経済論叢（京都大学）第176巻第3号，2005年9月

Debt Overhang, Soft Budget, and Corporate Investment : Evidence from Japan

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I Introduction

Is the allocation of capital efficient in the sense that profitable sectors obtain more capital than unprofitable sectors ? While this is one of the fundamental questions for macroeconomics, it has been attracting renewed interests in Japan since some economists insisted that the inefficient allocation of capital is one of the causes for the long-run stagnation in the 1990s or the "lost decade" (e.g., Caballero, Hoshi, and Kashyap [2003]). This paper tries to answer this question by focusing on the role of corporate debt on investment.

In Japan, many firms have been heavily indebted since the collapse of stock and land market in the early 1990s. Debt overhang hypothesis posits that heavily indebted firms face difficulty in financing due to the conflicts between existing creditors and new creditors or shareholders (Myers [1977], Myers and Majluf [1984]). As a result, they cannot carry out profitable projects. Many researchers found evidence for this under-investment effect of debt (e.g., Fazzari, Hubbard and Petersen [1988]).[1)]

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* Comments to an earlier version of this paper by Masaya Sakuragawa were helpful. Valuable research assistance was provided by Tatsuji Makino.

1) For other evidences on U. S. firms, see Gilchrist and Himmelberg [1995], Whited [1992], ↗

Suzuki [2000], among others, using a dataset of Japanese listed firms until 1993, found that investment was positively correlated with equity (and hence negatively correlated with debt).

More recent studies point out the soft budget problems associated with debt. According to this view, heavily indebted, unprofitable firms survive or even expand rather than downsize owing to banks' bailout.[2] Banks are willing to lend funds to these firms rather than to stop financing and to liquidate them in order to maintain their own capital ratio under capital adequacy requirements (Hosono and Sakuragawa [2002]). Hoshi [2000] first paid attention to the fact that the share of loans to real estate industries increased over the 1990s when land prices continued to decline and suggested the existence of rollover of bad loans. Sugihara and Fueda [2002], Kobayashi et *al.* [2002], and Hosono and Sakuragawa [2002] all found evidence on the banks' rollover of bad loans. However, these studies did not examine the effect of such a bank lending behavior on corporate investment.[3] It is not yet to be seen whether banks' rolling over of bad loans actually promote overinvestment by heavily indebted firms or just reflect the shift of financing sources from bond or stocks to bank loans by these firms. Caballero et al. [2003] investigated the effect of "zombie lending" (or the soft budget peoblem) on the real economy using

↘among others. For the evidences on Japanese firms, see Asako et al. [1991], Hayashi and Inoue [1991], Hoshi, Kashyap and Sharfstein [1991], and Ogawa et al., [1994]. Note, however, that Gomes [2001] points out that the cash-flow-augmented q-type investment regressions that many preceding studies employed are not suitable ways to examine the effects of external fund on investment.

2) Dewatripont and Maskin [1995] provide a theoretical foundation explaining the bank's soft budget behavior.

3) Hanazaki and Thuy [2002] estimated investment function using FSSC data for manufacturing and non-manufacturing. But they did not adjust the data to keep consistency across years or construct capital stock data. In addition, they did not estimate an investment function by major non-manufacturing industries.

data of listed firms.

This paper aims at investigating the validity of the debt overhang and soft budget hypotheses using time series data by industry and firm size.[4)] Aggregate time-series data is not suitable to this purpose. Given that leverage ratios vary to a large extent across industries and firm sizes, debt overhang may be found in some industries or sizes while soft budget may be found in other sectors. It might be possible that excess flow of funds to some sectors due to soft budget problems reduce the availability of funds and thus cause debt overhang problems in other sectors. Though individual firm data have rich information on investment and leverage, the availability of individual unlisted firms' data are very limited in Japan.[5)] Using only listed firms' data might cause a serious bias if small firms are more susceptible to information problems and hence to debt overhang problems. In addition, large firms might be more susceptible to soft budget problems if their effect on banks' balance sheet is large. To avoid such a sample bias, we utilize the time-series data by industry and firm size from *Financial Statements Statistics of Corporations by Industry (FSSC)*. This data covers small, medium- sized, and large non-financial firms that belong to manufacturing or non-manufacturing industries. Data of three major non-manufacturing industries, i.e., construction, commerce and real estate industries are also available.

The remainder of the paper is composed of five sections. In Sections 2, we present a simple model in which debt overhang and a soft budget constraint problem coexist. Section 3 describes the estimation framework

4) Lizal and Svejnar [2002] try to find the evidence of the soft budget constraint on the investment behavior by Czech firms.

5) Recently, Fukuda et al., [2005], Ogawa [2005], and Hosono and Masuda [2005] used datasets for non-listed firms and examine the effects of firm net worth and bank health on investment.

and data. Section 4 reports the estimation results of investment function. Section 6 concludes with some policy implications.

II A Simple Model of Debt Overhang and a Soft Budget Constraint

In this section, we present a simple model in which debt overhang and a soft budget constraint can coexist in equilibrium. Suppose that there are two firms, G and B. Firm G (the good borrower) has an investment opportunity that costs one and returns $R>1$. Firm B (the bad borrower) has an investment opportunity that costs one and returns zero. Firm G and firm B have an initial debt of D_G and D_B, respectively. There is one potential lender, who has an initial claim of $\alpha_G D_G$ and $\alpha_B D_B$ to firms G and B, respectively. The lender has two units of resources that she can lend to firm G or firm B or both. The lender can also access to a safe asset whose net return rate is zero.

In the following analysis, we make two critical assumptions. The first assumption is that the lender incurs a cost if a borrower defaults. There are several sorts of default costs. First, the lender may incur some verification costs in the face of borrower default. Second, under capital adequacy requirements, a lender bank decreases its capital ratio when a borrower defaults. If the bank cannot meet the minimum requirement level of capital, the default triggers a regulatory intervention that constrains bank business and hence imposes a regulatory cost. In addition, the bank managers may lose their positions if the regulators displace them due to insufficient capital. If the managers enjoy private benefit from keeping their positions, the borrower default may deprive the bank mangers of the private benefit. The default cost includes all these costs. Specifically, we assume that the default cost is proportional to the amount of claim. We capture such a regulatory cost that is associated with firm defaults by $b(1>b>0)$. If firm G (or firm B) defaults the initial debt, the lender incurs $b\alpha_G D_G$ (or $\alpha_B D_B$) Note that we implicitly assume that the potential lender will not be punished even if she extends unrecoverable loans to the bad borrower, reflecting the flaws of bank regulations, supervision, governance, and accounting standards (Hosono and Sakuragawa [2002]).

The second critical assumption is that the potential lender cannot renegotiate with the old creditors. Specifically, we assume that the lender gets all the investment returns net of the payment to the other initial claimants.

Under these assumptions, if the lender lends one unit to firm G, she obtains $R-(1-\alpha_G)D_G$. On the other hand, if the lender does not lend to firm G, she incurs the default cost of $b\alpha_G D$. Similarly, the lender obtains zero when she lends one unit to firm B and incurs the default cost of $b\alpha_B D_B$ when she does not lend to firm B. The following propositions are straightforward.

Proposition 1 (Soft budget): Suppose that

$$D_B > \frac{1}{b\alpha_B} \tag{1}$$

Then, the lender lends to firm B.

Proposition 2 (Debt overhang): Suppose that

$$D_G > \frac{R-1}{1-(1+b)\alpha_G} \tag{2}$$

Then, the lender does not lend to firm G.

Proof

The lender has four options. First, if she lends one unit to firm G and the other one unit to firm B, she obtains $\pi_{GB} \equiv R-(1-\alpha_G)D_G$. Second, if she lends one unit to firm G and the other one unit to the safe asset, then she obtains $\pi_{G0} \equiv R-(1-\alpha_G)D_G - b\alpha_B D_B + 1$, where the second term is the cost from firm B's default. Third, if she lends one unit to firm B and the other one unit to the safe asset, then, she obtains $\pi_{0B} \equiv 1 - b\alpha_G D_G$, where the second term is the cost from firm G's default. Finally, if she invests two units to the safe asset, she obtains $\pi_{00} \equiv 2 - b\alpha_G D_G - b\alpha_B D_B$.

From these four returns, we see that $\pi_{GB}-\pi_{G0}=\pi_{0B}-\pi_{00}=b\alpha_B D_B-1$. Therefore, if $b\alpha_B D_B-1>0$, then the lender lends to firm B (Proposition 1). Furthermore, we see that $\pi_{GB}-\pi_{0B}=\pi_{G0}-\pi_{00}=R-(1-\alpha_G)D_G-(1-b\alpha_G D_G)$ Therefore, if $R-(1-a_G)D_G-(1-b\alpha_G D_G)<0$, then the lender does not lend to firm G (Proposition 2). **QED.**

The inequality (1) is more likely to hold when α_B, b and D_B are larger. If the lender has a larger proportion of the initial claim to the bad borrower, if she incurs a higher default cost, or if the initial debt is larger, then she is more likely to bailout the bad borrower to avoid the default of the bad borrower. Under the capital adequacy requirement, a poorly-capitalized bank that incurs a high regulatory cost when a borrower defaults should tend to bailout a bad borrower

On the other hand, the inequality (2) is more likely to hold when α_G, b and R are smaller and D_G is larger. If she has a smaller proportion of the existing debt and the borrower's debt is larger, then a larger proportion of the investment return goes to the other initial claimants. Consequently, if the default cost is smaller, and if the return to investment is also smaller, she is less likely to lend to the good borrower.

A larger default cost, b, is more likely to result in the soft budget problem and less likely to lead to the debt overhang problem. More importantly, the inequalities (1) and (2) suggest that the underinvestment of profitable firms (debt overhang) and the overinvestment of unprofitable firms (soft budget) exist at the same time when both types of firms are highly indebted.

III The Estimation Framework

1 Specification

If the credit market is perfect and the firm maximizes the net present value of profits, then the basic neoclassical model holds in which investment is a function of the expected net present value of marginal productivity of capital and the cost of capital. If adjustment costs of capital exist, then the lagged investment also affects the current investment. In this case, debt does not matter.

If, on the other hand, the credit market is imperfect, then a firm's debt outstanding can lead to either underinvestment (debt overhang) or overinvestment (soft budget).

Given these opposing hypotheses, we estimate the following equation using OLS by industry and by size.

$$\frac{I_t}{K_{t-1}}=\beta_0+\beta_1 PROF_t+\beta_2 RR_t+\beta_3 DEBT_{t-1} +\beta_4 LAND_{t-1}+\beta_5\frac{I_{t-1}}{K_{t-2}}+\varepsilon_t \quad (3)$$

, where I_t is real investment, K_{t-1} is real capital stock at the end of period t-1, $PROF_t$ is operating profits as a proportion of nominal capital stocks, RR_t is real discount rate, $DEBT_{t-1}$ is interest-bearing debt outstanding as a proportion of total assets, $LAND_{t-1}$ is market-valued land stocks as a proportion of nominal capital stocks. The coefficient of $PROF_t$ is supposed to be positive if frictionless credit markets exist or the debt-overhang hypothesis holds, while it may be insignificant or negative if the soft budget hypothesis holds.[6] The coefficient on RR_t is supposed to be negative under the perfect credit market or the debt-overhang hypothesis, while it may be insignificant or even positive (in the case of interest reduction) under the soft budget hypothesis. The coefficient of $DEBT_{t-1}$ is negative if debt overhang hypothesis is valid, while it is insignificant or even positive if the soft budget hypothesis is relevant. The coefficient of $LAND_{t-1}$ is supposed to be positive if land assets serve as collateral and loosen the credit constraint that firms face.[7]

2 Data

Our main data source is the quarterly data from *Financial Statements Statistics of Corporations by Industry (FSSC)* published by Ministry of Finance. The sample period begins in 1980 : 3 and ends in 2005 : 1. FSSC sample covers non-financial corporations with equity 10 million yens and more. Because FSSC samples are different for each fiscal year, we corrected the original data to keep consistency over time, following Institute for Social Engineering, Inc. [1976] and Ogawa et al. [1994]. We also follow Ogawa et al. [1994] to construct capital stocks, investment, and

6) Lizal and Svejnar [2002] identify the soft budget constraints if the coefficient of profit is insignificant or negative.

7) See Ogawa et al. [1994] for the role of land as collateral for Japanese borrowers.

land stocks data. See the data appendix for details. All the data are seasonally adjusted by Census X12.

We divide the sample period into the two sub-periods: the so-called bubble period from 1980 : 3 to 1990 : 4 when land prices showed an increasing trend and the post-bubble period from 1991 : 1 to 2005 : 1 when land prices displayed a declining trend. We divide the sample firms by industry and equity size. Firms are classified by three equity size categories: small firms with equity less than 100 million yens, middle-sized firms with equity of 100 million yens and more but less than 1 billion yens, and large firms with equity of 1 billion yens and more. Firms are also divided into manufacturing and non-manufacturing industries. Data for construction, commerce, and real estate industries are available among non-manufacturing industries, though data by equity size is not available for these three non-manufacturing industries.

Table 1 shows descriptive sample statistics by industry and size for the bubble and the post-bubble periods. Comparing manufacturing firms with non-manufacturing firms after controlling for firm equity size (Table 1A), we see that manufacturing firms are characterized by relatively high operational profits as a proportion of total assets (*ROA*) and low interest bearing debt outstanding as a proportion of total assets (*DEBT*) both during the bubble and post-bubble periods. Comparing construction, commerce and real estate industries with manufacturing industries (Table 1B), *ROA* is lower for these industries than manufacturing firms during both the bubble and post-bubble periods and *DEBT* is higher than manufacturing firms during the post-bubble period.

Figures 1A and 1B depict the investment ratio (I_t/K_{t-1}) for manufacturing and non-manufacturing industries, respectively. Manufacturing industries

Table 1. Descriptive statistics

A. By industry / size

1980 : 3-1990 : 4						
	Mnfc. /Small	Mnfc. /Middle	Mnfc. /Large	Non-Mnfc. /Small	Non-Mnfc. /Middle	Non-Mnfc. /Large
I/K(-1)	0.039	0.041	0.039	0.039	0.041	0.042
	(0.005)	(0.005)	(0.004)	(0.010)	(0.004)	(0.006)
PROF	0.056	0.042	0.041	0.050	0.033	0.035
	(0.009)	(0.008)	(0.009)	(0.008)	(0.005)	(0.003)
RR	0.011	0.011	0.013	0.011	0.009	0.011
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
DEBT	0.385	0.348	0.328	0.446	0.471	0.491
	(0.030)	(0.013)	(0.024)	(0.044)	(0.029)	(0.022)
LAND	1.210	0.928	0.648	1.990	1.405	0.589
	(0.440)	(0.298)	(0.221)	(0.662)	(0.450)	(0.177)
ROA	0.018	0.016	0.014	0.012	0.009	0.012
	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
CF	0.022	0.022	0.022	0.014	0.012	0.016
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)

1991 : 1-2005 : 1						
	Mnfc. /Small	Mnfc. /Middle	Mnfc. /Large	Non-Mnfc. /Small	Non-Mnfc. /Middle	Non-Mnfc. /Large
I/K(-1)	0.026	0.025	0.028	0.030	0.030	0.034
	(0.008)	(0.006)	(0.006)	(0.010)	(0.007)	(0.012)
PROF	0.028	0.021	0.024	0.030	0.018	0.020
	(0.010)	(0.006)	(0.006)	(0.008)	(0.006)	(0.004)
RR	0.010	0.009	0.009	0.009	0.008	0.010
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
DEBT	0.438	0.346	0.267	0.510	0.480	0.466
	(0.020)	(0.031)	(0.027)	(0.021)	(0.044)	(0.038)
LAND	0.859	0.635	0.429	1.240	0.895	0.350
	(0.359)	(0.263)	(0.189)	(0.581)	(0.428)	(0.175)
ROA	0.010	0.010	0.009	0.007	0.006	0.008
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)
CF	0.015	0.018	0.018	0.010	0.012	0.016
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)

B. By industry

	1980 : 3-1990 : 4				1991 : 1-2005 : 1			
	Con-struction	Manu-facturing	Real estate	Com-merce	Con-struction	Manu-facturing	Real estate	Com-merce
I/K(-1)	0.043	0.039	0.032	0.036	0.031	0.027	0.027	0.029
	(0.010)	(0.003)	(0.014)	(0.006)	(0.013)	(0.006)	(0.016)	(0.007)
PROF	0.102	0.045	0.045	0.070	0.065	0.024	0.025	0.038
	(0.024)	(0.008)	(0.012)	(0.010)	(0.034)	(0.006)	(0.008)	(0.011)
RR	0.012	0.012	0.010	0.011	0.010	0.009	0.008	0.009
	(0.003)	(0.003)	(0.003)	(0.003)	(0.010)	(0.010)	(0.008)	(0.009)
DEBT	0.313	0.345	0.668	0.381	0.330	0.320	0.728	0.405
	(0.020)	(0.012)	(0.053)	(0.027)	(0.012)	(0.024)	(0.049)	(0.023)
LAND	2.171	0.811	2.594	2.324	1.347	0.545	1.546	1.420
	(0.791)	(0.279)	(0.975)	(0.796)	(0.630)	(0.239)	(0.790)	(0.713)
ROA	0.011	0.015	0.011	0.009	0.008	0.009	0.006	0.006
	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.001)
CF	0.013	0.022	0.008	0.010	0.010	0.017	0.005	0.009
	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)

Notes : 1. Numbers in parentheses are standard deviations.
2. For small firms, the sample period ends in 2004 : 1.

displayed a large increase in the investment ratio during the latter half of the 1980s, followed by a decrease in the first half of the 1990s. Non-manufacturing industries also displayed a similar trend with a particularly large swing for large firms. In 1998 and 1999, when the banking crisis culminated, the investment ratios decreased both for manufacturing and non-manufacturing industries. In 2003 and 2004, the investment ratios displayed an increasing trend except for the middle-sized non-manufacturing firms.

Figures 2A and 2B depict the return to capital stock ($PROF_t$). The trends of the return to capital stock are by and large similar to the trends of the investment ratio with the exception of small non-manufacturing firms that did not show a clear increasing trend in $PROF_t$ for the latter

Figure 1A. Investment ratio for manufacturing industries

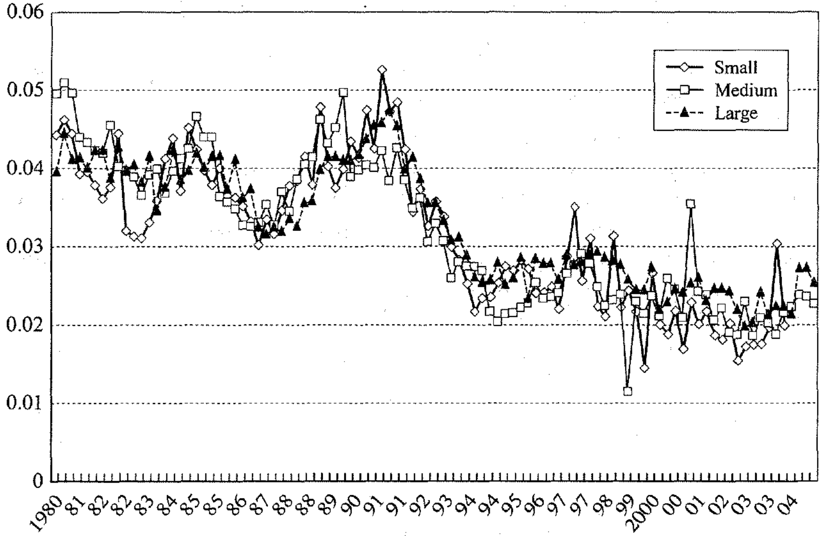


Figure 1B. Investment ratio for non-manufacturing industries

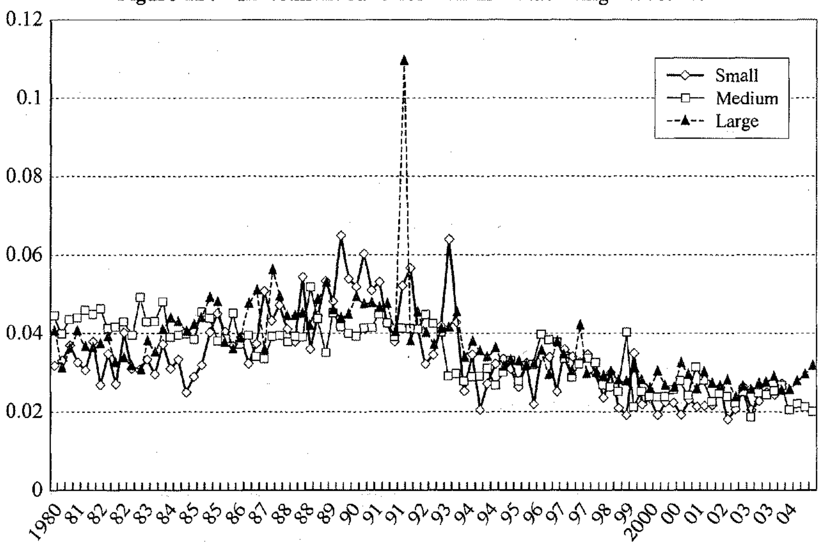


Figure 2A. Return to capital for manufacturing industries

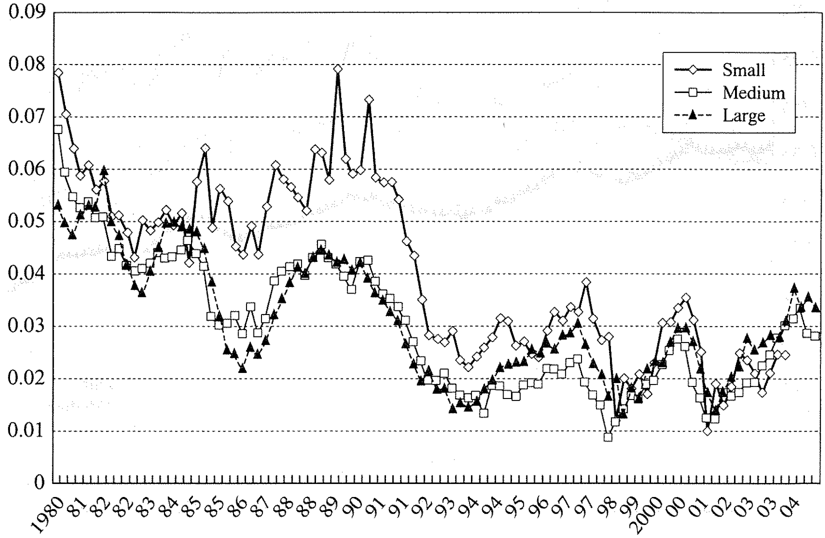


Figure 2B. Return to capital for non-manufacturing industries

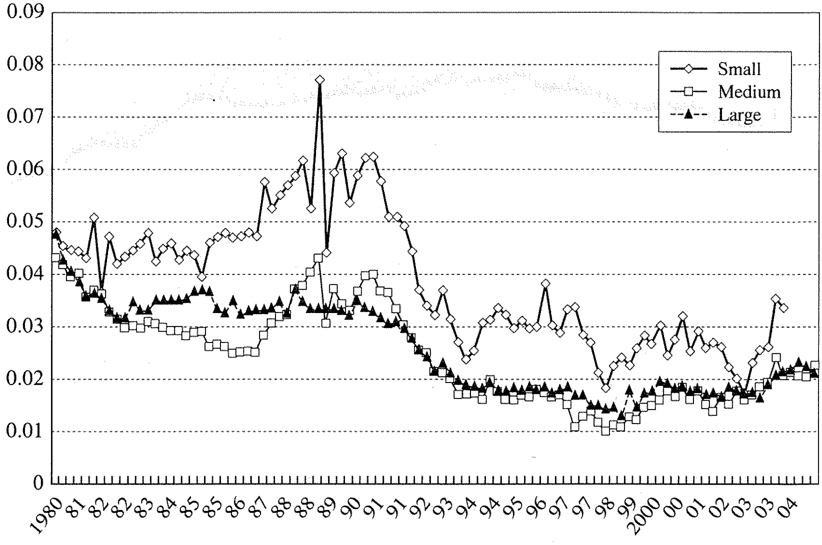


Figure 3A. Debt to asset ratio for manufacturing industries

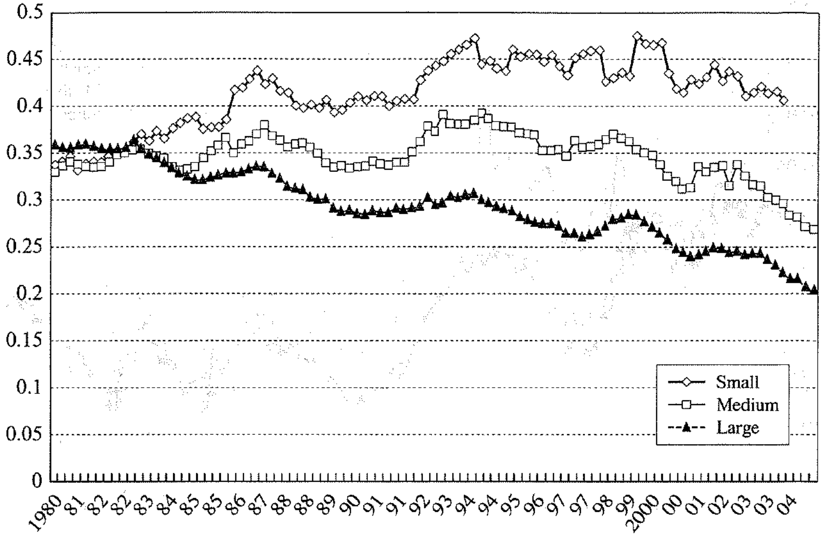
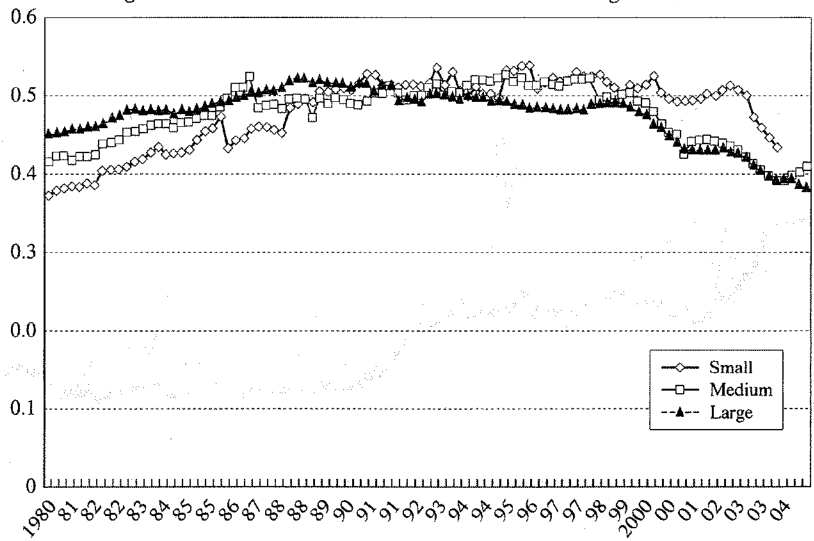


Figure 3B. Debt to asset ratio for non-manufacturing industries



half of the 1980s.

Figures 3A and 3B depict the debt-to-asset ratio ($DEBT_t$) for manufacturing and non-manufacturing industries, respectively. It is notable that the average debt-to-asset ratios for non-manufacturing firms are higher than manufacturing firms. Large manufacturing firms displayed a declining trend of the debt-to-asset ratio throughout the sample period. In contrast, small non-manufacturing firms displayed an increasing trend until 1991, and did not show a decreasing trend until 2002. These differences in investment, profitability and indebtedness across the industries and firm sizes motivate us to estimate the investment function for each sector.

IV Empirical Analyses

1 Estimation Results for Investment by Industry and Size

Table 2 shows the estimation results of the investment function (Eq. 3) by industry and size.

Looking at the results for the 1981 : 3–1990 : 4 period (Table 2A), we see that the coefficients of $PROF_t$ are positive for all the sectors and significant for medium-sized and large manufacturing firms. The coefficients of RR_t are negative except for medium-sized and large non-manufacturing firms and significantly negative for medium-sized manufacturing firms. The coefficients of $DEBT_{t-1}$ are significantly negative for small and medium-sized manufacturing firms, while they are significantly positive for large non-manufacturing firms and insignificant for the other sectors. Large non-manufacturing firms could increase investment while accumulating debt in the 1980s. The coefficients of $LAND_{t-1}$ are significantly positive for small manufacturing firms and small non-manufacturing firms, while they are insignificant for the other sectors. Increasing land prices

Table 2. Investment by industry and size. Dependent variable : I/K(t-1)

A. Sample period : 1980 : 4-1990 : 4

Industry Size	Manu-facturing Small	Manu-facturing Medium	Manu-facturing Large	Non-manu-facturing Small	Non-manu-facturing Medium	Non-manu-facturing Large
Constant	0.046**	0.056**	0.023	0.001	0.039*	−0.064
	(0.015)	(0.022)	(0.015)	(0.017)	(0.021)	(0.040)
PROF	0.032	0.215**	0.141**	0.146	0.364	0.500
	(0.122)	(0.093)	(0.049)	(0.232)	(0.239)	(0.458)
RR	−0.446	−0.347**	−0.005	−0.054	0.141	0.220
	(0.328)	(0.144)	(0.245)	(0.344)	(0.247)	(0.425)
DEBT(t-1)	−0.050**	−0.099**	−0.041	0.035	−0.014	0.153**
	(0.021)	(0.047)	(0.046)	(0.043)	(0.040)	(0.069)
LAND(t-1)	0.004**	0.001	−0.001	0.010**	−0.003	0.005
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.007)
I(t-1)/K(t-2)	0.279*	0.319**	0.632**	−0.116	−0.025	0.192
	(0.156)	(0.150)	(0.093)	(0.166)	(0.125)	(0.197)
Adjusted R-squared	0.381	0.700	0.528	0.663	0.137	0.384
Durbin-Watson stat	2.099	2.244	2.533	2.011	1.953	1.954

B. Sample period : 1991 : 1-2005 : 1

Industry Size	Manu-facturing Small	Manu-facturing Medium	Manu-facturing Large	Non-manu-facturing Small	Non-manu-facturing Medium	Non-manu-facturing Large
Constant	0.045**	0.041**	0.020**	−0.017	−0.009	0.006
	(0.015)	(0.017)	(0.007)	(0.050)	(0.012)	(0.016)
PROF	0.129	0.003	0.043	0.238	0.467*	0.287
	(0.085)	(0.153)	(0.052)	(0.179)	(0.254)	(0.312)
RR	−0.612*	−0.617**	−0.329**	−0.049	−0.556**	−0.365
	(0.306)	(0.168)	(0.157)	(0.676)	(0.218)	(0.308)
DEBT(t-1)	−0.071**	−0.070*	−0.030	0.050	0.049*	0.042
	(0.030)	(0.040)	(0.021)	(0.090)	(0.025)	(0.032)
LAND(t-1)	0.016**	0.023**	0.022**	0.006*	0.002	0.020**
	(0.003)	(0.004)	(0.006)	(0.003)	(0.004)	(0.010)
I(t-1)/K(t-2)	0.008	−0.013	0.307*	0.222*	0.320**	−0.073**
	(0.106)	(0.121)	(0.156)	(0.126)	(0.168)	(0.023)
Adjusted R-squared	0.801	0.759	0.903	0.566	0.687	0.926
Durbin-Watson stat	1.733	1.918	2.163	1.964	2.092	1.813

Notes : 1. White's heteroskedasticity-consistent standard errors are in parentheses.
**,* Significant at 5% and 10% levels, respectively.

stimulated investment for small firms during the 1980s.

Turning to the estimation results for the 1991 : 1-2005 : 1 period (Table 2B), we see that the coefficients of $PROF_t$ are positive for all the sectors and significant for medium-sized non-manufacturing firms. The coefficients of RR_t are negative for all the sectors and significant except for small and large non-manufacturing firms. The coefficients of $DEBT_{t-1}$ are significantly negative for the small and medium-sized manufacturing firms while they are significantly positive for medium-sized non-manufacturing firms and insignificant for the other sectors. The coefficients of $LAND_{t-1}$ are significantly positive for all the industries except for medium-sized non-manufacturing firms. Medium-sized non-manufacturing industries could continue to expand investment by accumulating debt despite their high debt-to-asset ratios and declining land prices after the bubble had collapsed in the early 1990s.

In sum, debt restrained small and medium-sized manufacturing firms both in the bubble period and post-bubble period, while debt did not restrain non-manufacturing firms irrespective of the size and period. Rather, debt promoted investment by large non-manufacturing firms during the 1980s and medium-sized non-manufacturing firms during the 1990s and early 2000s. Considering that ROA was lower for non-manufacturing firms than for manufacturing firms, the results for small and medium-sized manufacturing firms over the 1991 : 1-2005 : 1 period are consistent with the debt overhang hypothesis and the results for medium-sized non-manufacturing firms over the 1991 : 1-2005 period are consistent with the soft budget hypothesis.

2 Estimates Results for Investment by Industry

Table 3 shows the estimation results of the investment function (Eq. 3) for construction, commerce, real estate and manufacturing industries.

Looking at the estimates for the 1981 : 3-1991 : 1 period (Table 3A), we see that the coefficients of $PROF_t$ are positive except for the real estate industry and significantly positive for the manufacturing and commerce industries. The coefficients of RR_t are negative except for the real estate industry but not significant for any industry. The coefficients of $DEBT_{t-1}$ are significantly negative for the manufacturing and construction industries but insignificant for the commerce and real estate industries. Turning to the coefficients of $LAND_{t-1}$, we see that they are significantly positive for the construction and commerce industries, insignificant for the real estate industries, and significantly negative for the manufacturing industry. While the positive coefficients of $LAND_{t-1}$ are consistent with the hypothesis that land assets can serve as collateral and hence loosen the credit constraint, the negative coefficient of $LAND_{t-1}$ for the manufacturing industry suggest that investment by manufacturing firms might have been crowded out by the construction and commerce industries when land prices increased.

For the 1991 : 2-2005 : 1 period estimates (Table 3B), the coefficients of $PROF_t$ are positive except for the real estate industry and significantly positive for the manufacturing and construction industries. The coefficients of RR_t are negative except for the real estate industry and significantly negative for the manufacturing industry. The coefficients of $DEBT_{t-1}$ are negative except for the commerce industry and significantly negative for the real estate industry. The coefficients of $LAND_{t-1}$ are significantly positive for the manufacturing, commerce, and real estate industries

Table 3. Investment by industry. Dependent variable : I/K(t-1)

A. Sample period : 1980 : 4-1990 : 4

Industry	Manufacturing	Construction	Commerce	Real estate
Constant	0.097**	0.083**	0.019	−0.016
	(0.017)	(0.028)	(0.017)	(0.044)
PROF	0.166**	0.083	0.136**	−0.148
	(0.041)	(0.089)	(0.050)	(0.300)
RR	−0.051	−0.066	−0.444	0.799
	(0.143)	(0.271)	(0.300)	(0.834)
DEBT(t-1)	−0.199**	−0.205**	−0.025	0.045
	(0.038)	(0.088)	(0.043)	(0.085)
LAND(t-1)	−0.005**	0.008*	0.004**	0.008
	(0.002)	(0.004)	(0.002)	(0.006)
I(t-1)/K(t-2)	0.210*	0.010	0.375**	−0.120
	(0.112)	(0.139)	(0.122)	(0.096)
Adjusted R-squared	0.760	0.606	0.779	0.221
Durbin-Watson stat	2.252	1.949	2.012	2.035

B. Sample period : 1991 : 1-2005 : 1

Industry	Manufacturing	Construction	Commerce	Real estate
Constant	0.019**	0.014	0.006	0.058**
	(0.007)	(0.017)	(0.021)	(0.028)
PROF	0.112**	0.180**	0.092	−0.383
	(0.045)	(0.076)	(0.105)	(0.373)
RR	−0.415**	−0.400	−0.400	0.821
	(0.149)	(0.289)	(0.324)	(1.058)
DEBT(t-1)	−0.025	−0.021	0.021	−0.071*
	(0.016)	(0.048)	(0.044)	(0.039)
LAND(t-1)	0.017**	0.002	0.006*	0.015**
	(0.004)	(0.004)	(0.003)	(0.003)
I(t-1)/K(t-2)	0.273**	0.398**	0.225	−0.008
	(0.129)	(0.139)	(0.171)	(0.123)
Adjusted R-squared	0.916	0.883	0.755	0.342
Durbin-Watson stat	2.154	2.282	1.935	2.021

Notes : 1. White's heteroskedasticity-consistent standard errors are in parentheses.
**,* Significant at 5% and 10% levels, respectively.

but insignificant for the construction industry.

In sum, the estimation results by industry are somewhat mixed. We may conclude that the manufacturing industry has been subject to the debt overhang problem during the bubble and post-bubble periods, judging from the positive coefficients of $PROF_t$ and the negative coefficients of $DEBT_{t-1}$, though the coefficient of $DEBT_{t-1}$ is not significant for the post-bubble period.[8] On the other hand, it may be difficult to determine only from the estimation results by industry whether the debt-overhang hypothesis or the soft budget hypothesis has been valid to the construction, commerce and real estate industries. It should be important to classify firms by size as well as industry when we investigate the effects of debt on investment, as Table 2 actually suggests.

V Conclusions

How does corporate debt affect the allocation of capital? To answer this question, we first theoretically show that debt can constrain investment by profitable firms (debt overhang) and at the same time promote investment by unprofitable firms (soft budget). Then we conduct empirical analyses using the time series data of Japanese firms by industry and size over the 1980 : 3-1990 : 1 and 1991 : 1-2005 : 1 periods. Our estimation results for investment by firm size and industry over the 1991 : 1-2005 : 1 period, in particular, suggest that the debt overhang hypothesis was valid to the small and medium-sized manufacturing firms that were characterized by relatively high ROA and low debt ratios while the soft budget hypothesis was valid to the medium-sized, non-manufacturing

8) We restrict our sample to the 1991 : 1-1999 : 1 period to estimate Eq. 3, obtaining the results that the coefficient of $DEBT_{t-1}$ is significantly negative for the manufacturing industry.

firms that were characterized by a relatively low ROA and high debt ratios. Our results suggest that corporate debt distorted the allocation of capital in Japan for more than the last two decades.

One of the most important factors that linked debt and misallocation of capital is the flaw of the Japanese financial system. Debt overhang would not occur if renegotiations between new and old creditors were possible. Soft budget constraint problems would not emerge if creditors were well disciplined so that they did not extend unrecoverable loans to unprofitable firms. Considering that those firms that were severely affected by debt were small and medium-sized firms, the weakness of the banking system, rather than the capital market, in Japan seem to account for the debt overhang and soft budget problems. Restoring bank health and high-quality regulations and governance to banks would help resolve the problems of capital misallocation.

Data Appendix

1. Time series data of balance sheet variables

Data source is *Financial Statements Statistics of Corporations by Industry (FSSC)* by Ministry of Finance. Because samples are changed in every first quarter of fiscal year and fixed during the following three quarters, we correct the effects of sample changes to keep consistency of time series data, following Institute for Social Engineering, Inc. [1976] and Ogawa et al. [1994]. Assuming that balance sheet variables grow at the same rate between those firms that newly enter the samples and those that have been in the samples since the previous fiscal year, all the balance sheet variables as of the i th quarter of fiscal year t-1 are multiplied by the following multiplier :

$$\frac{(A_t^* - A_{t-1,\,4})}{4A_{t-1,\,4}} \frac{N_{t-1,\,4}}{N_{t-1,\,i}} i + 1 \qquad \text{(A1)}$$

where A_t^* is total assets of the first quarter samples of fiscal year t as of the previous quarter (i.e. as of the fourth quarter of fiscal year), $A_{t-1,4}$ is total assets of the fourth quarter samples of fiscal year t-1 as of the fourth quarter of fiscal year t-1, $N_{t-1,i}$ is the number of sample corporations as of the i th quarter of fiscal year t-1.

Samples of firms with equity less than 100 million yen until 1989 : 1 are chosen from the lists as of January of year t-1 and fixed throughout the fiscal year t. Following Institute for Social Engineering, Inc. [1976] and Ogawa et al. [1994] to correct for this sample selection lag for the small-sized firms, we multiply all the balance sheet variables as of the i th quarter of fiscal year t-1 by $\frac{N_{t,1}}{N_{t-1,1}}$ before we make adjustment of (A1). Samples of firms with equity less than 100 million yens after 1989 : 2 are chosen from the lists as of October of year t-1 and fixed throughout the fiscal year t. Therefore, we multiply all the balance sheet variables as of the i th quarter of fiscal year t-1 by $\left(\frac{N_{t,i}}{N_{t-1,i}}-1\right)/2+1$ before we make adjustment of (A1).

2. Capital stocks

We construct capital stock data based on the perpetual inventory method, following Ogawa et al. [1994].

First, we deflate "other tangible fixed assets" as of the first quarter of FY 1980 by "private fixed investment deflator" as of the first quarter of FY1973, considering the average vintage of capital stocks. We derive the 7-year vintage by averaging the vintages of each type of capital with weights from *National Wealth Survey* 1970, Economic Planning Agency.

Next, we derive real fixed investments by deflating "increases in other tangible fixed assets" by "private fixed investment deflator" as of the corresponding quarter.

Finally, we derive real capital stocks using the following equations :

$$K_t=(1-\delta)K_{t-1}+I_t \tag{A2}$$

, where K_t is the end-of-period real capital stock, δ is the depreciation rate, and I_t is real investment. The annual depreciation rates are borrowed from Ogawa et al. [1994]: 0.0869, 0.0774, 0.0692, 0.0519, and 0.0771 for construction, manufacturing, wholesale and retail, real estate industries, and non-manufacturing, respectively. We convert these annual rates to quarter rates by dividing by 4.

3. Land stocks

We also construct land stocks data based on the perpetual inventory method, following Ogawa et al. [1994].

First, we choose a bench mark at the first quarter of 1980 and convert the book value to the market value at the bench mark. The ratio of market-to-book as of the bench mark is assumed to be 3.98. This is Ogawa et al.'s estimates for the average of all industries.

Next, we derive net market-valued land investment $NILAND_t$, based on LIFO type assumption as follows :

$$NILAND_t = ILAND_t - DLAND_t \frac{P_t^L}{P_{t+1}^L} \tag{A3}$$

, where $ILAND_t$ is increase in land stocks, $DLAND_t$ is decrease in land stocks (due to sales), and P_t^L is land price deflator. The land price deflator is "six major urban land price index for all purposes" by Japan Real Estate Institute.

Finally, we derive market-valued land stocks $LANDY_t$ and real land investment IL_t, using the following equations :

$$LANDY_t = LANDY_{t-1} \frac{P_t^L}{P_{t+1}^L} + NILAND_t \tag{A4}$$

$$IL_t = \frac{ILAND_t}{P_t^L} - \frac{DLAND_t}{P_{t+1}^L} \tag{A5}$$

4. Other data

Investment Ratio(t) $= I_t / K_{t-1}$

PROF(t) = Operating profits(t)/(Investment deflator(t-1) · Real capital stock (t-1))

RR(t) = Interests paid(t)/(Short-term borrowings(t-1) + Bills receivable discounted outstanding(t-1) + Long-term borrowings(t-1) + Bonds(t-1)) − Rates of change in GDP deflator from the previous year/4

DEBT(t-1) = (Short-term borrowings(t-1) + Long-term borrowings(t-1) + Bonds(t-1))/Assets(t-1)

LAND(t-1) = Market-valued land stocks(t-1)/(Investment deflator(t-1) · Real capital stocks(t-1))

ROA(t)=Operating profits(t)/Total Assets(t-1)

CF(t-1)=(Current profits(t-1)+Depreciation(t-1))/Total Assets(t-2)

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