of shares held by the controlling shareholder; $CEOCHAIR$ is a binary variable with the value of 1 if the CEO is also the chairman of the board; and β is estimated based on the CAPM model annually and used to capture systematic risk, and B/M is the book-to-market ratio. Other firm-specific variables have been defined earlier.

We apply the GMM estimation on the listed firm sample and report the results in Table 7. The p-value of the J − test is 0.214, which rejects the hypothesis that our model is misspecified. The estimated coefficients of the production function and investment adjustment cost function (α_1, α_2, and μ) are in line with previous results in which the GMM estimations are applied to the NBS data. The results in Table 7 yield several interesting findings. First, the estimated coefficient of SOE is significantly positive with its value equal to 0.133. It suggests that all else equal, an

[27] We start from 1999 because the Chinese listed firms' corporate governance variables are not available until 1999. In our tests, we need to use the corporate governance variables to capture the impact of institutions.

SOE's "implied" discount factor is higher than that other listed firms. Approximately, an SOE's "implied" return on capital is 13.3 percentage points lower than that of non-SOE firms. The result is consistent with that from the NBS data.

Second, we find that other corporate governance variables have the expected signs and are statistically significant in most cases. For example, the listed firms with H– or B– shares traded by foreign investors tend to make better investment decisions. Those firms need to be audited by international accounting firms and they are arguably more transparent compared to other listed firms in China. We also find that firms with more outside board members perceive a higher "implied" return on capital. The result seems to indicate that board independence matters in improving investment efficiency. Firms with a larger percentage of shares owned by the controlling shareholder have a higher "implied" return on capital. When the controlling shareholder owns more shares, their interest is more aligned with that of the whole firm, which may lead to better decision making. We also find that CEO being board chairman and belonging to a group firm affects a listed firm's investment efficiency negatively, although they are not statistically significant. β is negative, but it is not significant in our listed firm sample. The book-to-market ratio is positive but not significant. CFK and HIND are all insignificant. The impact of those variables on the "implied" discount rate may have been picked up by other firm-level variables.

To sum up, the estimation results based on China's listed firms generate consistent findings — non-state firms make better investment decisions than state firms do; and improving institutions helps enhance firms' investment efficiency in China.

7 The Costs of Weak Institutions and Failing Financial System

China's fast growing economy has been largely built upon weak institutions and an ineffective financial system. Although the financial system in China is doing an outstanding job of mobilizing savings, it only directs a relatively small share of the country's savings to the economy's most productive enterprises. Such a model of development presents China as a counterexample to the well-accepted argument that finance is important to economic growth.[28] Bearing the parameters

[28]Two views related to the Chinese economy and its relation with financial system thus come along. Allen et al. (2005) suggest that Chins's financial system is actually quite effective because a sufficient amount of alternative, informal financial mechanisms are working in a quite efficient manner. Young (2001 and 2003) however argue that given the institutional deficiencies and the failing financial system, the economic growth in China is neither

estimated from our structural model in mind, we examine below the implications of our results for the Chinese model of development, and estimate the welfare loss due the misallocation of capital in the Chinese economy.

7.1 Implications for the Chinese model of economic growth

China's economic growth has been largely driven by fixed asset investments and FDI. However, as shown in Table A2, in 2005 the fixed asset investments of SOEs and mixed firms account for more than 60% of total fixed asset investment, RMB 8,877.4 billion. Such a significant amount of investment concentrating in the less efficient SOEs and mixed firms indicates a widespread mis-allocation of capital, for which poor institutions and failing financial systems are held accountable. It thus raises a valid concern that if China does not change its development model and still heavily relies on fixed asset investment, whether its economic growth can be sustained?

By deriving the "implied" return on capital based on the firm-level investment data, we identify significant gaps in investment efficiency between the state sector and non-state sectors in China. Based on our calculation, all else given, an average private firm, collective firms, mixed firms, HK/TW firm, and foreign firms have the rates of investment return that are respectively 11.9, 10.4, 9.1, 9.5, and 11.0 percentage points higher than that of an average SOE. However, the allocation of capital resources has be disproportionate by ownership identifications. Farrell et al. (2006) estimate that SOEs, mixed firms, collective firms, and private and foreign firms (include both HK/TW and foreign firms in our context) respectively account for 35% (23%), 27% (19%), 11% (6%), and 27% (52%) of the total corporate loans outstanding.[29] Because China's weak institutions and failing financial system fail to channel scarce capital resources to relatively more profitable sectors, the sectors that are efficient and contribute the most to the Chinese economy however are not receiving the bulk of bank loans.

Based on our model estimation, the costs of the resource mis-allocation are significant. According to the statistics released by China's central bank, the People's Bank of China (PBOC), by the end of 2005, the total loans amount to RMB 19,469 billion, among which about 35%, that is, RMB 6,814 billion, are allocated to SOEs. If this part of financing can be reallocated to more

unprecedented nor spectacular. The sustainability of the Chinese model of growth is thus questioned by him.

[29]The numbers in bracket is the share of total industrial value added contributed by each category of firms.

efficient private firms, or if SOEs in China can improve their investment efficiency to the level of private firms, the additional value added would amount to RMB 810 billion (it is computed as $6,814 \times 11.9\%$; the investment return of a typical private firm is 11.9 precentage points higher than that of an SOE.) The gains from improving institutions and enhancing the efficiency of financial system are economically significant (about 4.4% of the GDP based on the data in 2005).[30]

7.2 Welfare loss due to the mis-allocation of capital

Our estimates, together with the actual distribution of financial assets among different firms and several mild assumptions, allow for an assessment of the welfare loss due to the mis-allocation of capital in the Chinese economy. Figure 2 illustrates the deadweight loss in the bank lending market for SOEs.

By the end of 2005, the total value of financial assets in the Chinese banking sector is RMB 34.14 trillion,[31] 35% of which have been allocated to the SOEs (sources: PBOC; and Farrell et al. 2006). Since the interest rates have been regulated throughout China's reform era, we assume that the interest rate applied to SOEs is set to be at r, which is lower than market rate, r^*. Because the private sector in China has been discriminated, the private firms can only access to the bank lending through formal channels at a much higher rate, or resort to alternative financing channels for external finance. In either case, the interest rate they are facing is higher than market rate r^*. Our analysis could be simplified if we assume that the "implied" return on capital for mixed firms captures the marginal cost of capital in China. That is, we assume r^* is 9.1 percentage points higher than r.

Instead of accepting the market rate, r^*, the state sector can borrow money at r, which has been intentionally designated to them at a lower level. Their excess demand for bank lending by the state sector thus is given by $K^* - K$. The deadweight loss is given by area A in figure 1, which can be computed as:

$$Deadweight\ Loss = \frac{1}{2}(K^* - K)(r^* - r). \tag{17}$$

To compute the size of deadweight loss, we need to estimate the slopes of the demand and supply

[30] Of course, these numbers should be treated with a caution — they do not take into account the additional value added due to the improvement in banking efficiency; they do not fully consider different investment opportunities firms with different ownership types might be facing.

[31] We do not include corporate equity market and corporate bond market, and the assets in the insurance industry.

curves for capital as shown in Figure 1, which is non-trivial. Our analysis could be greatly simplified if we assume that the optimal amount of bank loans assigned to SOEs (K in figure 1) is proportional to SOEs' contribution to the total industrial value added in China. That is, K should be 23% instead of 35%. The excess part, captured by $K^* - K$, is thus 12% of total banking assets. Because $r^* - r = 0.091$, $K^* - K = 0.12$, and the total banking assets in China is RMB 34.14 trillion, plugging those numbers into Equation (17), we compute the deadweight loss in the financial market for SOEs due to the mis-allocation of capital to be RMB 186.4 billion.

Similarly, we use Figure 3 to illustrate the deadweight loss in the bank lending market for private firms, area B. Instead of getting 52% of bank lending (K^*), this sector only gets 27% of total bank lending in China. Because $r^{private} - r = 0.119$, we can compute the deadweight loss in the credit market for private firms to be RMB 507.8 billion. We sum up the deadweight losses in all the markets and obtain the total deadweight loss in the economy, which amounts to RMB 694.2 billion, 3.8% of China's GDP in 2005.

8 Concluding Remarks

In this paper, we propose an innovative empirical approach to examine the Chinese firms' investment efficiency. Based on the firm-level investment data, we derive the *equilibrium* cost of capital perceived and used by the managers to discount future payoffs. Such an "implied" cost of capital is equivalent to the marginal investment return in equilibrium, thus serves as a good proxy for investment efficiency. Using such a measure, we find that corporate investment efficiency varies dramatically across ownership. In particular, non-state firms in China in general enjoy higher investment returns than SOEs do. We also find that the SOEs tend to improve their investment efficiency dramatically after they are privatized. Applying the analysis to the universe of China's listed companies, we find that firms with better corporate governance tend to make better investments. Our analysis further demonstrates that the welfare loss due to the mis-allocation of capital amounts to 4% of China's GDP. We also find that redirecting the capital from SOEs to more profitable non-state sectors can unleash 4.4% GDP growth each year. These findings suggest that institutions and financial development are crucial for the sustainability of China's economic growth.

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Table 1 The Breakdown of the Sample Firms by Ownership and Industry

The data source is a database compiled by the National Bureau of Statistics in China (NBS) that covers all industrial firms in China with total sales above RMB 5 million for the period 2000-2005. We delete the firms with extreme variable values (one percent at both tails), and obtain a balanced panel of 36,103 firms for 2000-2005. Panel A reports the breakdown of our sample firms by ownership, in which SOE stands for state-owned enterprises; Collective stands for collective firms; Private refers to privately owned firms; Mixed refers to the joint-stock companies; Foreign stands for foreign firms operating in China; and HK/TW stands for the Hong Kong or Taiwan invested firms operating in China. Panel B presents the firm breakdown by the two-digit industry codes designated by NBS.

Panel A: By ownership

	# of Firms	% of the sample
SOE	4,799	13.29
Collective	5,087	14.09
Mixed	7,557	20.93
Private	7,777	21.54
HK/TW	5,482	15.18
Foreign	5,401	14.97
Total	36,103	100

Table 1 continued

Panel B: by industry

Industry Code	Industry	# of firms	Percent
6	Coal Mining	479	1.33
7	Petroleum and Natural Gas Extraction	10	0.03
8	Ferrous Mining	61	0.17
9	Nonferrous Mining	69	0.19
10	Nonmetal Mining	193	0.53
13	Timber Logging	1,465	4.06
14	Food Production	697	1.93
15	Beverage	538	1.49
16	Tobacco	73	0.2
17	Textile	2,738	7.58
18	Textile wearing apparel , Footwear and caps	1,410	3.91
19	Leather	749	2.07
20	Timber	377	1.04
21	Furniture	347	0.96
22	Papermaking	1,146	3.17
23	Printing	888	2.46
24	Cultural	465	1.29
25	Petroleum Processing	201	0.56
26	Raw Chemical	2,646	7.33
27	Medical	839	2.32
28	Chemical Fiber	172	0.48
29	Rubber	528	1.46
30	Plastic	1,609	4.46
31	Nonmetal Products	2,899	8.03
32	Pressing Ferrous	657	1.82
33	Pressing of Nonferrous	545	1.51
34	Metal Products	1,689	4.68
35	Ordinary Machinery	2,763	7.65
36	Special Equipment	1,284	3.56
37	Transport Equipment	1,820	5.04
39	Electrical machinery and equipment	3,218	8.91
40	Communication equipment computers and other electronic equipment	701	1.94
41	Measuring instruments and machinery for cultural activity and office work	818	2.27
42	Artwork and other manufacturing	1,158	3.21
44	Electric power and heat power	85	0.24
45	Gas Production	766	2.12
46	Water Production	479	1.33
Total		36,103	100

Table 2 The Corporate Investment Rate by Ownership
The investment rate is defined as the ratio of fixed asset investment (I_{it}) to total assets (K_{it}). Due to data limitation, we can only estimate the investment Euler equation models for 2003-2005. We report corporate investment rates in these three years.

Panel A: The distribution of corporate investment rates by ownership

	2003	2004	2005	average
SOE	0.105	0.086	0.097	0.096
Collective	0.155	0.139	0.146	0.148
Mixed	0.156	0.138	0.145	0.146
Private	0.196	0.173	0.166	0.177
HK/TW	0.150	0.128	0.137	0.138
Foreign	0.145	0.139	0.138	0.141

Panel B: The OLS regressions of investment rates on ownership and firm size, 2001-2005
The dependent variable is $(I/K)_{it}$, the coefficient of SOEs dummy is set to be zero. Firm size is measured by the natural log of the number of employees. t-statistics with robust standard errors reported in parentheses. *, **, and *** represent the significance levels at the 10%, 5%, and 1% respectively.

	(1)	(2)	(3)
$D^{private}$	0.0869***	0.0914***	0.0127*
	(54.78)	(57.28)	(1.65)
$D^{collective}$	0.0535***	0.0578***	0.0582***
	(33.25)	(35.78)	(7.58)
D^{mixed}	0.0515***	0.0495***	0.0593***
	(32.56)	(31.26)	(8.41)
$D^{foreign}$	0.0451***	0.0461***	0.0024
	(26.58)	(27.18)	(0.31)
$D^{HK/TW}$	0.0441***	0.0446***	-0.0028
	(26.73)	(27.18)	(-0.36)
LNLABOR		0.0097***	0.0563***
		(23.71)	(6.37)
$D^{private}$*LNLABOR			0.0153***
			(10.62)
$D^{collective}$*LNLABOR			-0.0004
			(-0.30)
D^{mixed}*LNLABOR			-0.0016
			(-1.27)
$D^{foreign}$*LNLABOR			0.008***
			(5.76)
$D^{HK/TW}$*LNLABOR			0.0087***
			(6.32)
Adj. R-squared	0.0166	0.0197	0.0208
# of obs.	180,515	180,515	180,515

Table 3 Summary Statistics, 2001-2005

The table presents the summary statistics of the variables used in our empirical analysis for the period from 2001 to 2005 (year 2000 is not included because there is no investment data for that year). We drop from our sample the firms with extreme variable values (one percent at both tails). We obtain a panel with 36,103 firms in each year. The definition of variables can be found in the variable column. LNLABOR is the natural log of the number of the employees, NERI is a variable designed by Fan and Wang (2004) to examine the extent of marketization in each province in China. CFK is the ratio of cash flow to total assets; HIND is the Hirfindahl index at the two-digit industry level; AGE refers to firm age.

Variable	Obs	Mean	Std. Dev.	Min	Max
Long term liabilities / total assets (TLTD)	180,515	0.064	0.121	0.000	0.726
Cash flow / total assets (CFK)	180,515	0.034	0.132	-0.469	0.950
Depreciation Rate (DRATE)	180,515	0.172	0.250	0.000	0.700
Total sales /total assets (ST)	180,515	1.274	1.037	0.060	9.525
Inventories / total assets (INVEN)	180,515	0.181	0.141	0.000	0.696
Income tax / total assets (TAX)	180,515	0.009	0.015	0.000	0.122
Sales costs / total assets (VC)	180,515	1.094	0.965	0.038	8.447
Current assets /total assets (CA)	180,515	0.031	0.024	0.000	0.182
Profits/total sales (INCOME)	180,515	0.027	0.083	-0.663	0.331
Sales growth rate (SG)	180,515	0.194	0.602	-0.984	10.000
Investment Rate (I_{it}/K_{it})	180,515	0.149	0.194	0.000	0.976
Industry Hirfindahl index (HIND)	180,515	0.011	0.015	0.001	0.486
Firm size (LNLABOR)	180,515	5.354	1.138	0.000	11.903
LABOR	180,515	500.4	2082.1	30	147,722
NERI	180,515	6.294	1.583	3.910	9.740
Current liabilities / total assets (CL)	180,515	0.511	0.244	0.000	1.346
Firm Age	180,515	16.120	13.854	1	105

Table 4 The Investment Euler Equation Estimations: Baseline Models

We estimate the investment Euler equation model based on a sample of industrial firms from a database maintained by the National Bureau of Statistics of China (NBS). Our sample contains 36,103 industrial firms for the period from 2001 to 2005. Nonlinear GMM estimation is conducted on the model in first differences with twice lagged instruments. There are in total 20 instruments in our estimations. α_1 and α_2 are adjustment cost parameters, and μ is a mark-up. $D^{private}$, $D^{collective}$, D^{mixed}, $D^{foreign}$, $D^{HK/TW}$ and D^{SOE} are dummy variables indicating a firm's ownership type. The estimated coefficients of D^{SOE}, and D^{SOE}*LNLABOR are set to be zero. LNLABOR is the natural logarithm of the number of the employees, CFK is the ratio of cash flow to total assets; HIND measures the industry-level Hirfindahl index; TLTD is the ratio long-term liabilities to total assets. NERI is a variable designed by Fan and Wang (2004) to examine the extent of marketization in each province in China. Standard errors are reported in parentheses. The p-values of the J-Test and L-Test on model specification are reported in the last two rows. *, **, and *** represent the significance levels at the 10%, 5%, and 1% respectively.

	(1)	(2)	(3)	(4)	(5)
α_1	-0.119	-0.118*	-0.129	-0.113	0.122**
	(0.096)	(0.070)	(0.102)	(0.121)	(0.058)
α_2	0.204	0.204*	0.210	0.179*	-0.170*
	(0.169)	(0.119)	(0.164)	(0.110)	(0.093)
μ	1.142***	1.138***	1.162***	1.169***	1.155***
	(0.036)	(0.017)	(0.025)	(0.024)	(0.011)
$D^{private}$	-1.349**	-1.353***	-1.729***	-1.903***	-0.178***
	(0.542)	(0.344)	(0.440)	(0.466)	(0.050)
$D^{collective}$	-1.233***	-1.210***	-1.591***	-1.578***	-0.142***
	(0.369)	(0.307)	(0.371)	(0.427)	(0.054)
D^{mixed}	-0.437	-0.390	-0.845***	-0.939***	-0.107***
	(0.676)	(0.357)	(0.440)	(0.336)	(0.033)
$D^{foreign}$	-0.640	-0.557	-1.036**	-1.113*	-0.330***
	(0.965)	(0.592)	(0.477)	(0.609)	(0.048)
$D^{HK/TW}$	-1.097**	-1.142***	-1.245***	-1.201**	-0.465***
	(0.554)	(0.333)	(0.445)	(0.537)	(0.048)
LNLABOR	-0.138***	-0.134***	-0.164***	-0.155***	-0.149***
	(0.035)	(0.026)	(0.008)	(0.008)	(0.008)
$D^{private}$*LNLABOR	0.277***	0.278***	0.301***	0.310***	
	(0.113)	(0.061)	(0.078)	(0.084)	
$D^{collective}$*LNLABOR	0.226***	0.223***	0.278***	0.257***	
	(0.054)	(0.047)	(0.064)	(0.074)	
D^{mixed}*LNLABOR	0.083	0.075	0.141***	0.146***	
	(0.106)	(0.054)	(0.047)	(0.055)	
$D^{foreign}$*LNLABOR	0.109	0.090	0.173*	0.178	
	(0.208)	(0.117)	(0.096)	(0.124)	
$D^{HK/TW}$*LNLABOR	0.198***	0.203***	0.215***	0.201**	
	(0.071)	(0.053)	(0.081)	(0.096)	
HIND	-4.295*	-4.364***	-2.456*		
	(2.384)	(1.430)	(1.304)		
NERI	-0.032	-0.034*			
	(0.021)	(0.021)			
SG	0.000				
	(0.035)				
TLTD	0.010				
	(0.051)				
Chi-squared	0.805	0.828	1.892	4.671	59.559
Degree of freedom	2	4	5	6	11
J-Test	0.669	0.935	0.864	0.613	0.000
L-Test	n.a.	0.989	0.587	0.091	0.000

Table 5 The Investment Euler Equation Estimations: Controlling for Industries

We estimate the investment Euler equation models on various Chinese industries for 2003-2005. We choose the industries with sizeable number of firms in our sample (see Table 1). Columns (1) – (5) report the estimation results for Textile (17), Raw Chemical (26), Nonmetal Products (31), Ordinary Machinery (35), and Electrical Machinery and Equipments (39) respectively. Column (6) reports the estimation results on the full sample, in which we include thirty-seven industry dummies into the discount factor function. GMM estimation is conducted on the model in first differences with twice lagged instruments. α_1 and α_2 are adjustment cost parameters, and μ is a mark-up. $D^{private}$, $D^{collective}$, D^{mixed}, $D^{foreign}$, $D^{HK/TW}$ and D^{SOE} are dummy variables indicating a firm's ownership type. The estimated coefficients of D^{SOE}, and D^{SOE}*LNLABOR are set to be zero. LNLABOR is the natural logarithm of the number of the employees. Standard errors are reported in parentheses. The p-values of the J-Test on model specification are reported in the last row.
*, **, and *** represent the significance levels at the 10%, 5%, and 1% respectively.

	(1) Textile	(2) Raw Chemical	(3)Nonmetal Products	(4)Ordinary Machinery	(5)Elec. Machinery	(6) Full sample
α_1	0.013	-0.018	0.179	0.102*	0.075	0.067
	(0.029)	(0.050)	(0.129)	(0.057)	(0.111)	(0.128)
α_2	-0.008	0.035	-0.324	-0.157*	-0.092	-0.086
	(0.046)	(0.079)	(0.221)	(0.093)	(0.165)	(0.202)
μ	1.246***	0.934***	1.193***	1.189***	0.997***	1.025***
	(0.079)	(0.109)	(0.060)	(0.035)	(0.043)	(0.028)
$D^{private}$	-0.811**	-1.052***	-1.598***	-1.008***	-1.557***	-1.578***
	(0.184)	(0.094)	(0.422)	(0.096)	(0.421)	(0.731)
$D^{collective}$	-1.027***	-1.065***	-1.821***	-0.973***	-1.055***	-0.355
	(0.110)	(0.094)	(0.607)	(0.136)	(0.251)	(0.946)
D^{mixed}	-1.037***	-0.845***	-0.607	-1.418***	-0.252	0.531
	(0.142)	(0.126)	(0.415)	(0.213)	(0.501)	(1.220)
$D^{foreign}$	-1.117***	-0.881***	-0.733	-1.077***	-1.137***	-2.013***
	(0.179)	(0.254)	(1.510)	(0.226)	(0.233)	(0.621)
$D^{HK/TW}$	-0.791**	-1.520***	-1.175	-1.094***	-0.396	0.245
	(0.247)	(0.495)	(0.921)	(0.275)	(0.573)	(1.248)
LNLABOR	-0.132***	-0.153***	-0.160***	-0.163***	-0.186***	-0.130***
	(0.009)	(0.010)	(0.014)	(0.009)	(0.018)	(0.018)
$D^{private}$*LNLABOR	0.094**	0.163***	0.288***	0.161***	0.302***	0.280*
	(0.040)	(0.024)	(0.088)	(0.022)	(0.093)	(0.154)
$D^{collective}$*LNLABOR	0.139***	0.165***	0.317***	0.159***	0.190***	0.061
	(0.019)	(0.021)	(0.115)	(0.031)	(0.043)	(0.152)
D^{mixed}*LNLABOR	0.135***	0.122***	0.101	0.240***	0.041	-0.108
	(0.024)	(0.022)	(0.067)	(0.037)	(0.089)	(0.202)
$D^{foreign}$*LNLABOR	0.154***	0.129***	0.112	0.178***	0.212***	0.356***
	(0.179)	(0.050)	(0.297)	(0.042)	(0.039)	(0.115)
$D^{HK/TW}$*LNLABOR	0.091*	0.259***	0.198	0.182***	0.070	-0.084
	(0.047)	(0.099)	(0.184)	(0.063)	(0.098)	(0.235)
# of firms (% of full sample)	2,738 (7.6%)	2,646 (7.3%)	2,899 (8.0%)	2,763 (7.7%)	3,218 (8.9%)	36,103 (100%)
Chi-squared	4.747	7.439	1.020	9.811	2.556	0.604
Degree of freedom	6	6	6	6	6	6
J-Test	0.577	0.282	0.985	0.133	0.862	0.996

Table 6 The Investment Euler Equation Estimations: On Privatized Firms

We estimate the investment Euler equation models over a sub-sample of firms that were privatized during the 2003-2005 period. We start with **5,163** state-owned enterprises (SOEs) in 2003. **500** firms changed their ownership status to mixed (joint stock); and **98** firms changed their ownership status to private either in 2004 or 2005. We create two dummies variable **MIX** and **Private**, both of which take the value of 1 if an SOE's status is either a mixed or private firm in that year. Nonlinear GMM estimation is conducted on the model in first differences with twice lagged instruments. There are in total 20 instruments in our estimations. α_1 and α_2 are adjustment cost parameters, and μ is a mark-up. LNLABOR is the natural logarithm of the number of the employees, SG is sale growth rates; HIND measures the industry-level Hirfindahl index; NERI is a variable designed by Fan and Wang (2004) to examine the extent of marketization in each province in China. TLTD is the ratio long-term liabilities to total assets. Standard errors are reported in parentheses. The p-values of the J-Test and L-Test on model specification are reported in the last two rows.

*, **, and *** represent the significance levels at the 10%, 5%, and 1% respectively.

	(1)	(2)	(3)
α_1	0.106	0.109	0.206*
	(0.169)	(0.167)	(0.114)
α_2	-0.282	-0.288	-0.421*
	(0.307)	(0.302)	(0.216)
μ	1.023***	1.025***	1.177***
	(0.061)	(0.061)	(0.027)
MIX	-1.223**	-1.260***	-0.075*
	(0.579)	(0.437)	(0.421)
Private	-0.546		
	(2.679)		
LNLABOR	-0.193***	-0.193***	-0.173***
	(0.014)	(0.014)	(0.006)
MIX*LNLABOR	0.198**	0.206***	
	(0.093)	(0.069)	
Private*LNLABOR	0.117		
	(0.546)		
HIND	6.409**	6.349**	4.876*
	(2.642)	(2.601)	(2.816)
NERI	-0.091***	-0.095***	-0.088***
	(0.019)	(0.017)	(0.017)
SG	-1.603***	-1.606***	-1.358***
	(0.433)	(0.430)	(0.375)
TLTD	-0.599***	-0.593***	-0.441***
	(0.183)	(0.178)	(0.141)
Chi-squared	5.933	6.036	17.622
Degree of freedom	8	10	11
J-Test	0.747	0.871	0.128
L-Test	n.a.	0.765	0.011

Table 7 The Investment Euler Equation Estimation on China's Listed Firms, 1999-2005

We estimate the investment Euler equation model against another firm population --- the universe of China's listed firms. We exclude financial firms and firms with missing variables, and obtain a balanced sample with 646 listed firms. We construct several corporate governance variables to capture the impact of institutions on the discount factor perceived by firm managers. The detailed definition is in the first column of the table. LNLABOR is the natural log of the number of the employees, H- and B- dummy specifies whether a firm has shares issued to and traded by foreign investors. CFK is the ratio of cash flow to total assets; HIND measures the industry-level Hirfindahl index; B/M refers to book to market ratio. Standard errors are reported in parentheses. The p-value of the J-Test on the model specification is reported in the last row.

***, **, and * represent significance at 1%, 5%, and 10% respectively.

	GMM estimated coefficients
α_1	-0.226
	(0.275)
α_2	0.245
	(0.349)
μ	1.057***
	(0.057)
SOE dummy	0.133***
	(0.041)
H- or B- share dummy	-0.355**
	(0.169)
Is CEO also the Board Chairman?	0.029
	(0.038)
Percentage of Shares held by controlling shareholder	-1.168**
	(0.521)
Outside board members / total board members	-0.117**
	(0.054)
Is the listed firm one part of a group?	0.081
	(0.062)
LNLABOR	-0.094***
	(0.014)
CFK	0.062
	(0.054)
HIND	0.042
	(0.073)
β – measure of systematic risk	-0.721
	(1.019)
B/M	0.231
	(0.171)
Chi-squared	
	13.387
J-Test	
	0.214

Table A1 GDP, Fixed asset investment, and FDI in China 1990-2005
Source: China Statistical Yearbook
Exchange rate: 1 US$ = RMB 8.026

Year	Gross Domestic Product (RMB bn)	Fixed asset investment (RMB bn)	Percent of GDP	Foreign Direct Investments (USD bn)	Percent of GDP
1990	1871.8	451.7	24.13%	3.49	1.50%
1991	2182.6	559.5	25.63%	4.37	1.61%
1992	2693.7	808.0	30.00%	11.01	3.28%
1993	3526.0	1307.2	37.07%	27.52	6.26%
1994	4810.9	1704.3	35.43%	33.77	5.63%
1995	5981.1	2001.9	33.47%	37.52	5.03%
1996	7014.3	2291.4	32.67%	41.73	4.77%
1997	7765.3	2494.1	32.12%	45.26	4.68%
1998	8302.4	2840.6	34.21%	45.46	4.39%
1999	8818.9	2985.5	33.85%	40.32	3.67%
2000	9800.1	3291.8	33.59%	40.72	3.33%
2001	10806.8	3721.4	34.44%	46.88	3.48%
2002	11909.6	4349.9	36.52%	52.74	3.55%
2003	13517.4	5556.7	41.11%	53.51	3.18%
2004	15958.7	7047.7	44.16%	60.63	3.05%
2005	18395.6	8877.4	48.26%	60.33	2.63%

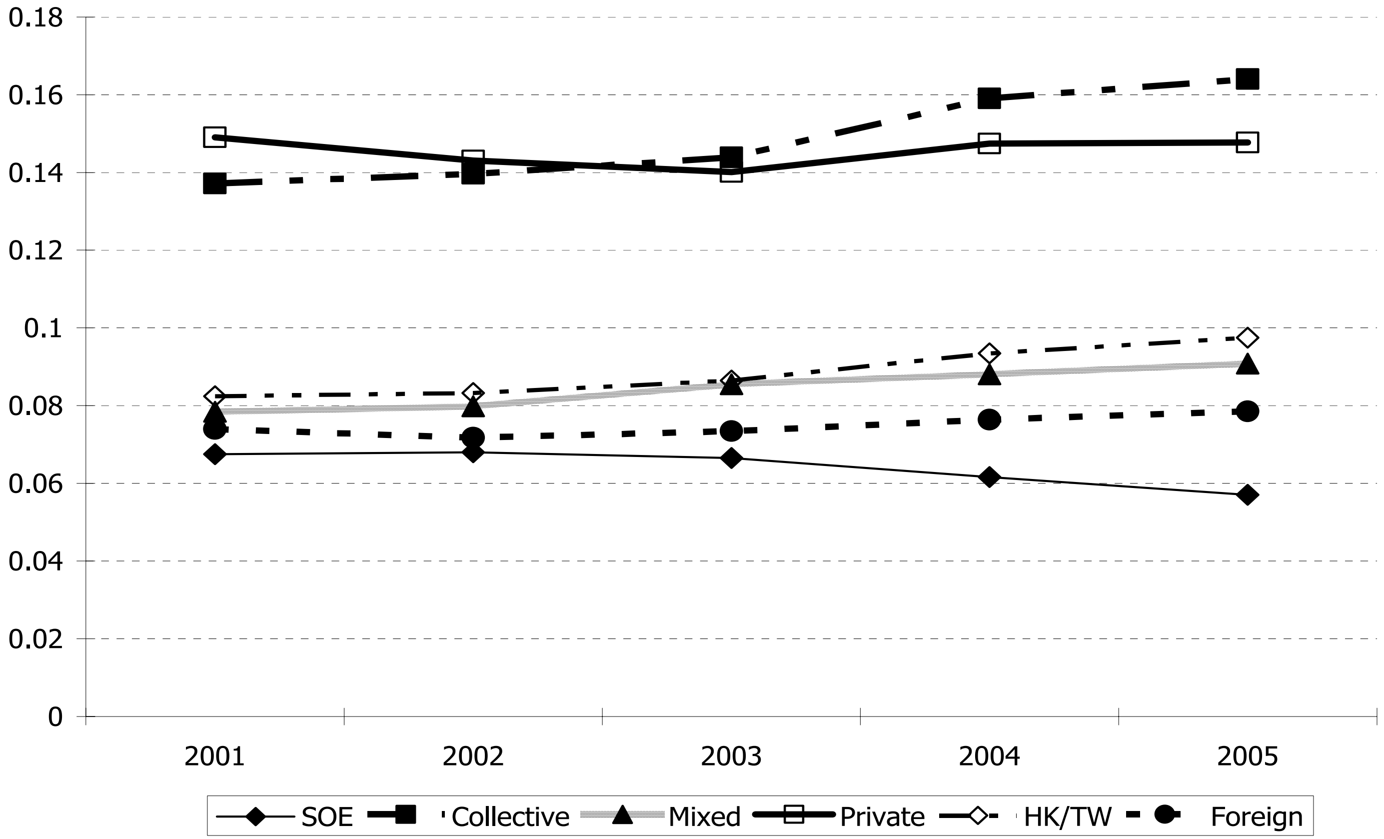
Table A2 Fixed asset investment by corporate ownership 2000-2005
Source: China Statistical Yearbook
Unit: RMB bn

Fixed Asset Investment						
	2000	2001	2002	2003	2004	2005
SOE	1650.4	1760.7	1887.7	2166.1	2502.8	2966.7
	50.14%	47.31%	43.40%	38.98%	35.51%	33.42%
Collective	489.6	537.3	612.6	819.8	1018.3	1219.9
	14.87%	14.44%	14.08%	14.75%	14.45%	13.74%
Mixed	406.2	566.4	832.9	1273.4	1769.8	2353.6
	12.34%	15.22%	19.15%	22.92%	25.11%	26.51%
Private	470.9	542.9	651.9	772.0	988.1	1389.1
	14.31%	14.59%	14.99%	13.89%	14.02%	15.65%
HK/TW	129.3	158.3	176.5	237.5	311.4	376.7
	3.93%	4.25%	4.06%	4.27%	4.42%	4.24%
Foreign	131.3	141.5	168.5	253.4	385.4	465.7
	3.99%	3.80%	3.87%	4.56%	5.47%	5.25%
Others	13.9	14.2	19.8	34.6	72.1	105.7
	0.42%	0.38%	0.46%	0.62%	1.02%	1.19%
Total	3291.8	3721.3	4349.9	5556.7	7047.7	8877.4
	100%	100%	100%	100%	100%	100%

Table A3 The breakdown of sample firms by region

Code	Region	# of firms	Percent
11	Beijing	993	2.75
12	Tianjin	936	2.59
13	Hebei	1,337	3.7
14	Shanxi	511	1.42
15	Inner Mongolia	292	0.81
21	Liaoning	1,352	3.74
22	Jilin	337	0.93
23	Heilongjiang	357	0.99
31	Shanghai	2,664	7.38
32	Jiangsu	4,911	13.6
33	Zhejiang	5,399	14.95
34	Anhui	649	1.8
35	Fujian	2,254	6.24
36	Jiangxi	284	0.79
37	Shandong	2,561	7.09
41	Henan	1,313	3.64
42	Hubei	590	1.63
43	Hunan	364	1.01
44	Guangdong	4,721	13.08
45	Guangxi	488	1.35
46	Hainan	100	0.28
50	Chongqing+Sichuan	1,666	4.61
52	Guizhou	403	1.12
53	Yunnan	537	1.49
54	Tibet+Qinghai+Ningxia	121	0.34
61	Shaanxi	502	1.39
62	Gansu	235	0.65
65	Xinjiang	226	0.63
Total		36,103	100

Figure 1 The Investment-Implied Return on Captial By Ownership: 2001-2005



Note: We plug the variable values for each firm into the estimated discount factor function as specified in Model 3 of Table 4 (the benchmark model). We make an assumption that the average discount rate for all of the firms in our sample is 10%. We thus back out the value of the intercept in the discount factor function, 1.929. We then compute the investment-implied discount rate for each firm in each year. We aggregate those firm-year observations by ownership and year.

Figure 2 The market of bank lending for SOEs

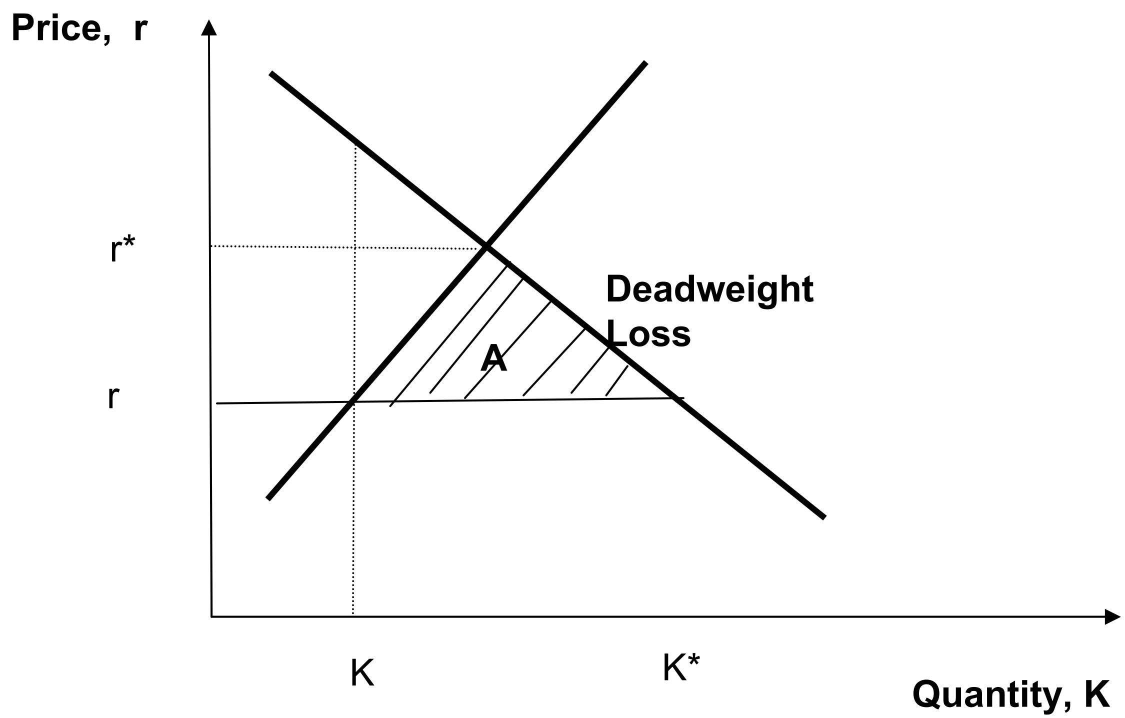


Figure 3 The market of bank lending for the private firms