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Kentaro Imai †

(Abstract)

Using a panel dataset of firms for the period 1999-2008, we estimated the prevalence of zombies among Japanese Small- and Medium-sized enterprises (SMEs) and their borrowing and investment behaviors. We observe that 4-14% of SMEs were zombie firms during the period 1999-2008.

Analysis of borrowing behavior indicates that zombie firms could not reduce their loans. Reductions in the land values of SMEs did not lead to a decrease in the borrowing of zombie firms due to ever-greening. We also observe that the profitability of investment, measured by marginal q, did not increase investment among zombie firms because evergreen loans increased investment in less productive and profitable projects.

Keyword; zombie firms, ever-greening, SMEs, borrowing, investment
JEL classification G21 E22 and E44

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1. Introduction

This paper explores the extent to which zombie SMEs existed in Japan and their borrowing and investment behavior using firm panel data. The dataset we use is a balanced dataset of non-consolidated financial statements of 4,090 SMEs from 1998 to 2008 that were edited by Tokyo Shoko Research.

Many studies have analyzed listed zombie firms in Japan, but far less research explores the existence of SME zombies in Japan. The misallocation of bank lending has been implicated in the ever-greening of loans. Caballero, Hoshi and Kashyap (2008) (hereafter, CHK) argue that the existence of zombie firms, that is, firms that should exit the market but continue to operate through bank assistance[1], has negative effects on the firm performance, productivity and investment of healthy firms. CHK conclude that the existence of zombie firms is responsible for stagnation in the Japanese economy. Fukuda and Nakamura (2011) (hereafter, FN) argue that CHK include excellent firms in their definition of zombie firms. Thus, FN identify zombie firms using a unique method. Additionally, FN consider why most of these firms recovered and did not experience bankruptcy primarily using listed firm data. However, CHK and FN consider only listed firms.

However, the Japanese economy dominantly consists of SMEs rather than listed firms. The 99.7% of firms operated in non-primary industry is SMEs and the 62.7% of full-time workers are employed in SMEs in 2012. [2]Moreover, SMEs may have been more affected by the banking sector than listed firms because the SMEs mainly rely on bank loans and do not issue bonds.

Therefore, it is important to analyze how extensively the banking sector influenced SMEs. No research has examined the emergence of ever-greening and zombie SMEs, using the analytical methods employed by CHK and FN. Moreover, very few studies estimate the borrowing and investment functions of SMEs using micro data. In particular, no research has shed light on the borrowing and investment behaviors of zombie SMEs. For these reasons, we examine the characteristics of zombie SMEs in Japan and their borrowing and investment behaviors.

The remainder of this paper is organized as follows. In section 2, we review previous research on the identification of zombie firms and borrowing and investment behaviors in Japan. In section 3, we estimate the extent to which zombie SMEs existed in Japan by modifying the methods developed by CHK and FN. In section 4, we present our estimated model. In section 5, we present descriptive statistics, and in section 6, we report the estimation results. Section 7 concludes.

2. A Literature Review of Zombie Firm Identification and their Behavior

In this section, we review the previous research that addresses the identification of zombie firms, ever-greening as well as the borrowing and investment behaviors of Japanese SMEs.

2.1 Identification of Zombie Firms

[1] This assistance includes interest rate exemption and ever-greening.

[2] See 2012 Economic Census reported by Ministry of Internal Affairs and Communications and Ministry of Economy, Trade and Industry.

Before addressing zombie identification using the method developed by FN, we identify zombie firms using the CHK method. The CHK criterion is defined as the minimum required interest payment for each firm each year, $R^*_{i,t}$, as follows:

$$\mathrm{R}^*_{i,t} = \mathrm{rs}_t \cdot BS_{i,t-1} + \left(\frac{1}{5}\sum_{j=0}^{4} rl_{t-j}\right) \cdot BL_{i,t-1} + \min(rcb_{t-4}, \dots, rcb_t) \cdot Bonds_{i,t-1}{}^{3} \qquad (1)$$

where $BS_{i,t-1}, BL_{i,t-1}$, and $Bonds_{i,t-1}$ represent short-term bank loans (less than one year), long-term bank loans (more than one year), and total bonds outstanding (including convertible bonds (CBs) and warrant-attached bonds), respectively, for firm i at the end of year t. Additionally, rs_t, rl_t, and $\min(rcb_{t-4}, \dots, rcb_t)$ represent the average short-term prime rate in year t, average long-term prime rate in year t, and minimum observed coupon rate for convertible corporate bond issued over the last five years, respectively.

The CHK criterion compares the actual interest payments made by firm $R_{i,t}$ with a hypothetical lower bound $R^*_{i,t}$. The CHK criterion normalizes the interest payment difference using the total outstanding of borrowing at the beginning of the period, $(\mathrm{B}_{i,t-1} = BS_{i,t-1} + BL_{i,t-1} + Bonds_{i,t-1} + \mathrm{CP}_{i,t-1})$, where $\mathrm{CP}_{i,t-1}$ represents the commercial paper outstanding for firm i at the beginning of period t, so that the units are comparable to the interest rate. Using the CHK criterion, the firm is considered zombie if $(R_{i,t} - R^*_{i,t})/B_{i,t-1} = r_{i,t} - r^*_{i,t} < 0$,.

However, FN warn that high-performing firms that receive low interest rates might be considered zombies according to the CHK criterion. According to the FN, firms should satisfy both a profitability criterion and a financial support criterion in order to qualify as zombies.

The profitability criterion holds if the earnings before interest and taxes (EBIT)[4] fall below the minimum required interest payment. The following basic concept underpins this criterion: if a firm cannot pay the minimum required interest, a firm is non-performing.

The financial support criterion holds if firms either satisfy the CHK criterion or can obtain new loans. If current year borrowing exceeds the previous year borrowing (with a threshold for long-term borrowing of 1 year), it implies that the firm was able to obtain new loans. When a firm cannot pay the minimum required interest payment or receives new loans, the firm experiences ever-greening.

FN state that the zombie ratio of listed firms decreases after 2005. However, only a few firms declared bankruptcy; therefore, most listed zombie firms recovered and became healthy firms[5].

We basically identify zombie firms and estimate the zombie ratio using the methods developed by CHK and FN. However, the FN method is also inadequate because healthy firms that experience temporary

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[3] CHK use the long-term prime rate, short-term prime rate and coupon rate on convertible corporate bond on the previous fiscal year base. However, we use current year interest rates. As FN presume that CHK organize financial data and interest rates by calendar year, we organize the database by fiscal year. We then use these interest rates for the current year base period.

[4] We calculate EBIT as follows: current profit + interest expense – interest income.

[5] FN note that listed zombie firms recovered by downsizing employees and assets.

decreases in profits might be identified as zombies. We therefore devised an original zombie identification method (i.e., a modified FN method). This method is discussed in details in section 3.

We now describe the previous research that addresses ever-greening among SMEs.

Fukuda et al. (2006) analyze whether ever-greening exists in unlisted Japanese firms and argue that ever-greening exists when the debt-asset ratio is greater than 3. They note that only a few firms exhibit debt-asset ratios greater than 3 and conclude that ever-greening seldom occurs among SMEs.

Sakai et al. (2010) conclude that no unnatural selection or ever-greening occurs among SMEs because the expected borrowing cost of surviving firms falls below that of the exiting firms and the expected ROA of the surviving firms exceeds that of the exiting firms.

However, Fukuda et al. (2006) consider only the profit rate and debt-asset ratio of the borrowing firms and do not consider other firm characteristics. Moreover, they do not identify firms as zombies or non-zombies. While Sakai et al. (2010) compared surviving firms with exiting firms, they do not analyze remaining zombie firms that should have exited, such as those considered by CHK.

Therefore, it is important to identify zombie SMEs directly using their financial statements.

2.2 Borrowing and Investment Behaviors of SMEs

In this section, we review the previous research that addresses the borrowing and investment behavior of SMEs during the recent years in Japan.

A considerable amount of research addresses recent firm investment in Japan. However, no research investigates recent borrowing and investment behaviors among SMEs from the viewpoint of changes in bank lending, and the soft budget problem. We take account of the bank's capital adequacy ratio and ratio of nonperforming loans to proxy for bank soundness, which intrinsically affects the behavior of their client firms through bank lending.

Ogawa (2003) estimates the firm investment function using firm micro data, and he indicates that bank willingness to lend affected firm investment significantly and that the severe lending attitudes of financial institutions deterred investment among small firms. However, the measure of bank willingness to lend is not constructed from micro data and cannot represent individual banks' willingness to lend.

In a subsequent study, Ogawa (2008) uses micro data and indicates that a bank nonperforming loan ratio negatively affects lending attitudes toward their client SMEs and subsequently the rate of change in fixed tangible assets of their client SMEs. However, this study did not utilize the change or changing rate of bank lending to client firms.

Fukuda et al. (2007) estimate investment function for SMEs using recent micro data. They use the capital adequacy ratio and nonperforming loans ratio of the firms' main banks and conclude that the soundness of the banks affected client investment. However, these authors do not consider changes in bank lending.

These studies indicate that a capital crunch occurred and it decreased recent investment, especially among SMEs. Bank financial health and firm land values affected firm investment through the lending of their main banks. However, these investigations did not consider change or changing rate of bank lending directly for recent years in Japan using SME micro data. Bank soundness would have affected their client

firms through bank lending. Therefore, it is important to estimate the borrowing and investment functions, including the change in bank lending, using SME micro data.

3. The Identification of Zombie SMEs

Before estimating the borrowing and investment functions, we first estimate the number of zombie SMEs in Japan. We identify zombie firms using both the CHK and FN criteria. If we use only the FN criteria, we might mistakenly identify non-zombie firms as zombie firms if the non-zombie firms experienced temporary profit decreases[6]. Similarly, we might mistakenly identify zombie firms as non-zombie firms if the zombie firms experienced temporary profit increases.

Therefore, we use the following modified FN profit criterion to identify zombie firms (.i.e., we do not change the FN financial support criterion in this paper).

Where the firms satisfy the following dynamic condition, we say that the firms satisfy the modified FN profit criterion:

$$\sum_{m=0}^{T}(EBIT_{i,t-m} - R^{*}_{i,t-m}) < 0 \qquad (2)$$

Note that when T equals 0, this condition corresponds to the FN profit criterion.

If firms satisfy the modified FN profit and financial support criteria (the CHK criterion that the actual interest payment falls below the theoretical minimum interest payment or that the firm can obtain a new loan), we consider them zombies. In so doing, we excluded firms that capitalized more than 10 billion yen to focus on SME zombies.

We identify zombie firms by the CHK, FN and modified FN with T=1-9 criterion, respectively and then calculate the zombie ratios. The results are displayed in Table 1. Using the CHK criterion, between 30-40% of SMEs are zombie firms. Using the FN criteria, we regard approximately 14% of firms as zombies in 1999 and thereafter the zombie ratio exhibits a downward trend. Moreover, the zombie ratios after T=3 hovers around 4-7% stably. Therefore, when SMEs satisfy both modified FN profit criterion for T=3 and the financial support criterion, we consider these SMEs to be zombie firms by modified FN criterion[7].

Judging from the proportion of zombie firms in Table 1, we can confirm that between 4-7% of SMEs were zombies even if we estimate zombie firms conservatively. This result is quite different from the previous studies, which reported that there were only a few zombie firms among SMEs. Figures 1 to 4 compares the FN and modified FN criteria zombie firm ratios by industry and equity capital.

Figure 1 provides the FN zombie ratio by equity capital and Figure 2 provides the modified FN zombie ratio by equity capital. These figures indicate that there are many zombie firms among SMEs capitalized at less than 10 million yen. Between 9-20% of the SMEs capitalized at less than 10 million yen are zombie firms by the modified FN zombie criteria. Using the modified FN zombie criteria, the zombie ratio of SMEs capitalized at between 10 million and 100 million yen is approximately 5%. Additionally, the zombie ratio of SMEs capitalized at between 100 million 1 billion yen is in the range of

[6] For example, non-zombie firms may experience temporary losses.

[7] In the subsequent section it turns out that the estimation results of borrowing and investment functions were unaltered regardless of the choice of T in identifying FN zombie firms. We therefore present only modified FN zombie firms for T=3.

4-7%. These ratios are relatively low and have similar values. In addition, using the modified FN criteria, the zombie ratio of firms capitalized at more than 1 billion yen is in the range of 5-13%. The zombie ratio for these large firms is relatively high.

Interestingly, the results above indicate that ever-greening occurred even in SMEs. Therefore, it suggests that the Regional Banks, Second Association of Regional Banks, Sinkin Banks and Credit Unions, known as regional financial agencies, may have protected their client firms. Moreover, the credit-guarantee system (Sinyo Hosho Seido) of local governments would have protected regional SMEs. Hoshi and Kashyap (2010) note that the Japanese government required banks receiving public capital to increase lending to SMEs. This forced lending may have increased non-performing loans. A white paper on SMEs in Japan (1999) observed that smaller firms faced more permissive lending in 1998 as a Japanese government took countermeasures against the credit crunch. This policy might explain why many SMEs capitalized at less than 10 million yen are identified as zombies.

Figures 3 and 4 depict the zombie ratios by equity capital using the FN criteria and modified FN criteria, respectively. Many zombie firms existed in the finance and real estate industries. The figures hint that disposition of non-performing loans did not progress in these industries. The zombie ratio in the finance industry increased after the Lehman Brothers bankruptcy. However, the zombie ratio in the construction industry is relatively low. It seems that in the construction sector, banks bankrupted many non-performing firms, and ever-greening did not occur. Moreover, we also observe high zombie ratios in other industries. These industries exhibit zombie ratios in the range of 3-12%, which decrease over time, as indicated in Figure 4.

Note that the zombie ratio is extremely high in March 1999, as indicated in Figures 1 and 3. The special credit-guarantee system, established for saving troubled SMEs, might have temporarily increased the number of zombie firms[8]. The special credit-guarantee system was accessed on over 1,720,000 occasions for a total of 29 trillion yen. Matsuura and Hori (2003) demonstrated that firms that used the special credit-guarantee system tended to suffer from excessive debt and low profits. Many of these firms might be identified as zombies[9]. The zombie ratio exhibits a downward trend until 2007, which indicates that many zombie firms eventually became healthy firms.

There is a caveat in interpreting our results. Our dataset is a balanced panel consisting of surviving firms, so that these data do not include failed firms by definition, which were likely zombie firms prior to bankruptcy[10]. A dataset that included failed firms would have enabled us to analyze why banks protect rather than bankrupt their non-performing clients. If the information of whether firms had used the special credit-guarantee system were available, we could estimate the effect of this policy measure on zombie ratio and bankruptcies.

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[8] This was kindly pointed out by Yasuo Goto.

[9] Access to the firm micro data used by Matsuura and Hori (2003) would enable them to calculate the zombie ratio of firms that utilized the special-credit guarantee system.

[10] If the data had included failed firms, we could have checked whether the zombie ratio was higher than the current estimate. Hoshi (2006) states that listed zombie firms tend to exit.

4. Models of Borrowing and Investment Behaviors of SMEs

To investigate the borrowing and investment behaviors of SMEs, notably zombie SMEs, we estimate the following borrowing and investment equations, separately for all firms, FN zombie firms and modified FN zombie firms.

4.1 Specification of Borrowing Function

The borrowing function to be estimated is specified as follows:

$$\Delta Borrowing_{i,t} \Big/ Asset_{i,t-1} = \alpha_0 + \alpha_1 \Delta lnS_{i,t} + \alpha_2 \frac{\pi_{i,t}}{Asset_{i,t-1}} + \alpha_3 \frac{Debt_{i,t-1}}{Asset_{i,t-1}} + \alpha_4 \frac{Land_{i,t-1}}{Borrowing_{i,t-1}}$$

$$+\alpha_5 BankCap + \alpha_6 BankNPL + \alpha_7 yeardummy + \alpha_8 Industialdummy + u_{i,t} \qquad (3)$$

where $Borrowing_{i,t}$ is the sum of the real value of long-term and short-term borrowing.[11] $S_{i,t}$, $\pi_{i,t}$, $\mathrm{Debt}_{i,t}$, $Land_{i,t}$ and, $u_{i,t}$ represent the real values of sales, real values of current profit, long- and short-term borrowing and bonds, land values, and error terms.

$BankCap$ and $BankNPL$ are the capital adequacy ratios and non-performing loans (NPL) ratios The firms located in the same prefecture take the same values of $BankCap$ and $BankNPL$ since we can identify the firm location, but we cannot identify the main bank of individual firms. Therefore we use the capital adequacy ratios and non-performing loans (NPL) ratios of the Regional Banks and Second Association of Regional Banks that are available on prefecture basis.[12].

We include the land-borrowing ratio as one of the explanatory variables because firm land is often used as collateral when firms borrow from banks, especially in SME financing. [13] Land collateral mitigates asymmetric information between firms and banks. Therefore we expect the sign of α_4 to be positive for all firms. However, we expect that α_4 is negative or statistically insignificant for zombie firms because a decrease in the collateral value might cause a soft budget problem. According to Berglof and Roland (1997), hard budget constraint equilibrium occurs when collateral value exceeds net verifiable returns from refinancing. On the other hand, when collateral value falls below net verifiable return refinancing, the bank has no incentive to activate the client and refinance a poor project.

We expect that α_1 is positive because firms require borrowing to expand their economic activities. We expect that α_2 is negative. When an asymmetric information problem exists, the internal financing cost will be lower than the external financing cost. Hence, the firms would raise the funds internally rather than borrowing from banks.

Comparison of the value of α_3 between all firms and zombie firms might be interesting because it corresponds to the comparison of the severity of over-leveraging between the entire sample and zombie firms.

[11] We use total borrowing rather than bank borrowing since the latter figure is not available in our dataset of SMEs.

[12] Details on the construction of capital adequacy ratios and NPL ratios on prefecture basis are provided in Appendix 3.

[13] Appendix 2 shows the procedure to calculate land value.

4.2 Specification of Investment Function

Now we turn to estimation of the marginal q-type investment function specified as follows:

$$I_{i,t}/K_{i,t-1} = \beta_0 + \beta_1 \Delta Borrowing_{i,t}/Asset_{i,t-1} + \beta_2 Mq_{i,t} + \beta_3 \frac{Cashflow_{i,t}}{K_{i,t-1}} + \beta_4 \frac{Debt_{i,t-1}}{Asset_{i,t-1}}$$

$$+\beta_5 yeardummy + \beta_6 Industialdummy + u_{i,t} \quad (4)$$

where $I_{i,t}$, $K_{i,t}$, $Mq_{i,t}$, and $CFLOW_{i,t}$ are investment, capital stock, marginal q and cash flow, respectively[14].

We calculated $Mq_{i,t}$ as follows. We assumed that the discount rates and profit rates of the firm follow the random walk.

$$r_{i,t+1} = r_{i,t} + u_{i,t+1}$$
$$\pi_{i,t+1} = \pi_{i,t} + v_{i,t+1} \quad (5)$$

where $\pi_{i,t}$, and $r_{i,t}$, are the profit rates and discount rates, respectively, and $u_{i,t+1}$ and $v_{i,t+1}$ represent stationary white noise. The discount rate was calculated by dividing the interest paid and the discount on note by the outstanding of long- and short-term borrowing, bonds and discount bills at the end of previous year. The profit rate was calculated by dividing the operating profit by the capital stock at the end of previous year.

Given the above assumptions, $Mq_{i,t}$ is expressed as follows:

$$Mq_{i,t} = \frac{\pi_{i,t}}{P_t^I} \frac{1 + r_{i,t}}{r_{i,t} + \delta} \quad (6)$$

where δ and P_t^I represent the capital depreciation rate, which is also used to construct capital stock series as reported by Hayashi and Inoue (1991) and the investment goods deflator reported by the Bank of Japan.

The cash flow is calculated as current income plus depreciation minus directors' bonus minus interim dividend. We expect that β_1, β_2, β_3 are positive for the entire sample of firms. When marginal q, borrowing and cash flow increase, investment would expand. When the Modigliani-Miller theorem is held, borrowing and cash flow do not affect investment. However, when asymmetric information exists between firms and banks, banks cannot monitor their clients perfectly and thus the external financing premium does exist. Moreover, we expect that β_1 is statistically insignificant for FN and modified FN zombie firms because new loans would be allocated to inefficient use, not efficient investment under ever-greening among zombie firms.

5. Descriptive Statistics

Tables 2 to 4 depict the descriptive statistics for all variables. We excluded sample firms whose absolute values of $\Delta Borrowing_{i,t}/Asset_{i,t-1}$, $\Delta lnS_{i,t}$ and $\pi_{i,t}/Asset_{i,t-1}$ exceeded 1, $I_{i,t}/K_{i,t-1}$ exceeded 2,

[14] The calculations for investment and capital stock series are detailed in Appendix 1.

$Mq_{i,t}$ exceeded 20, and $Land_{i,t-1}/Borrowing_{i,t-1}$ exceeded 10 as outliers. Moreover, we excluded firms capitalized at more than 10 billion yen as large firms.

First, we show the descriptive statistics of the explanatory variables of the borrowing function. Note that $\Delta Borrowing_{i,t}/Asset_{i,t-1}$ decreases over time for all firms. To the contrary, for FN and modified FN zombie firms, $\Delta Borrowing_{i,t}/Asset_{i,t-1}$ exhibited an increasing trend because they satisfied the financial support criterion and experienced ever-greening.

As for $Land_{i,t-1}/Borrowing_{i,t-1}$, it decreased for all firms as well as FN and modified FN zombie firms. These results indicate that the collateral value of land decreased. Comparing the $Land_{i,t-1}/Borrowing_{i,t-1}$ of FN and modified FN zombie firms with that of all firms, the former is approximately 30-50% of the latter. This fact might suggest that zombie firms borrowed more than the collateral land value or received ever-greening. The soft budget theory proposed by Berglof and Roland (1997) implies that ever-greening occurs when the value of collateral decreases. As the value of collateral decreases, the liquidation value decreases. This reduces lenders' incentives to bankrupt non-performing firms and leads to ever-greening. These results imply that zombie firms might experience soft budget problems. If the soft budget hypothesis is held, the land-borrowing ratio of bankrupt firms would be higher than that of zombie firms.

For all firms, $\Delta lnS_{i,t}$ and $\pi_{i,t}/Asset_{i,t-1}$ are positive, while for FN and modified FN zombie firms, these values are negative. These results indicate that healthy firms increased sales and that profit rates are positive while non-performing zombie firms could not increase sales and profit rates are negative[15].

Notably, the debt-asset ratios for FN and modified FN zombie firms were over 40% and did not decrease. The debt-asset ratio for all firms was approximately 30% in 2000 and exhibits a decreasing trend. These results suggest that healthy SMEs succeeded in reducing their debt; however, zombie firms are still burdened with debt.

Next, we outline the descriptive statistics for investment. $I_{i,t}/K_{i,t-1}$ is relatively stable, irrespective of firm type. We do not observe differences in the $I_{i,t}/K_{i,t-1}$ for either the entire sample or the zombie firm subsample, except for FN zombie firms in 2000 and 2001. These results indicate that there was no remarkable difference in investment rate across firms over time.

The marginal q and cash flows for all firms and zombie firms are very different. The marginal q and cash flow of zombie firms are lower than those of all firms. In particular, the marginal q and cash flow of FN zombie firms are extremely low. It might reflect our definistion of zombie firms because we imposed a profit criterion on zombie firms and marginal q and cash flow are calculated from the operating profit. In particular, FN zombie firms are considered zombie firms when their EBIT is under the minimum required interest payment even for only one year, in which case, the low profit firms are most likely concentrated within FN zombie firms.

6. Estimation Results

[15] We imposed a profit criterion on zombie firms, and thus $\pi_{i,t}/Asset_{i,t-1}$ of zombie firms are low.

We provide the estimation results of the borrowing function in Table 5. We estimated the borrowing function using fixed effects, random effects, OLS and robust OLS methods. The various statistics, such as F test, Hausman test and Blues Pegan Lagrange Multiplier (BPLM) test, suggest that the fixed effect results are acceptable for all firms, FN zombies and modified FN zombies. Thus, we present only the fixed effects results.

The estimated coefficient of $\Delta lnS_{i,t}$ is significant and positive for the entire sample of firms. Moreover, the coefficients of $\pi_{i,t}/Asset_{i,t-1}$ and $Debt_{i,t-1}/Asset_{i,t-1}$are significant and negative. The coefficients of $\Delta lnS_{i,t}$ and $\pi_{i,t}/Asset_{i,t-1}$ satisfy the expected signs.

As for the coefficient of $Land_{i,t-1}/Borrowing_{i,t-1}$, it is positive and significant at the 5% level for all firms, while it is insignificant for FN and modified FN zombies. These results demonstrate that decreases in the value of land collateral reduced borrowing from banks among healthy firms[16]. Note that the land-borrowing ratios of zombie firms are lower than those of all firms. These results for the zombies support the soft budget hypothesis proposed by Berglof and Roland (1997). The value of land collateral for non-performing firms decreased, and the liquidation value decreased, so that their lenders could not recover a profit by selling the land collateral. The banks therefore had no incentive to bankrupt firms. If the soft budget hypothesis is held, the value of land collateral of bankrupt firms, which is not included in our dataset, increases. As these liquidation values increased, banks could eliminate non-performing loans and gained profits by selling the land. Therefore, we could not obtain a significant coefficient of land-borrowing ratio for FN and modified FN zombies.

In Table 6, we show the estimation results of the Mq-type investment function. We used the panel instrument variable method. The endogenous variable is $\Delta Borrowing_{i,t}/Asset_{i,t-1.}$ The instruments are the explanatory variables of the investment function lagged by one year and the current and one-year-lagged explanatory variables for the borrowing function. The F test and Hausman test statistics indicate that the random effects instrumental variable method is appropriate for the entire sample of firms and the FN zombie firms, while the fixed effects instrumental variable method is adopted for modified FN zombies.

First, note that the coefficient estimate of $\Delta Borrowing_{i,t}/Asset_{i,t-1}$ is positive and significant at the 1% level for all firms, FN zombies and modified FN zombies. Moreover, the absolute value of the coefficient is much larger for all firms. According to the soft budget hypothesis, most of the ever-greening received by zombie firms would be allocated to repay their main banks and ever-greening would not affect investment so much. Thus our results support the soft budget hypothesis. Note that for all firms, $\Delta Borrowing_{i,t}/Asset_{i,t-1}$ and $Land_{i,t-1}/Borrowing_{i,t-1}$ exhibits a decreasing trend. These results imply that the decrease in land values for healthy firms decreased borrowing and investment.

As for the effect of marginal q on investment, the coefficient estimate of the marginal q is insignificant for modified FN zombie firms. Moreover, the coefficient estimate of the marginal q is negative and

[16] Note that $Land_{i,t-1}/Borrowing_{i,t-1}$ for all firms and zombie firms decreases over time as indicated in Table 3.

significant for FN zombies[17]. These results indicate that ever-greening received by modified FN zombie firms increased investment but these investments were not necessarily profitable or productive[18].

For all firms, the coefficients of marginal q and cash flow are positive and significant at the 1% level. The coefficients of cash flows are also significant and positive for FN and modified FN zombie firms.

As for the effect of debt-asset ratio on investment, the effects are mixed. The coefficient of the debt-asset ratio is insignificant for FN zombies, while it is positive and significant for all firms and modified FN zombies. The absolute value of the coefficient is much larger for modified FN zombies and it suggests that modified FN zombie firms aggressively allocated debt to investment.

7. Concluding Remarks

We estimated the extent to which zombie SMEs existed in Japan and examined their borrowing and investment behavior using balanced panel data of SMEs edited by Tokyo Shoko Research.

We confirm that many zombie firms existed among SMEs, especially among firms capitalized at less than 10 million yen at a modest estimate. One reason for this observation may be that regional financial agencies and local government credit-guarantee systems (Sinyo Hosho Seido) protected non-performing SMEs in each region.

Furthermore, recent decreases in land values induced a credit crunch in healthy firms. However, this crunch did not lead to a decrease of borrowing among zombie firms. This result suggests that the ever-greening of zombie firms was prevalent. Moreover, the credit crunch reduced productive or profitable investment among healthy firms, while ever-greening induced non-productive and non-profitable investment among zombie firms.

Given these results, it is a task for economists to analyze how ever-greening among zombie firms affected their productivity compared to the productivity of healthy firms[19]. In particular, we should investigate the determinants of the productivity of zombie firms. Hayashi and Prescott (2002) claim that the productivity of the Japanese economy slowed down during the lost decade. This slowdown might be attributable to non-efficient investment induced by ever-greening and zombie SMEs.

If we could obtain data from bankrupt firms and identify each firm's major lenders, we could analyze why banks protected zombie firms or bankrupted non-performing firms. In addition, we would be able to calculate the zombie ratio of SMEs by incorporating the bankrupt incidents of SMEs. It would be important to account for the factors, such as the credit-guarantee system (Sinyo Hosho Seido), bank type, bank

[17] According to FN criterion firms that experienced temporarily low profits and were otherwise healthy are classified as zombie firms, so that a low marginal q might be correlated with high investment for FN zombies.

[18] One might cast doubt on the reliability of computed marginal q for FN zombie firms because they reflect temporarily low evaluation. However, we excluded firms that experienced temporary losses from the modified FN zombie category. Therefore, the criticism above on marginal q is not held for the modified FN zombie.

[19] Ahearne and Shinada (2005) state that total borrowing in the non-traded goods sectors, such as construction, retail and wholesale, rose sharply during the 1990s and these sectors experienced low productivity growth. They conclude that ever-greening of zombie firms in non-traded goods sectors induced low productivity growth. However, they did not identify zombie firms from financial statements.

soundness, and trade terms with main lenders. Moreover, if the soft budget theory is held, fall of land value induced ever-greening. Thus, land values determine the choice of ever-greening or bankruptcy. It is one of the policy goals that regional financial agencies and governments protect local client firms to support regional economies[20]. Exploration into the banks' decision to bankrupt or ever-greening client SMEs is our future avenue for research.

[20] Recent SME data would allow us to calculate the effect of the Financial Service Agency's circular notice, which requested that banks protect their clients after the Lehman bankruptcy.

Appendices

Appendix 1. Construction of Investment and Capital Stock Series

We calculated investment series as follows. First, we calculated the real capital stock by dividing the capital stock by the capital goods deflator. Capital goods deflators are included in the "Index by Stage of Demand and Use" published by the Bank of Japan. We represent capital stock as K_t^{real}.

Second, we compute I_t as follows:

$$I_t = K_t^{real} - K_{t-1}^{real} + CIP_t + Dep_t$$

where CIP represents construction in progress and Dep represents depreciation.

Finally, we obtained the capital stock series following the perpetual inventory method:

$K_t = (1-\delta)K_{t-1} + I_t$

where δ is the depreciation rate reported by Hayashi and Inoue (1991). Benchmark stock is the capital stock in 1998.

Appendix 2. Construction of Land Stock Series

We calculated the current value of land from book values of land as follows. First, we estimated the book values of land per representative firm for four groups categorized by equity capital, using Surveys for the Financial Statements Statistics of Corporations (Hojin Kigyo Tokei Nenpo) reported by Ministry of Finance. Our four firm groups categorized by equity capital are those less than 10 million yen, those between 10 million yen and 100 million yen , those between 100 million yen and 1 billion yen and those more than 1 billion yen . Second, we estimated the current value per representative firm for each firm group by utilizing the Corporations Survey on Land (Hojin Tochi Kihon Chosa) compiled by the Ministry of Land, Infrastructure, Transport and Tourism. As of January 1, the data for 1998, 2003 and 2008 are available. Thus, we use the 1998 survey to compute the 1998-2000 current values. Similarly, we use the 2003 survey to compute the 2001-2005 current values and the 2008 survey to compute the 2006-2007 current values.

Third, we evaluated the current book value ratio for each firm group as:

$$\text{current book value ratio}_t = \frac{current\ value_t}{book\ value_t}$$

Finally, we calculated each firm's land assets at current value by multiplying each firm's book value of land by the current book value ratio above.

Appendix 3 Construction of the Capital Adequacy Ratio and

Non-Performing Loan Ratio by Prefecture

We calculated a measure for capital adequacy ratio and non-performing loan ratio of the Regional Banks (RB) and Second Association of Regional Banks (SARB) by prefecture.

We calculated each prefecture's capital adequacy ratio as follows:

$$\text{capital adequacy ratio by prefecture}_t = \frac{\sum_{i=1}^{n}(\{Capital\ adequacy\ ratio - BIS\ ratio) \times Loan\}_{i,t}}{\sum_{i=1}^{n} Loan_{i,t}}$$

where i is the bank, t is the year and n is the number of RBs and SARBs in each prefecture. The $BIS\ ratio$ is 8% when the bank is a bank operating international business. The $BIS\ ratio$ is 4% when the bank is operating domestic business only.

We calculate each prefecture's non-performing loan ratio as follows:.

$$\text{Non Performing Loan ratio by prefecture}_t = \sum_{i=1}^{n}\left(\frac{Non\ Performing\ Loan_{i,t}}{Loan_{i,t}} \times \frac{Loan_{i,t}}{\sum_{i=1}^{n} Loan_{i,t}}\right)$$

$$= \frac{\sum_{i=1}^{n} Non\ Performing\ Loan_{i,t}}{\sum_{i=1}^{n} Loan_{i,t}}$$

A $NonPerforming\ Loan$ is a risk-management loan.

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Figure 1
FN's Zombie Ratios by Equity Capital

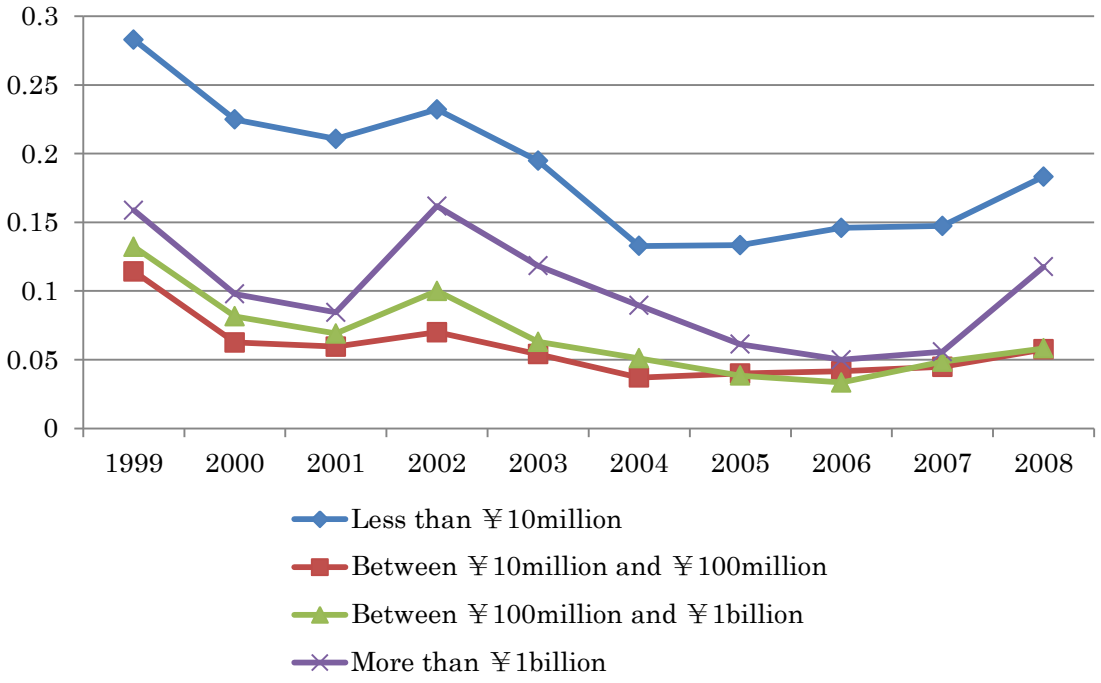
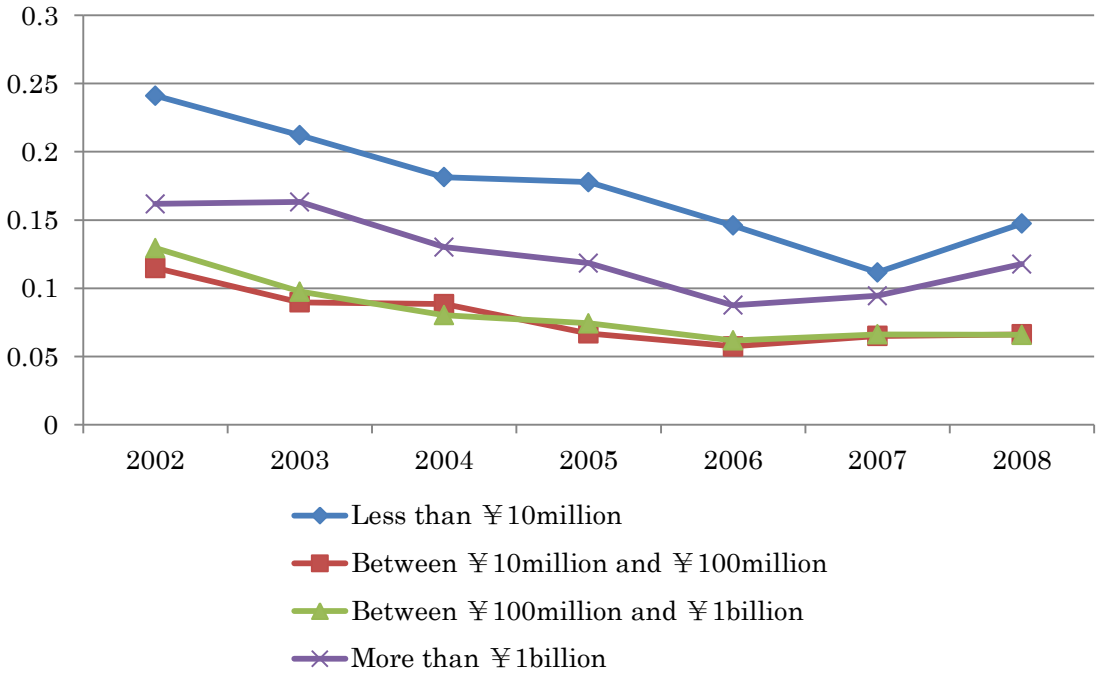


Figure 2
Modified FN's Zombie Ratios by Equity Capital



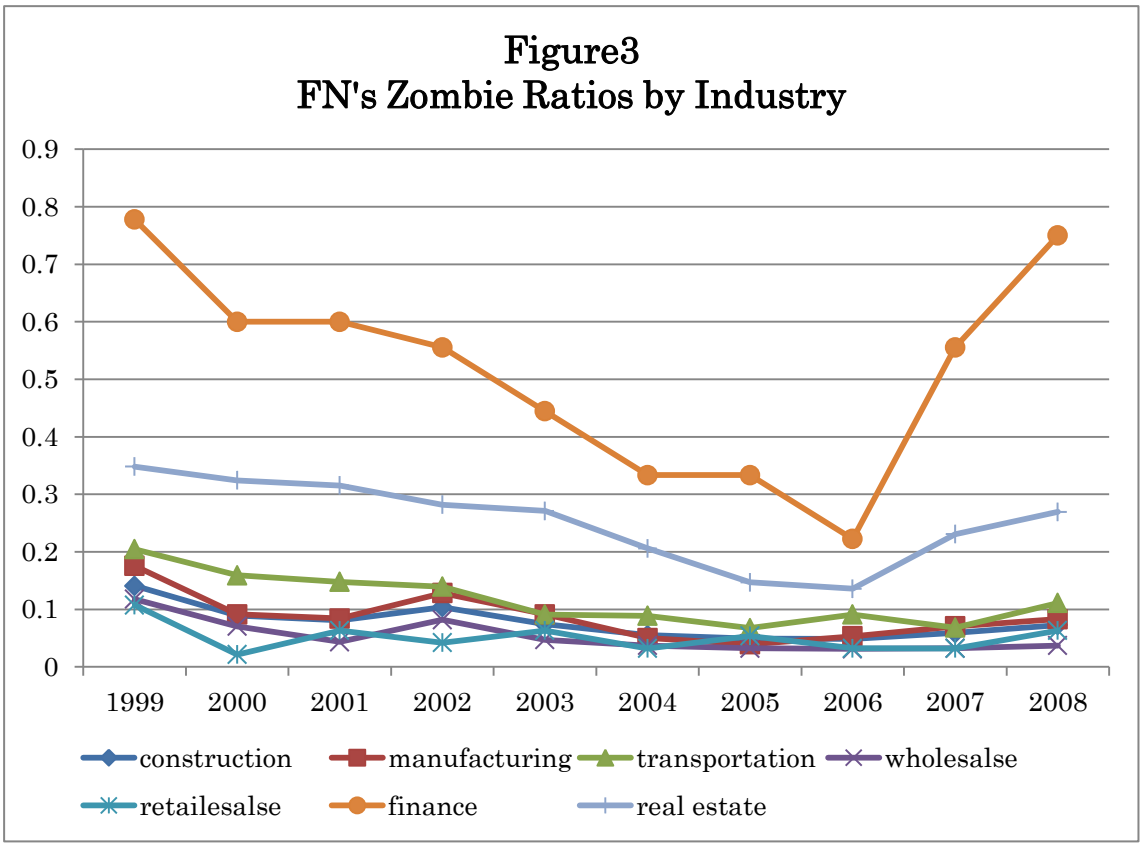


Figure3
FN's Zombie Ratios by Industry
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
construction
manufacturing
transportation
wholesalse
retailesalse
finance
real estate

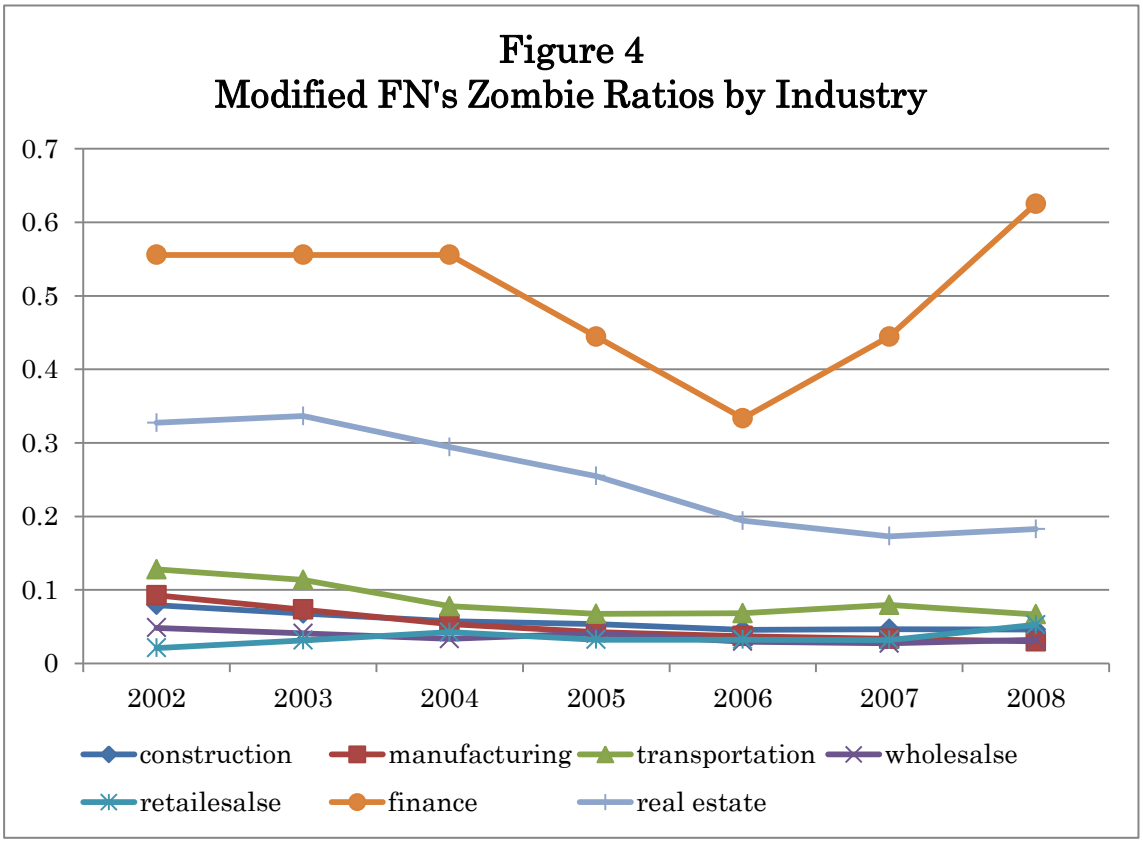


Figure 4
Modified FN's Zombie Ratios by Industry
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2002
2003
2004
2005
2006
2007
2008
construction
manufacturing
transportation
wholesalse
retailesalse
finance
real estate

Table 1 Estimates of Zombie Ratios by Three Criteria

year	CHK's criterion T=0(FN's criterion)	T=1	T=2	T=3(Modified FN's criterion)	T=4	T=5	T=6	T=7	T=8	T=9
1999	0.4190	0.1409	.	.	.	.	.	.	.	.
2000	0.3936	0.0890	0.1050	.	.	.	.	.	.	.
2001	0.4250	0.0807	0.0732	0.0816	.	.	.	.	.	.
2002	0.4290	0.1039	0.0836	0.0752	0.0794	.	.	.	.	.
2003	0.4298	0.0744	0.0833	0.0734	0.0678	0.0702	.	.	.	.
2004	0.4037	0.0551	0.0622	0.0645	0.0575	0.0523	0.0542	.	.	.
2005	0.3950	0.0490	0.0433	0.0490	0.0537	0.0518	0.0457	0.0471	.	.
2006	0.4030	0.0484	0.0442	0.0404	0.0456	0.0484	0.0470	0.0437	0.0432	.
2007	0.4050	0.0590	0.0492	0.0468	0.0468	0.0445	0.0515	0.0482	0.0459	0.0435
2008	0.3759	0.0727	0.0610	0.0521	0.0460	0.0460	0.0455	0.0511	0.0483	0.0450
Total	0.4079	0.0773	0.0672	0.0604	0.0567	0.0522	0.0488	0.0475	0.0458	0.0443

Table 2 Descriptive statics 1

year		⊿Borrowing/Asset,t-1			⊿lnS			π /Asset,t-1		
		All Firms	FN's Zombie	Modified FN's Zombie	All Firms	FN's Zombie	Modified FN's Zombie	All Firms	FN's Zombie	Modified FN's Zombie
1999	Mean	0.0100	0.0198		-0.0371	-0.0870		0.0241	-0.0162	
	S.D.	0.0757	0.0844		0.1418	0.1622		0.0408	0.0340	
2000	Mean	0.0050	0.0216		0.0116	-0.0401		0.0305	-0.0105	
	S.D.	0.0894	0.1245		0.1353	0.1518		0.0403	0.0226	
2001	Mean	-0.0009	0.0186		0.0487	0.0116		0.0326	-0.0152	
	S.D.	0.0840	0.0885		0.1432	0.1560		0.0441	0.0611	
2002	Mean	0.0009	0.0335	0.0234	-0.0215	-0.0759	0.0037	0.0254	-0.0193	-0.0089
	S.D.	0.0816	0.1006	0.0997	0.1497	0.1794	0.1830	0.0410	0.0472	0.0533
2003	Mean	-0.0126	-0.0011	-0.0128	0.0136	-0.0248	-0.0045	0.0303	-0.0140	-0.0017
	S.D.	0.0790	0.1145	0.1081	0.1446	0.1757	0.1803	0.0395	0.0322	0.0388
2004	Mean	-0.0144	0.0063	-0.0060	0.0282	-0.0273	0.0064	0.0354	-0.0127	0.0032
	S.D.	0.0910	0.0734	0.0904	0.1439	0.1641	0.1771	0.0442	0.0313	0.0326
2005	Mean	-0.0213	0.0044	-0.0230	0.0358	-0.0361	0.0119	0.0399	-0.0108	0.0112
	S.D.	0.0816	0.0667	0.0858	0.1400	0.1552	0.1615	0.0423	0.0287	0.0467
2006	Mean	-0.0140	0.0102	0.0069	0.0281	-0.0239	0.0100	0.0416	-0.0171	0.0022
	S.D.	0.0831	0.1042	0.0802	0.1266	0.1153	0.1048	0.0440	0.0521	0.0551
2007	Mean	-0.0113	0.0083	-0.0036	0.0289	-0.0265	0.0014	0.0418	-0.0185	-0.0048
	S.D.	0.0853	0.1149	0.1172	0.1377	0.1709	0.2050	0.0484	0.0466	0.0574
2008	Mean	-0.0022	0.0143	0.0156	0.0188	-0.0312	-0.0044	0.0378	-0.0175	-0.0095
	S.D.	0.0814	0.0870	0.1032	0.1318	0.1109	0.1010	0.0430	0.0395	0.0522
Total	Mean	-0.0059	0.0159	0.0007	0.0151	-0.0436	0.0033	0.0337	-0.0154	-0.0015
	S.D.	0.0838	0.0983	0.0997	0.1420	0.1609	0.1661	0.0432	0.0406	0.0486

Table 3 Descriptive statics 2

year		Debt,t−1/Asset,t−1			Land,t−1/Borrowing,t−1		
		All Firms	FN's Zombie	Modified FN's Zombie	All Firms	FN's Zombie	Modified FN's Zombie
1999	Mean	0.3486	0.4705		0.9391	0.4926	
	S.D.	0.2227	0.2456		1.3641	0.6635	
2000	Mean	0.3589	0.5096		0.9681	0.5729	
	S.D.	0.2215	0.2669		1.4051	1.1452	
2001	Mean	0.3509	0.4951		0.9588	0.5822	
	S.D.	0.2155	0.2735		1.3664	0.8998	
2002	Mean	0.3415	0.4558	0.4833	0.7062	0.4383	0.4558
	S.D.	0.2160	0.2509	0.2593	1.1594	0.9429	0.8039
2003	Mean	0.3492	0.4521	0.5063	0.7898	0.4627	0.4573
	S.D.	0.2172	0.2662	0.2752	1.2228	0.6794	0.7184
2004	Mean	0.3447	0.4267	0.4754	0.7425	0.4825	0.4718
	S.D.	0.2140	0.2850	0.2777	1.1302	0.8027	1.0413
2005	Mean	0.3323	0.4427	0.4599	0.8070	0.6657	0.4296
	S.D.	0.2111	0.2611	0.2672	1.1528	1.4075	0.9862
2006	Mean	0.3173	0.4656	0.4158	0.8783	0.5027	0.4470
	S.D.	0.2094	0.2550	0.2756	1.2851	0.8980	0.8831
2007	Mean	0.3039	0.4673	0.4453	0.8680	0.4857	0.4506
	S.D.	0.2051	0.2605	0.2736	1.3122	0.7928	0.8378
2008	Mean	0.2904	0.4266	0.4540	0.8882	0.4939	0.2734
	S.D.	0.2039	0.2640	0.2725	1.3802	0.9332	0.4543
Total	Mean	0.3345	0.4645	0.4673	0.8551	0.5102	0.4322
	S.D.	0.2149	0.2612	0.2712	1.2846	0.9046	0.8371

Table 4 Descriptive statics 3

year		I/K,t-1			Mq			Cashflow/K,t-1		
		All Firms	FN's Zombie	Modified FN's Zombie	All Firms	FN's Zombie	Modified FN's Zombie	All Firms	FN's Zombie	Modified FN's Zombie
1999	Mean	0.2016	0.1923		2.6224	-1.1090		0.2238	-0.1344	
	S.D.	0.2692	0.2502		4.6074	4.4473		0.5125	0.6787	
2000	Mean	0.1835	0.2856		3.3348	-0.6571		0.2874	0.0639	
	S.D.	0.2329	0.3443		4.5796	3.7290		0.3621	0.4623	
2001	Mean	0.1943	0.3304		3.4147	-0.8336		0.2195	0.0909	
	S.D.	0.2603	0.3952		4.5567	3.5669		0.5378	0.8797	
2002	Mean	0.1762	0.2002	0.2123	2.7992	-1.4366	0.0898	0.1997	-0.0752	0.1137
	S.D.	0.2277	0.2243	0.2433	4.5836	4.4775	4.0334	0.5290	0.9346	0.8378
2003	Mean	0.1524	0.1392	0.1409	3.2103	-0.4385	0.4734	0.2249	0.0798	0.1172
	S.D.	0.1790	0.1414	0.1529	4.4308	4.2254	4.3387	0.4413	0.8094	0.9021
2004	Mean	0.1600	0.1566	0.1383	3.5763	-0.7429	0.3437	0.2467	-0.0011	0.0745
	S.D.	0.2057	0.1416	0.1654	4.6086	4.7169	3.5821	0.3602	0.4005	0.2993
2005	Mean	0.1654	0.1618	0.1189	3.9471	-0.5545	0.4831	0.2334	-0.0134	0.0805
	S.D.	0.1977	0.1565	0.1611	4.6772	3.0121	3.3217	0.5140	0.4073	0.4227
2006	Mean	0.1734	0.1869	0.1424	3.7869	-1.5599	-0.2096	0.2346	-0.1505	-0.0661
	S.D.	0.1981	0.2418	0.1875	4.8543	4.6641	4.7044	0.5274	0.9683	0.9762
2007	Mean	0.1695	0.1353	0.1623	3.5753	-0.1604	0.5168	0.2413	-0.1054	-0.0605
	S.D.	0.1865	0.1180	0.1899	4.6351	3.3887	5.4731	0.5123	1.2165	1.4220
2008	Mean	0.1600	0.1083	0.1304	3.4731	-0.4290	-0.1306	0.2380	0.0322	0.0724
	S.D.	0.1863	0.0949	0.2420	4.6616	3.8034	4.2314	0.3104	0.4637	0.5235
Total	Mean	0.1738	0.1959	0.1544	3.3679	-0.8380	0.2409	0.2347	-0.0252	0.0602
	S.D.	0.2175	0.2488	0.1970	4.6339	4.0940	4.2215	0.4689	0.7795	0.8369

Table 5 The Estimation Results of Borrowing Function

	All firms	FN's zombie firms	Modified FN's zombie firms
	Fixed effect b/t/p	Fixed effect b/t/p	Fixed effect b/t/p
⊿lnS	0.0955	0.1171	0.1001
	[21.28]***	[6.26]***	[4.4]***
	0.000	0.000	0.000
π /Asset,t-1	-0.3965	-0.3944	-0.2798
	[-19.82]***	[-4.39]***	[-3.66]***
	0.000	0.000	0.000
Debt,t-1/Asset,t-1	-0.3459	-0.4729	-0.5986
	[-41.2]***	[-12.38]***	[-12.09]***
	0.000	0.000	0.000
Land,t-1/Borrow,t-1	0.0018	-0.0015	0.0062
	[2.14]**	[-0.25]	[0.68]
	0.033	0.806	0.499
BankCap,t-1	-0.0003	-0.0004	0.0021
	[-0.37]	[-0.11]	[0.27]
	0.711	0.914	0.787
BankNPL,t-1	0.000	-0.0005	-0.001
	[0.711]	[0.914]	[0.787]
	0.854	0.659	0.537
N	19282	1667	947
group	2185	757	376
r2	0.137	0.2073	0.2854
r2_a	0.0259	-0.4755	-0.2093
F test	F(2184, 17082) = 2.19	F(756, 895) =1.41	F(375, 559) =1.98
	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000
Hausman test	chi2(15) =2494.64	chi2(15) = 138.17	chi2(12) = 193.05
	Prob>chi2 = 0.0000	Prob>chi2 =0.0000	Prob>chi2 =0.0000
BPLM test	chi2(1) = 155.49	chi2(1) = 20.33	chi2(1) =10.36
	Prob > chi2 = 0.0000	Prob >chi2 =0.0000	Prob > chi2 = 0.0006

*Significant at 10%.
**Significant at 5%.
***Significant at 1%

Table 6 The Estimation Results of Investment Function

	All firms	FN's zombie firms	Modified FN's zombie firms
	Random effect b/t/p	Random effect b/t/p	Fixed effect b/t/p
⊿Borrowing/Asset,t-1	1.9777 [14.92]*** 0.000	1.3865 [5.08]*** 0.000	0.8466 [3.19]*** 0.001
Mq	0.0049 [7.08]*** 0.000	-0.0053 *[-1.91] 0.056	0.0031 [0.91] 0.362
Cashflow/K,t-1	0.0669 [9.47]*** 0.000	0.0669 [4.08]*** 0.000	0.0407 [2.20]** 0.028
Debt,t-1/Asset,t-1	0.0971 [6.07]*** 0.000	0.0052 [0.10] 0.918	0.6829 [2.67]*** 0.008
N	8281	587	394
group	1527	328	187
r2			
r2_a			
F test	F(1526,6742) = 1.51 Prob > F = 0.0000	F(327,247) = 1.24 Prob > F = 0.0353	F(186,197) =1.40 Prob > F = 0.0105
Hausman test	chi2(12) = -40.70	chi2(12) = -177.35	chi2(10) = 20.93 Prob>chi2 =0.0216

Instrumented: ⊿Borrowing/Asset,t-1

Instruments: ⊿lnS π /Asset,t-1 Land,t-1/Borrow,t-1 BankCap,t-1 BankNPL,t-1

⊿lnS,t-1 π ,t-1/Asset,t-2 Land,t-2/Borrow,t-2 BankCap,t-2 BankNPL,t-2 a time lag of 1 of explanetary variables

*Significant at 10%.

**Significant at 5%.

***Significant at 1%