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The Effects of Monetary Policy on Firm Investment after the Collapse of the Asset Price Bubble: An Investigation Using Japanese Micro Data

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Abstract

This paper investigates what can be learned about the effects of monetary policy on firm investment after the collapse of the asset price bubble in Japan. By estimating firm investment functions based on corporate panel data, the paper reveals that the monetary easing after the bubble burst worked through the interest rate channel, but not through the credit channel—the credit channel was blocked because of a deterioration in balance-sheet conditions. The paper finds that this deterioration in balance-sheet conditions, especially in bank balance-sheet conditions, hampered investment by smaller non-bond-issuing firms more severely than that by larger bond-issuing firms.

JEL Classification Number: E22, E50

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1 Introduction

This paper investigates what can be learned about the effects of monetary policy on firm investment after the collapse of the asset price bubble in Japan.

For this purpose, based on corporate panel data, the paper estimates accelerator-type firm investment functions augmented with variables relating the balance-sheet conditions both of firm themselves and of their main banks. This approach relates the paper to the existing literature as follows:

- Our paper is one of few examples that estimate accelerator-type investment functions using Japanese data. Most of the previous studies employing Japanese corporate panel data estimate Q-type investment functions. These include Asako et al. (1989), Hoshi and Kashyap (1990) and Hayashi and Inoue (1991). More recently, Ogawa and Kitasaka (1998) and Suzuki (2001) follow this tradition.

- Our results are comparable with findings in other industrial countries. Outside Japan, there are several studies that estimate accelerator-type investment functions to gauge the effects of monetary policy. For instance, a series of studies organized by the European Central Bank (ECB) adopt the same type of functional forms to model firm investment behavior in their countries.[1] Chirinko, Fazzari, and Meyer (1999) also estimate accelerator-type investment functions, using U.S. corporate panel data.

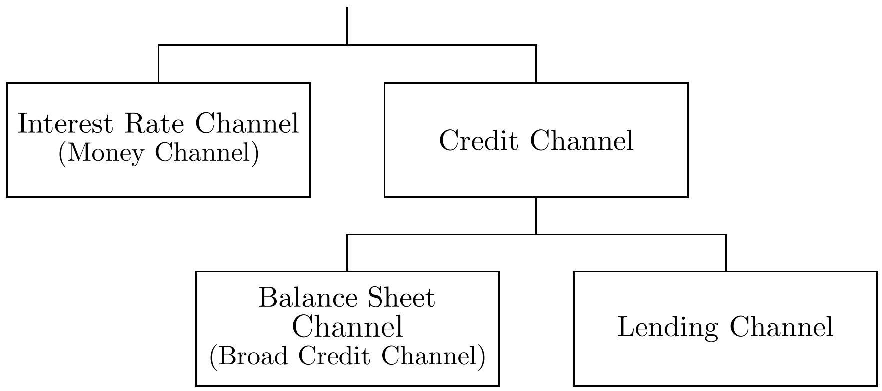
- Our paper follows Sekine (1999) in that balance-sheet conditions of both firm themselves and of their main banks are controlled simultaneously. In order to observe the impact of asset price fluctuations, some researchers augment their investment functions either with variables reflecting balance-sheet conditions of firms themselves (Ogawa et al. 1996) or those of their main banks (Gibson, 1997). Sekine (1999) combines these two approaches by examining the balance-sheet conditions of both at the same time.

The paper finds that the monetary easing after the bubble burst worked through the interest rate channel, but not through the credit channel. The credit channel was blocked because financial constraints became tighter following the deterioration in balance-sheet conditions. The paper demonstrates this by showing that the deterioration in balance-sheet conditions, especially in bank balance-sheet conditions, hampered investment by smaller non-bond-issuing firms more severely than that by larger bond-issuing firms.

The rest of the paper is organized as follows: Section 2 begins with a discussion of the functioning of the interest rate and credit channels of monetary policy in the aftermath

[1] The studies cover investment functions in six Euro countries including Germany (von Kalckreuth, 2001); France (Chatelain and Tiomo, 2001); Italy (Gaiotti and Generale, 2001); Austria (Valderrama, 2001); Belgium (Butzen, Fuss, and Vermeulen, 2001); and Luxembourg (Lünnemann and Methä, 2001). Chatelain et al. (2001) and Angeloni et al. (2002) provide overviews of these papers.

Figure 1: Monetary Transmission Channels



of the bursting bubble. It then introduces the reduced-form investment functions used to examine these monetary transmission channels. Section 3 outlines our micro data set. Section 4 presents our estimation results. Section 5 concludes the paper by discussing some policy implications of the research. Appendix 1 reports estimation results obtained using alternative specifications, and this is followed by a Data Appendix (Appendix 2).

2 Theoretical Models

This section is intended to develop a heuristic understanding of the interest rate channel and the credit channel of monetary policy, focusing in particular upon their relative efficacy in the aftermath of a bursting bubble in asset prices. The section then introduces the accelerator-type investment functions cum balance-sheet variables.

2.1 The Interest Rate and Credit Channels

The interest rate channel[2] and the credit channel[3] are often regarded as essential for monetary transmission (Figure 1).

[2]The interest rate channel is sometimes called the money channel (Hubbard, 1996). This is because, in a model such as the textbook IS-LM, the central bank changes the level of the interest rate by altering the money balance.

[3] The term "credit channel" sometimes becomes a source of confusion:

The misunderstanding sometimes arises that the "credit channel" is independent of the interest rate channel. Unfortunately Figure 1 may be taken to reinforce this misconception. However, as we will see below, the credit channel is dependent on the interest rate channel in the sense that it amplifies the effects of the interest rate channel. The point is emphasized by Bernanke and Gertler (1995), saying "[T]he term "credit channel" is something of a misnomer;...However, it is probably too late to change the terminology now."

Through the interest rate channel, a change in monetary policy translates into a change in the risk-free market interest rate, which affects economic activities such as firm investment. Behind this channel lies the conventional investment theory that a firm adjusts the level of its capital stock so that the marginal productivity of capital equals the cost of funds under perfect capital markets.

Through the credit channel, a change in monetary policy translates into a change in the amount of funds available to a firm, and thus affects firm investment. Underlying the functioning of this channel is the assumption of imperfect capital markets due to asymmetric information between borrowers and lenders. Under this assumption, there exists a wedge in costs between internal and external funds. That is, each firm faces a different interest rate depending on its risk premium.

The upper panel of Figure 2 depicts the case where the credit channel works. Under the assumption of asymmetric information, the supply schedule has a kink at A. F indicates the amount of internal funds that the firm has on hand, and these are available at the market interest rate r: i.e. the opportunity cost of internal funds. Beyond F, the firm needs external funds to finance its investment. The cost of external funds is relatively high since the firm is required to pay a risk premium (or external finance premium). The more external funds the firm relies on, the higher the premium required, since the default risk increases as the firm's debt-asset ratio rises (Bernanke, Gertler, and Gilchrist, 1999). In this case, internal funds are cheaper than external funds and thus the availability of internal funds affects firm investment—the situation is called 'financial hierarchy' or 'pecking order,' and it stands in contrast to the Modigliani-Miller theorem.

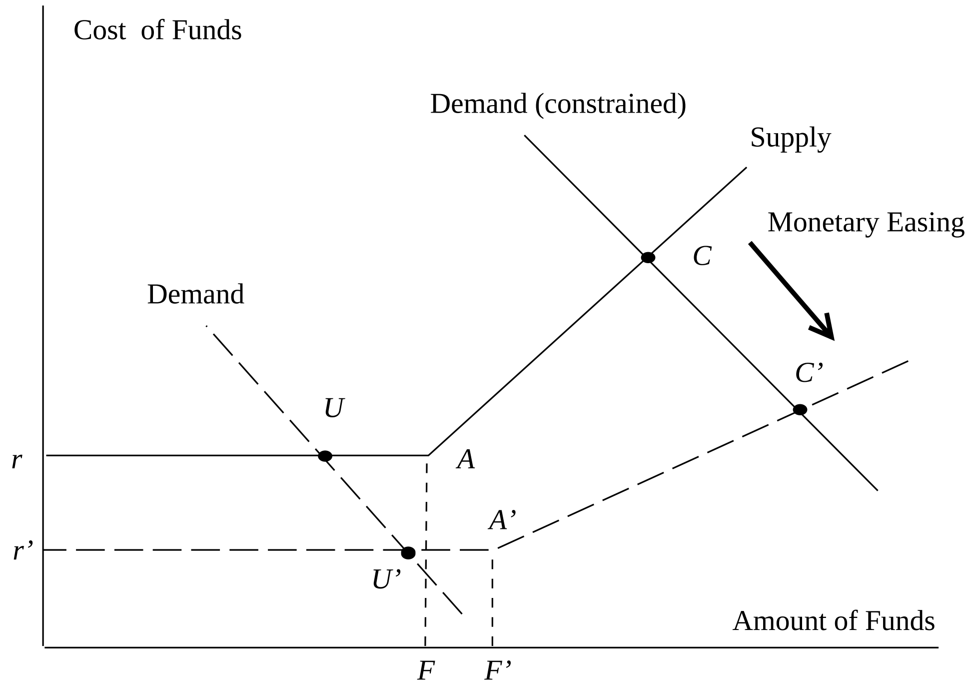
The equilibrium amount of funds, and thus investment, is determined at the intersection of the demand schedule and the supply schedule. When the demand schedule crosses the supply schedule at point U, the firm is not financially constrained. When the demand schedule crosses the supply schedule at point C—investment exceeds internal funds—the firm is financially constrained.

A relaxation in monetary policy has the following effects: First, it lowers the market interest rate from r to r'. Second, it increases the amount of available internal funds from F to F', because it decreases the amount of interest payments. Third, it reduces the gradient of the supply schedule, because it improves the firm's net worth and thus reduces the risk premium. The first effect is captured by the interest rate channel, while the latter two effects are captured by the credit channel.

In this case, the effect of an easing of monetary policy on the financially constrained firm is larger than that on the non-constrained firm. The easing monetary policy shifts the equilibrium of the non-constrained firm from U to U', whereas it shifts the equilibrium of

The interest rate and credit channels are also sometimes mistakenly thought to be two sides of the same coin: "Any change in the interest rate is associated with a change in the amount of credit. So why do we have two different channels?" Again, as we will see below, conceptually, a change in the interest rate can be decomposed into a change in the market interest rate and a change in the risk premium of an individual firm. The interest rate channel corresponds to the former (the change in the market rate) and the credit channel corresponds to the latter (the change in the risk premium).

Figure 2: Monetary Policy under Financial Constraints



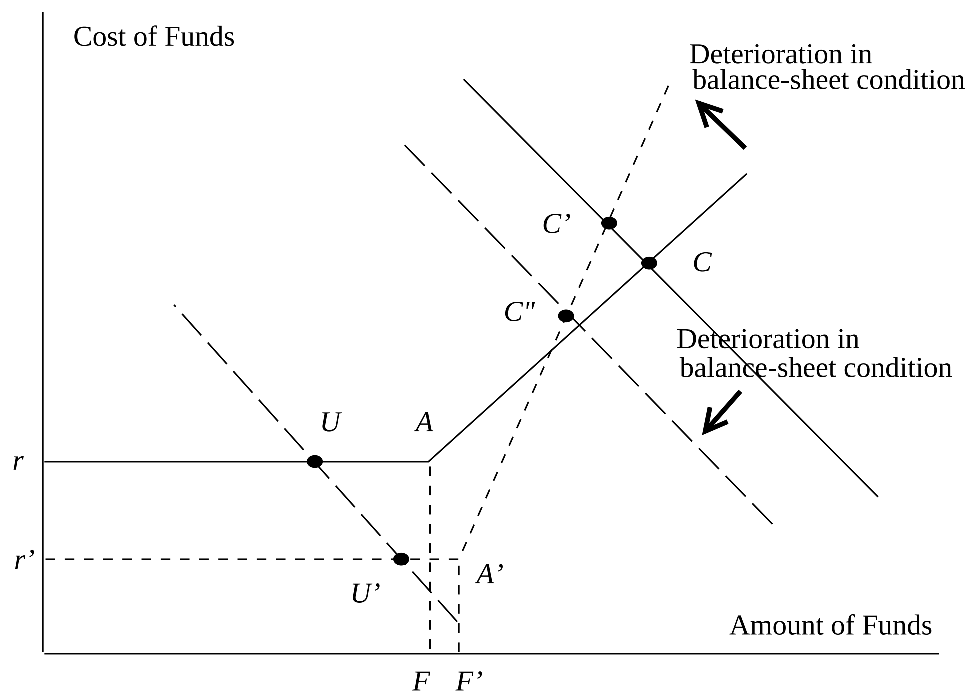
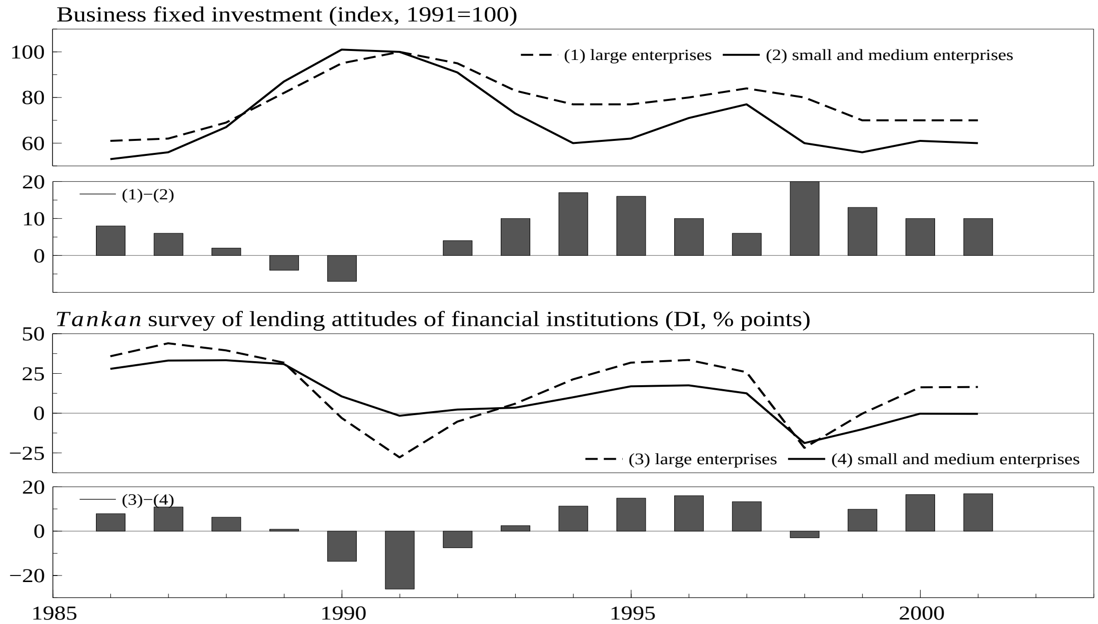


Figure 3: Business Fixed Investment and Lending Attitudes



Notes:

1. (Investment) Ministry of Finance, "Financial Statement Statistics of Corporations by Industry, Quarterly." "Large firms" refers to firms with stockholders' equity of 1 billion yen or more, and "small and medium firms" refers to firms with stockholders' equity of 10 million or more but less than 1 billion yen.

2. (Lending Attitude) Bank of Japan, "The *Tankan* Short-term Economic Survey of Enterprises in Japan." DI is calculated as the share of firms answering "accommodative" minus that of firms answering "severe." The DI of "small and medium firms" is obtained as the average DI between "small firms" and "medium firms."

the constrained firm from C to C'. The effect on the constrained firm is larger because only the interest rate channel works for the non-constrained firm, whereas both the interest rate channel and the credit channel work for the constrained firm. The credit channel is referred to as the 'financial accelerator,' since it magnifies the effect of monetary policy on the constrained firm.

The above story of the financial accelerator, however, does not hold for the Japanese economy in the 1990s. Despite monetary easing after the collapse of the asset price bubble, the *Tankan* survey indicates that a greater number of small- and medium-sized firms experienced tight lending conditions (Figure 3). According to Ogawa and Suzuki (2000), the proportion of firms which were financially constrained increased in the 1990s. If the credit channel had worked, these firms should have enjoyed the benefits of easy monetary policy in the form of looser financial constraints. Where have the effects of easy monetary policy gone?

In our view, the deterioration in balance-sheet conditions is the key to solving this puzzle. The plunge in asset prices after the bubble burst caused a sharp deterioration in the balance-sheet conditions of firms and banks, and this might be supposed to have made the slope of the supply schedule steeper despite the easing monetary policy (Figure 2, bottom panel).[4] Furthermore, a deterioration in a firm's balance-sheet condition is thought to shift its demand schedule. As a result, the equilibrium of the constrained firm shifts from C to C'' with less bank lending and firm investment.

Conceptually, the credit channel consists of two channels (Bernanke and Gertler, 1995): one is called the balance-sheet channel, which works through the firm's balance-sheet condition;[5] the other is called the lending channel, which works through the bank's balance-sheet condition.

2.2 Investment Functions

As one choice of accelerator-type investment functions, some of the ECB studies estimate an error correction model (ECM) such as:

$$\begin{aligned}\left(\frac{I_{it}}{K_{i,t-1}}\right) &= \rho\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)+\sum_{h=0}^{1}\beta_h\Delta y_{i,t-h-1}+\sum_{h=0}^{1}\gamma_h\Delta j_{i,t-h-1}\\ &\quad+\lambda_0(k-y)_{i,t-2}+\lambda_1 y_{i,t-2}+\lambda_2 j_{i,t-2}\\ &\quad+\theta\left(\frac{CF_{it}}{p^k_{i,t-1}K_{i,t-1}}\right)+d_t+\eta_i+\nu_{it},\end{aligned}\tag{1}$$

where I_{it} is the real investment of firm i at time t; K_{it} is its real capital stock (small k is in logarithms); y_{it} is the log of its real output; j_{it} is the log of its user cost of capital; CF_{it} is its cash flow; p^k_{it} is the price it pays for capital goods. d_t is a time-specific effect, η_i is a firm-specific effect and ν_i is an idiosyncratic shock. Δ denotes the first difference operator.

The first and second lines of the equation correspond to the accelerator-model developed by Jorgenson (1963).[6] Given that $I_{it}/K_{i,t-1}$ (which approximates to Δk_{it}), Δy_{it} and Δj_{it} converge to a steady-state level in the long-run equilibrium, we can derive the

[4] Theoretically, it is ambiguous whether a deterioration in balance-sheet conditions induces a bank to cut its lending exposure: Krugman (1998) claims that a bank with an impaired balance-sheet might attempt to 'gamble for resurrection' and hence might increase risky lending. In opposition to this, Van den Heuvel (2001) shows how a bank with an impaired balance-sheet might decrease its lending in order to satisfy the risk-based capital requirements of the Basle Accord. Similarly, Bernanke (1983) argues that such a bank might squeeze lending, because it would have an increased preference for liquidity. Since theory is unable to posit a firm conclusion, we tend to believe there is an important role for empirical analysis in shedding further light on the problem.

[5] The "balance-sheet" of the balance-sheet channel refers to the balance-sheets of firms, but not to those of banks. Some researchers call the balance-sheet channel "the broad credit channel" (Oliner and Rudebusch, 1996).

[6] The specification is derived from a firm's profit maximization problem subject to a constant elasticity of substitution (CES) production function (Bond, Elston, Mairesse, and Mulkay, 1997).

optimal capital stock from the first and second lines as (dropping the time subscript t):

$$k_i = \frac{\lambda_0 - \lambda_1}{\lambda_0} y_i - \frac{\lambda_2}{\lambda_0} j_i + constant.$$

Thus, in the long-run equilibrium, the optimal capital stock depends on real output, as the accelerator model predicts.

In equation (1), the expected sign of λ_0 is $\lambda_0 < 0$, since the firm may be supposed to make downward adjustments in the future course of its investment, when it has excess capital stock vis-à-vis its output (i.e. when $k - y$ is large). The expected sign of λ_2 is $\lambda_2 < 0$, since an increase in the user cost may be supposed to exert a negative impact on investment.[7]

The role of the interest rate channel can be tested by checking the signs and significance of the coefficients on the user cost, γ_h (the expected sign is $\gamma_h < 0$) and λ_2. This is because the user cost reflects the market interest rate, as we will discuss below.

The role of the credit channel is thought to be tested by checking the sign and significance of the coefficient on the cash flow term in the third line of the equation. Since cash flow roughly corresponds to changes in available internal funds, higher investment-cash flow sensitivities can be considered evidence of greater financial constraints (Hubbard, 1998). If the credit channel works, θ is expected to be positive and significant for the constrained firms.

However, interpretation of the cash flow term is open to some debate. First, cash flow might be significant because it is correlated with firm profitability and thus serves as a proxy for expectations of future activity. Second, it might be significant because freely flowing cash allows managers to over-invest: as Jensen (1986) points out, managers might have incentives to make firms grow beyond their optimal size (the 'free cash flow' problem).

Furthermore, as the discussion in the previous subsection suggests, in the aftermath of a bursting bubble, there is some doubt as to whether we can test the degree of financial constraint solely by looking at the cash flow term. As shown in the bottom panel of Figure 2, a deterioration in balance-sheet conditions may cause financial constraints to tighten, even in the case when an easier monetary policy increases the amount of internal funds available (from F to F'). In this case, in order to properly test the degree of financial constraints faced by firms, balance-sheet variables need to be added to the equation.

We add two balance-sheet variables to equation (1). One is a balance-sheet variable for the firms themselves (BS^f), while the other is for their main banks (BS^b). These two balance-sheet variables reflect respectively the balance-sheet channel and the lending channel. Then, our preferred specification becomes:

$$\left(\frac{I_{it}}{K_{i,t-1}}\right) = \rho\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \sum_{h=0}^{1} \beta_h \Delta y_{i,t-h-1} + \sum_{h=0}^{1} \gamma_h \Delta j_{i,t-h-1}$$

[7] λ_1 is a parameter which reflects the degree of returns to scale in the underlying production function. In the case of constant returns to scale, $\lambda_1 = 0$.

$$+ \lambda_0(k-y)_{i,t-2} + \lambda_1 y_{i,t-2} + \lambda_2 j_{i,t-2}$$
$$+ \theta \left(\frac{CF_{it}}{p^k_{i,t-1} K_{i,t-1}} \right) + \phi BS^f_{i,t-1} + \psi BS^b_{i,t-1} + d_t + \eta_i + \nu_{it}. \tag{2}$$

If the credit channel had been blocked because of a deterioration in balance-sheet conditions, the added balance-sheet variables would be expected to be significant, whereas θ may not be.

As an alternative way of specifying the accelerator model, the ECB studies also make use of an Auto-Distributed Lag Model (ADL). As Bond, Elston, Mairesse, and Mulkay (1997) show, both the ECM and the ADL are two variants derived from the same profit maximization problem. In our set-up, the ADL specification replaces the first and second lines of equation (2) with the first line of the equation below.

$$\begin{aligned} \left(\frac{I_{it}}{K_{i,t-1}} \right) &= \sum_{h=1}^{2} \rho_h \left(\frac{I_{i,t-h}}{K_{i,t-h-1}} \right) + \sum_{h=0}^{2} \beta_h \Delta y_{i,t-h-1} + \sum_{h=0}^{2} \gamma_h \Delta j_{i,t-h-1} \\ &\quad + \theta \left(\frac{CF_{it}}{p^k_{i,t-1} K_{i,t-1}} \right) + \phi BS^f_{i,t-1} + \psi BS^b_{i,t-1} + d_t + \eta_i + \nu_{it}. \end{aligned} \tag{3}$$

We estimate this equation in addition to equation (2) in order to provide robustness checks of our findings. In equation (3), the role of the interest rate channel can be tested by examining the sign and significance of γ_h, and that of the credit channel can be tested by examining the signs and significance of θ, ϕ, ψ.

In this paper, we do not use the Q-type investment function popular in the existing literature of Japanese investment functions. This is because we feel that identifying the interest rate channel becomes problematic when a Q-type investment function is employed. Conceptually, since Tobin's q reflects changes in the interest rate, the interest rate channel can be tested by examining the sign and significance of the coefficient on q. However, practice tells us that the empirically observable average q, typically calculated from firms' share prices, are governed by fluctuations in asset prices. This causes problems in identification of the interest rate channel after the bubble burst, because asset prices plummeted in spite of a fall in the interest rate. Since q did not improve, we cannot see the effect of lowering the interest rate.

3 Data

The use of a micro panel data set is indispensable for this research. The micro data is needed to divide the sample according to the degree of financial constraints faced by individual firms. We then want to compare, across the divided sample, the estimated coefficients on the cash flow and balance-sheet variables in order to examine the role of the credit channel. The micro data is also needed to differentiate between balance-sheet effects that originate with firms and those that originate with their banks. With more aggregated data, the balance-sheet conditions of firms and of their main banks fluctuate in a more or less similar way, so that it is almost impossible to distinguish their differing roles. At the level of a diversified micro data set, however, we can distinguish between the effects of these two balance-sheet conditions, provided that there is a sufficient number of firms whose own balance-sheets are in a good condition, but whose main banks' balance-sheets are not, and vice versa.

For the remaining analyses, we exploit corporate finance data from the Corporate Finance Data Set compiled by the Development Bank of Japan, which includes balance-sheets and income statements for Japanese non-financial firms listed in the first and second sections of the Tokyo, Osaka and Nagoya stock exchanges; or in the JASDAQ, the NASDAQ Japan and the TSE Mothers (three share trading markets geared to small- and medium-sized companies). The database contains both consolidated and unconsolidated data. We choose the unconsolidated data, which contains more detailed time series data than the consolidated data.

3.1 Sample Selection

We retain non-manufacturing firms in our sample,[8] in spite of the fact that most researchers, estimating Japanese micro investment functions, select only manufacturing firms to maintain sample homogeneity. We add non-manufacturing firms to the sample, because we want to examine the efficacy of monetary transmission within the widest possible spectrum of firms. We also want, as far as possible, to retain within the sample firms that suffered from balance-sheet problems. The construction, real estate, wholesale and retail industries are often said to have suffered the most severe deterioration in their balance-sheet conditions after aggressive investment during the bubble period.

The following sample selection rules are applied to all records in each sample period.

1. We select firms that continued to exist for at least seven years during the period required for estimation (from a couple of years prior to the beginning of the sample period—the lengths of the prior period depend on the lag lengths of the estimated models—to the end of the sample period). This excludes from the sample newly-listed firms that did not survive beyond seven years. This presumably results in conservative estimates of the effects of the credit channel, since these firms may be supposed to have been confronted by more severe informational asymmetries.

2. In order to exclude outliers, we drop firms whose J_{it} take negative values. Furthermore, we drop firms which observe values of Δy_{it}, $I_{it}/K_{i,t-1}$ and $CF_{it}/(p^k K)_{i,t-1}$ that are within the upper or lower 0.5 percentiles. Also, we drop firms which observe values of J_{it} and $(D/A)_{it}$ that are within the upper one percentile.

Consequently, the ECM (Table 2 below) and the ADL (Table 5 below) are estimated using slightly different samples, because these two models have different lag lengths. We

[8]However, we exclude firms in the electric industry, which are quasi-public enterprises in nature.

take this as another robustness check. That is, we check the robustness of our findings not only by comparing different specifications but also by using different samples.

Following Gibson (1997), we split our sample into two sub-samples according to whether the firms have issued bonds or not. Non-bond-issuing firms are thought to face tighter financial constraints than bond-issuing firms, because they have fewer external funding options and hence are more dependent on bank lending. Non-bond-issuing firms also tend to be small, as we will see below, and hence face more severe asymmetric information problems.[9]

3.2 Variables

This subsection elaborates on some of the variables in the investment functions. The other variables are more or less standard, and the data appendix summarizes their calculation.

- In addition to depreciable assets, we take into account land holdings when calculating real investment I and real capital stock K. This is because a non-negligible part of investment by non-manufacturing firms consists of investment in land. In the case of real estate firms, we also take inventory into account because most of their inventory consists of real estate for sale.

- We calculate the user cost of capital J based on the JGB yield. This is because an apparent interest rate, calculated from total interest payments divided by outstanding debts, contains the default risk that will be compounded into average financing costs. This makes it difficult to distinguish between the interest rate and credit channels (see footnote 3). We assume that the default risk depends on cash flow and the firm's balance-sheet condition, and hence the effects of the risk premium (and thus the credit channel) are measured by the coefficients on these variables.

- For the firm balance-sheet condition variable, BS^f, we use the debt-asset ratio D/A: i.e. debt outstanding divided by assets, of which (i) inventory, (ii) land, (iii) machinery, and (iv) non-residential buildings and structures are adjusted to their market values by perpetual inventory methods. This enables us to take into account the fall in asset prices after the bubble burst.

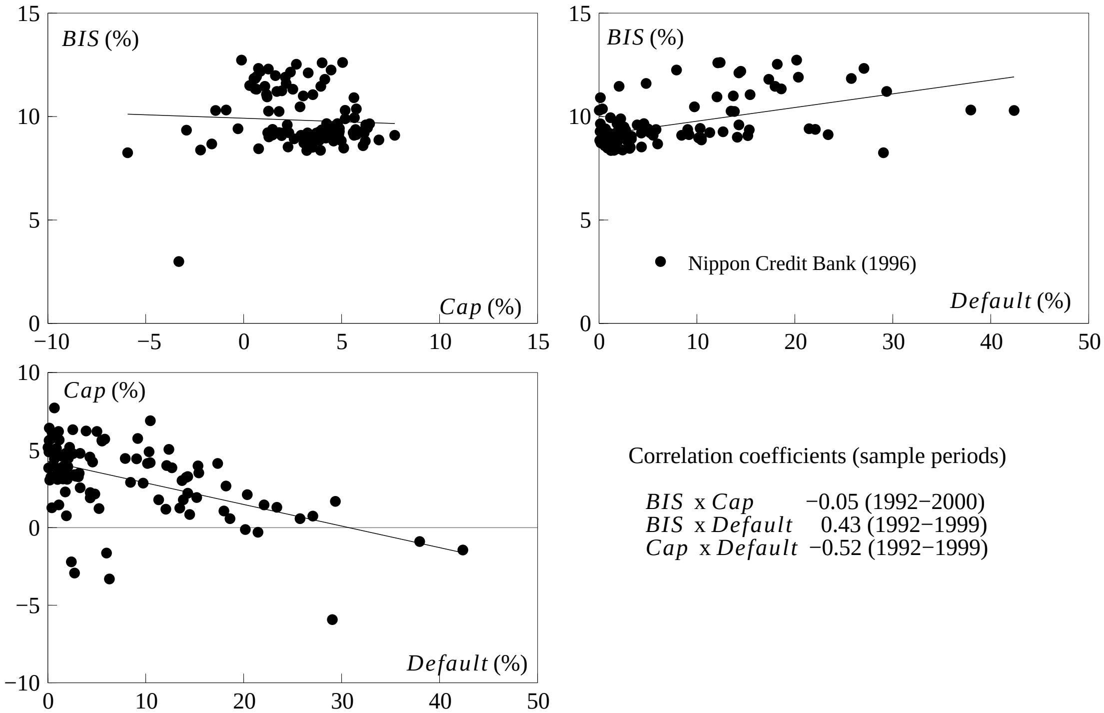
- For the main bank balance-sheet condition variable, BS^b, we need not only to find an indicator that reasonably captures the true conditions of these banks' balance-sheets, but also to determine the main banks of each firm.

  First, for the bank health indicator, we mainly use the adjusted capital adequacy ratio, Cap, which takes into account non-performing loans, capital gains/losses and

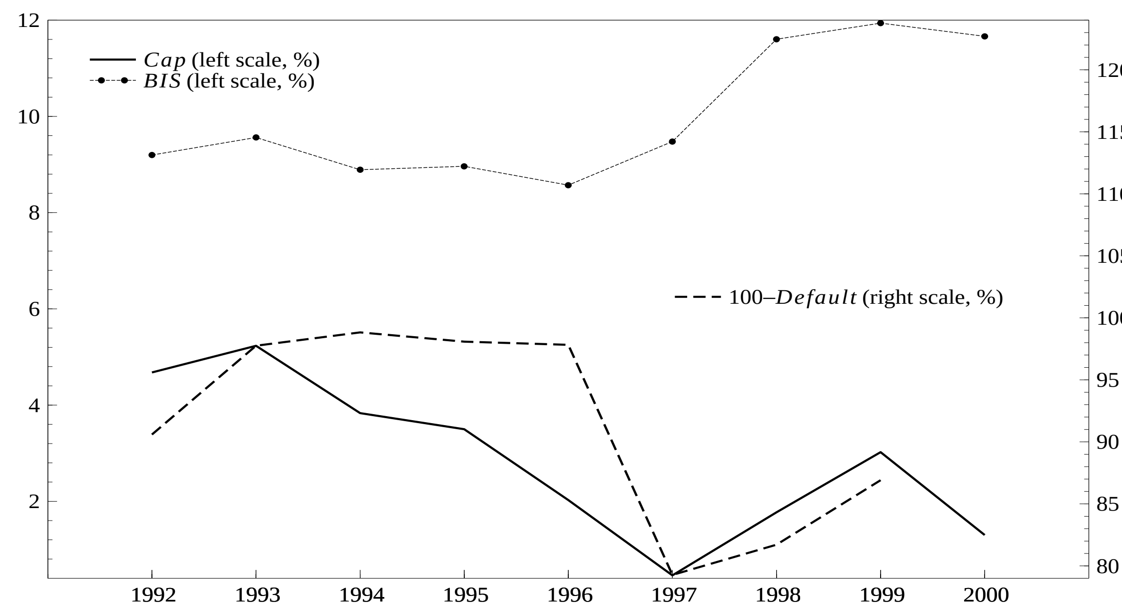
[9]The line used to split the sample is bound to be more or less subjective. It is true that some bond-issuing firms with inferior ratings face severe financial constraints, as evident in the yield spread on their bonds. We choose the above criteria because it is easy to apply—the data base contains information on bond-issuing but not bond-rating.

Figure 4: Bank Health Indicators

(1) Cross Plots



(2) Time-Series Graph



deferred tax assets.[10]

We also use the BIS capital adequacy ratio, BIS, and the likelihood of the bank's default, $Default$. The latter is calculated for each bank from its balance-sheet and share price using option theory (Oda, 1999, and Fukao, 2000).

Comparison among these three indicators highlights the difference between BIS and the other two indicators:

- BIS is not correlated with Cap but is positively correlated with $Default$—a bank with a higher BIS is likely to have a higher default risk (Figure 4, upper panel). In the meantime, the correlation coefficient between Cap and $Default$ is negative, which looks more sensible—a bank with a lower Cap is likely to have a higher default risk.
- The variation coefficient (the standard deviation divided by the mean) of BIS is very small (0.14) across banks, compared with those of Cap (0.77) and $Default$ (1.12).
- BIS improved during the period of the 1997-1998 financial crisis, whereas Cap and $Default$ deteriorated (Figure 4, bottom panel).

Next, main banks are defined to be the three principal banks whose shares of long-term loans in any given firm are largest.[11] Principal banks are city banks and long-term credit banks, which are generally considered to perform the role of main bank for Japanese listed firms (Aoki and Patrick, 1994). Three banks are chosen, because there are some cases where the top two or three banks have the same share, particularly with regard to large firms.

Accordingly, BS^b is calculated as a weighted average of the top three banks' health indicators, where the weights represent these three banks' shares of long-term loans in each firm.

3.3 Sample Properties

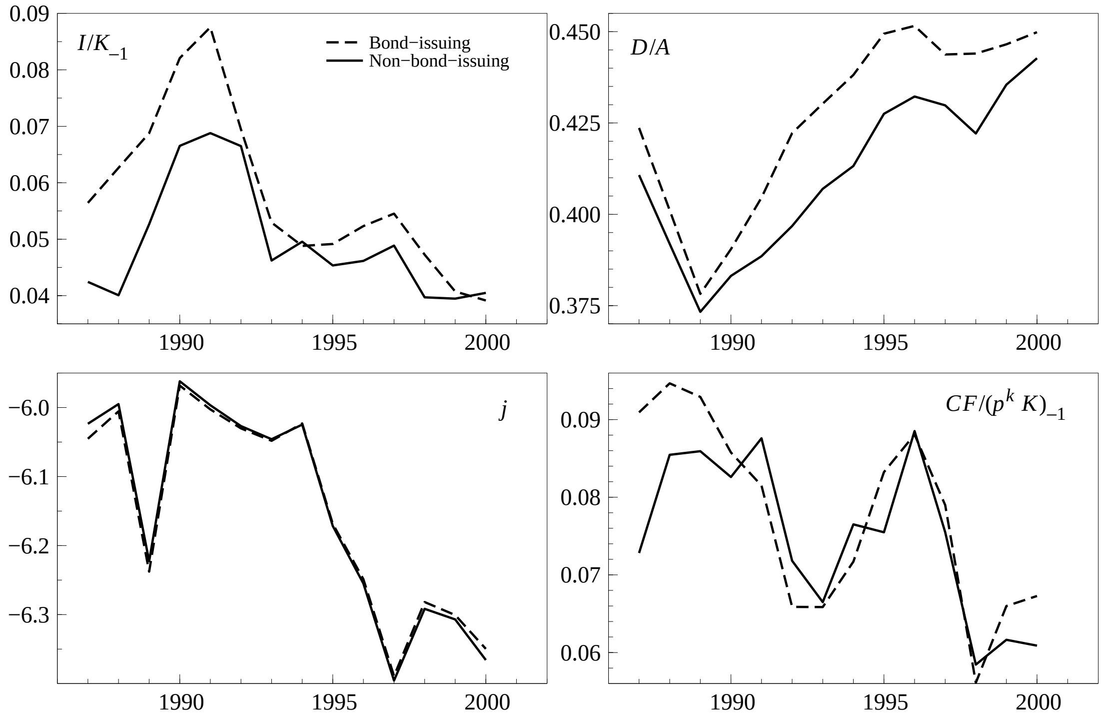
Figure 5 shows the movement over time of the sample means of our main indicators.[12] During the bubble period, bond-issuing firms invested heavily and had rich cash flow. After the bubble burst, the difference in cash flows between bond- and non-bond-issuing firms narrowed, but bond-issuing firms kept somewhat higher levels of investment than non-bond-issuing firms. Meanwhile, both groups of firms faced a sharp deterioration in their debt-asset ratios. The debt-asset ratios of bond-issuing firms, which are supposed to

[10](Shareholders' equity + Capital gains/losses from securities + Loan-loss provisioning − Risk management assets − Deferred tax assets)/Assets. See Fukao (2000) for more details.

[11]Data on firms' long-term borrowing from individual banks in FY1999 and FY2000 are obtained from the Nikkei Financial Quest database, since the Corporate Finance Data Set contains the corresponding data only prior to FY1999.

[12]The figure is obtained by applying the above sample selection rules to all the data records from FY1987 to FY2000 (except for the electricity firms).

Figure 5: Main Indicators



be relatively free from financial constraints, were higher than those of non-bond-issuing firms.[13] As for the user cost of capital, there is no big difference between two groups of firms. This is because we calculate the user cost based on the market interest rate.

The top panel of Table 1 summarizes the sample properties of four subsamples: the sample is divided into four subsamples according to whether the firms have issued bonds or not, and whether or not we have bank information for them. y is much larger for bond-issuing firms (column (2) vis-à-vis column (3), and column (4) vis-à-vis column (5)). On the other hand, firms for which we have bank information are relatively large in terms of y (column (2) vis-à-vis column (4), and column (3) vis-à-vis column (5)). There is no big difference between the four groups in terms of the user cost—as seen above, this is because we calculate the user cost based on the market interest rate. The cash flow term is higher on average for firms for which we have no bank information. This might imply that more young and promising firms are contained within this category. The debt-asset ratio D/A is higher for the firms for which we have bank information.

Correlation coefficients show that I/K_{-1} is correlated with Δy and $CF/(p^k K)_{-1}$. By contrast, its correlations with the other variables are low (Table 1, middle panel). In

[13]Amongst bond-issuing firms, the debt-asset ratios of non-manufacturing firms are higher than those of manufacturing firms. This might reflect 'forbearance lending' to the real estate industry (Kobayashi, Saita, and Sekine, 2002).

Table 1: Sample Properties

(1) Sample Properties: Means (Standard Deviations)

	(1)	(2)	(3)	(4)	(5)
	All industries	All industries	All industries	All industries	All industries
Bond issue	Yes+No	Yes	No	Yes	No
Bank info.	Yes+No	Yes	Yes	No	No
I/K_{-1}	0.06	0.05	0.04	0.06	0.06
	(0.08)	(0.07)	(0.08)	(0.08)	(0.09)
y	13.04	13.60	12.25	13.24	12.13
	(1.41)	(1.44)	(1.12)	(1.31)	(1.11)
j	-6.17	-6.17	-6.15	-6.13	-6.15
	(0.29)	(0.29)	(0.28)	(0.28)	(0.28)
$CF/(p^kK)_{-1}$	0.07	0.05	0.04	0.12	0.11
	(0.11)	(0.08)	(0.08)	(0.12)	(0.16)
D/A	0.43	0.48	0.49	0.34	0.32
	(0.18)	(0.16)	(0.18)	(0.15)	(0.18)
Cap		2.76	2.73		
		(2.17)	(2.15)		
$Default$		6.60	6.74		
		(7.25)	(7.66)		
BIS		9.69	9.62		
		(1.23)	(1.23)		
Firms	2,154	856	222	497	217

(2) Correlation Coefficients

	I/K_{-1}	Δy	Δj	$CF/(p^kK)_{-1}$	D/A	Cap
I/K_{-1}	1.00					
Δy	0.14	1.00				
Δj	-0.02	-0.11	1.00			
$CF/(p^kK)_{-1}$	0.22	0.27	-0.05	1.00		
D/A	0.01	-0.04	-0.04	-0.21	1.00	
Cap	0.04	0.03	0.06	0.05	-0.10	1.00

(3) Correlation Coefficients between I/K_{-1} and Cap

FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
-0.001	0.045	0.004	0.020	0.057	-0.077	-0.001	0.016

Notes:

1. Sample properties (the top panel) are calculated from the sample data corresponding to Tables 2 and 9. Cap, $Default$ and BIS are in percent.
2. Correlation coefficients (the bottom two panels) are calculated from the sample data corresponding to columns (2) and (3) in the top table.

particular, its correlation with *Cap* is quite low, even if we examine it on a yearly basis (Table 1, bottom panel).[14] We will see below how the correlation changes, once we control various factors properly by estimating panel investment functions.

4 Estimation Results

This section presents the results of estimating the ECM, equation (2), and the ADL, equation (3), using the data discussed above.

Our focal (but not exclusive) points of interest are whether the user cost of capital and two balance-sheet variables (one for firms and the other for their main banks) are significant or not; and whether the estimated coefficients differ across bond-issuing and non-bond-issuing firms. If these variables are significant, we may reasonably say that the decline in the user cost sustained firm investment in the 1990s, but that deterioration in balance-sheet conditions adversely affected it. Furthermore, for instance, if the bank balance-sheet variable is significant only for non-bond-issuing firms, we may also say that the credit channel, which is supposed to work primarily through these firms, was blocked because of the deterioration in the balance-sheet conditions of banks. At the end of the section, we try to obtain a sense regarding the sizes of these effects.

4.1 Error Correction Model (ECM)

Table 2 summarizes the estimation results of equation (2).[15] Inclusion of a bank balance-sheet variable requires us to focus on the firms for which we have bank information. Following Kobayashi, Saita, and Sekine (2002), the sample period begins in FY1993, when the non-performing loan problems are considered to have started to affect the economy (the appendix reports estimation results prior to FY1993). Columns (1) and (2) list estimation results based on all industrial firms, and columns (3) and (4) list those based on the manufacturing firms, which are expected to provide a more homogeneous sample.

Signs and sizes of estimated coefficients are largely in line with prior expectations.[16] For example, the coefficients on the error correction term $(k - y)_{-2}$ are negative and significant. This implies that excess capacity vis-à-vis output discouraged firm investment as a part of the stock adjustment process.

[14] The correlation is low, but positive during FY1994-FY1997 and in FY2000—I/K_{-1} becomes high as *Cap* improves. The correlation turns out to be negative from FY1998 to FY1999. This might be because during the period of the financial crisis, even healthy banks squeezed their lending.

[15] Hereafter, all estimations are conducted using *DPD for Ox*, version 1.2 (Doornik, Arellano, and Bond, 2001). The Blundell and Bond (1998) dynamic GMM estimators are used with the Windmeijer (2000) small sample bias corrections for the standard errors of the two-step estimators.

[16] For estimation of column (1), the lag length of the Δy instruments for the first-difference equation is truncated, since the original instrument set fails to pass the Sargan test at the five percent significance level. Qualitative results do not alter, even employing the original instrument set.

Table 2: ECM

	(1) All industries	(2) All industries	(3) Manufacturing	(4) Manufacturing
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	Yes	Yes	Yes	Yes
I_{-1}/K_{-2}	-0.01 (0.04)	0.001 (0.04)	-0.07 (0.04)*	0.01 (0.04)
Δy	0.04 (0.04)	0.03 (0.05)	0.03 (0.04)	0.05 (0.07)
Δy_{-1}	0.09 (0.04)**	0.01 (0.04)	0.11 (0.04)***	0.03 (0.04)
$(k-y)_{-2}$	-0.08 (0.04)**	-0.07 (0.04)*	-0.11 (0.04)***	-0.07 (0.04)**
y_{-2}	-0.002 (0.01)	-0.05 (0.03)	-0.01 (0.02)	-0.04 (0.03)
Δj	-0.06 (0.02)***	-0.10 (0.03)***	-0.05 (0.03)*	-0.13 (0.06)**
Δj_{-1}	-0.07 (0.03)***	-0.08 (0.03)**	-0.08 (0.04)**	0.02 (0.06)
j_{-2}	-0.07 (0.04)*	-0.11 (0.06)	-0.09 (0.06)*	-0.02 (0.09)
$CF/(p^kK)_{-1}$	-0.05 (0.07)	0.11 (0.07)	0.08 (0.06)	0.08 (0.06)
$(D/A)_{-1}$	-0.16 (0.05)***	-0.25 (0.09)***	-0.19 (0.05)***	-0.21 (0.08)***
Cap	0.07 (0.15)	0.56 (0.26)**	0.23 (0.14)*	0.49 (0.28)*
Sample period	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000
Observations	6,871	1,617	4,345	1,171
Firms	856	222	538	161
σ	0.086	0.096	0.073	0.082
Sargan	123.9 [0.10]	141.1 [0.28]	139.4 [0.31]	135.3 [0.40]
AR(2)	-0.33 [0.74]	-0.51 [0.61]	-0.72 [0.47]	0.92 [0.36]

1. System GMM Estimation. Coefficients on constants and time dummies are omitted.
2. Estimated coefficients are obtained from two-step estimators. Figures in parentheses are t-values calculated from two-step estimators. "***", "**" and "*" denote statistical significance at the 1%, 5% and 10% level, respectively.
3. AR(2) is a test for the second-order residual serial correlation (the null hypothesis is no serial correlation). Sargan is a test for over-identifying restrictions (the null hypothesis is to satisfy over-identification). Figures in squared brackets are p-values.
4. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-9}/K_{t-10})$, $\Delta y_{t-2,...,t-9}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$, Δj_t, Δj_{t-1}, Cap_t, Cap_{t-1}. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$. For column (1), the $\Delta y_{t-2,...,t-9}$ instruments for the first-differenced equations are replaced with Δy_{t-2} and Δy_{t-3}.

Although the coefficients on the level of the user cost, j_{-2}, are not significant for non-bond-issuing firms, those on the first-difference terms, Δj and Δj_{-1}, are significant in almost all cases. That is, the easing monetary policy sustained firm investment through the interest rate channel. The sum of the coefficients on Δj and Δj_{-1} ranges from -0.11 to -0.18. Compared with estimation results based on similar specifications for other industrial countries, this range covers the Italian case (-0.18, Gaiotti and Generale (2001)), although it is larger in negative than that for the French case (-0.03, Chatelain and Tiomo (2001))—in fact, the user cost is not significant in the French case.

While the coefficients on the cash flow term $CF/(P^kK)_{-1}$ are insignificant, those on the firm balance-sheet variable D/A are negative and significant in all cases. That is, the deterioration in firm balance-sheet conditions hampered firm investment. These coefficients tend to take relatively large negative values for non-bond-issuing firms (column (1) vis-à-vis column (2), and column (3) vis-à-vis column (4)). With the caveat that the standard errors are large, this is consistent with the situation shown in the bottom panel of Figure 2: a firm facing tighter financial constraints was more heavily influenced by asset price fluctuations.[17]

As for the coefficients on the bank balance-sheet variables Cap, a sharper contrast emerges between bond-issuing and non-bond-issuing firms. Amongst all industrial firms, the coefficient on Cap is positive and significant for non-bond-issuing firms (column (2)), whereas it is insignificant for bond-issuing firms (column (1)). Amongst the manufacturing firms, the coefficient on Cap becomes significant even for the bond-issuing firms, but its size is just half of that for the non-bond-issuing firms (columns (3) and (4)). These findings support the view that the deterioration in bank balance-sheet conditions more heavily affected the investment of firms which faced tighter financial constraints by causing a steeping in the gradient of their supply schedules.

In short, the estimation results of the ECM indicate that: (i) although firm investment was supported by the lower interest rate, it was depressed by the existence of the excess capacity and by the deterioration in balance-sheet conditions; (ii) the deterioration in balance-sheet conditions (especially in bank balance-sheet conditions) more heavily affected investment by non-bond-issuing firms; and (iii) cash flow did not serve as a good proxy for financial constraints in this period.

With regard to (ii) and (iii) above, we conduct some robustness checks as follows:

- **Cash flow based on operating profits:** In Table 3, we use cash flow based on operating profits (denoted by CF') instead of that based on after-tax earnings. This is because after-tax earnings were subject to accounting changes during this period. The most recent example is the special loss in retirement benefit expenses arising from the adoption of a new accounting standard for pension funds. Although

[17]As we will see below, the ADL model gives us more muted results on this matter. Presumably, this is because the deterioration in firm balance-sheet conditions affected the demand schedule more than the supply schedule.

firms did not make a cash outlay, they recorded a large special loss, which affected after-tax earnings but not operating profits.

The coefficients on CF' are by and large insignificant, and thus support (iii) above. Although the coefficient becomes significant in column (3), it is rather difficult to consider this significance something to do with the degree of financial constraints, because column (3) contains the results for bond-issuing firms.

- **Other bank health indicators:** In Table 4, we replace Cap with the other two bank health indicators, $Default$ and BIS.

  Columns (1) and (2) show the estimation results based on $Default$. The signs of the coefficients on $Default$ are negative as expected—firms tend to reduce investment as their main banks' default risks increase—but the results are not significant at the conventional 10 percent level. However, we consider the case for non-bond-issuing firms to be borderline, since its p-value is 13.9 percent, and the one-step estimator of the same coefficient is significant at the 10 percent level.

  Columns (3) and (4) contain the estimation results based on BIS. The coefficients on BIS are insignificant.[18] Given the difference described above between BIS and the other two bank health indicators, it is not surprising that the coefficients on BIS are so much less significant than those on Cap and $Default$. Since BIS is said to be subject to a certain degree of arbitrariness given varying accounting techniques (Fukao, 2001), we retain our view that the bank balance-sheet variable is significant at least for non-bond-issuing firms despite the outcomes of BIS, and proceed to the next subsection, where we conduct a further robustness check using the ADL specification.

4.2 Auto-Distributed Lag Model (ADL)

Table 5 reports the estimation results of equation (3). The upper panel of the table summarizes individual coefficients (which are shown in the lower panel) in the form of long-run coefficients.[19]

Although the ADL gives a slightly different picture from the ECM in a couple of places, it generally supports the thrust of the above argument.

[18] Although this causes a failure in the Sargan test, the coefficient on BIS in column (3) remains insignificant, even if BIS_t and BIS_{t-1} are added to the instrument set.

[19] Suppose that all the variables reach steady state in the long run. We can derive the following equation by dropping time subscripts and rearranging equation (3).

$$\left(\frac{I}{K}\right)_i = \frac{\sum_h \beta_h}{1-\sum_h \rho_h}\Delta y_i + \frac{\sum_h \gamma_h}{1-\sum_h \rho_h}\Delta j_i + \frac{\theta}{1-\sum_h \rho_h}\left(\frac{CF}{p^k K}\right)_i + \frac{\phi}{1-\sum_h \rho_h}BS_i^f + \frac{\psi}{1-\sum_h \rho_h}BS_i^b + \ldots.$$

The long-run coefficients are obtained as coefficients in this equation. Significance of these long-run coefficients are tested using a Wald-test on the numerators (e.g. test $\sum_h \beta_h = 0$).

Table 3: ECM (Cash Flow Based on Operating Profits)

	(1)	(2)	(3)	(4)
	All industries	All industries	Manufacturing	Manufacturing
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	Yes	Yes	Yes	Yes
I_{-1}/K_{-2}	0.01 (0.03)	-0.008 (0.04)	-0.05 (0.04)	-0.01 (0.04)
Δy	0.003 (0.04)	0.04 (0.04)	0.01 (0.04)	0.08 (0.06)
Δy_{-1}	0.06 (0.04)*	0.02 (0.05)	0.09 (0.04)**	0.06 (0.05)
$(k-y)_{-2}$	-0.06 (0.03)*	-0.07 (0.04)*	-0.09 (0.03)***	-0.09 (0.03)***
y_{-2}	-0.005 (0.01)	-0.05 (0.03)*	-0.01 (0.02)	-0.03 (0.03)
Δj	-0.06 (0.02)***	-0.09 (0.03)***	-0.04 (0.03)	-0.13 (0.06)**
Δj_{-1}	-0.07 (0.03)***	-0.07 (0.03)**	-0.07 (0.03)**	0.01 (0.08)
j_{-2}	-0.07 (0.04)	-0.10 (0.06)	-0.09 (0.05)*	-0.04 (0.11)
$CF'/(p^kK)_{-1}$	0.20 (0.13)	0.02 (0.14)	0.16 (0.09)*	-0.05 (0.13)
$(D/A)_{-1}$	-0.16 (0.04)***	-0.19 (0.08)**	-0.17 (0.04)***	-0.17 (0.09)*
Cap	0.09 (0.15)	0.52 (0.28)*	0.31 (0.14)**	0.47 (0.30)
Sample period	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000
Observations	6,893	1,618	4,348	1,172
Firms	858	222	538	161
σ	0.078	0.093	0.068	0.082
Sargan	122.5 [0.09]	142.1 [0.19]	135.5 [0.31]	139.2 [0.24]
AR(2)	-0.53 [0.60]	-0.47 [0.64]	-0.70 [0.49]	0.74 [0.46]

1. See notes for Table 2.
2. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-8}/K_{t-9})$, $\Delta y_{t-2,...,t-8}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$, Δj_t, Δj_{t-1}, Cap_t, Cap_{t-1}. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$.

Table 4: ECM (Other Bank Health Indicators)

	(1)	(2)	(3)	(4)
	All industries	All industries	All industries	All industries
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	Yes	Yes	Yes	Yes
I_{-1}/K_{-2}	-0.01 (0.03)	-0.002 (0.04)	-0.01 (0.03)	-0.002 (0.04)
Δy	0.005 (0.04)	0.05 (0.05)	0.003 (0.04)	0.06 (0.04)
Δy_{-1}	0.07 (0.03)**	0.02 (0.05)	0.07 (0.04)*	0.02 (0.04)
$(k-y)_{-2}$	-0.06 (0.03)**	-0.07 (0.04)	-0.06 (0.03)*	-0.08 (0.04)*
y_{-2}	-0.02 (0.01)	-0.05 (0.03)	-0.02 (0.01)	-0.06 (0.03)
Δj	-0.04 (0.02)**	-0.09 (0.02)***	-0.04 (0.02)**	-0.10 (0.02)***
Δj_{-1}	-0.06 (0.02)**	-0.07 (0.03)**	-0.06 (0.03)**	-0.08 (0.03)***
j_{-2}	-0.09 (0.04)**	-0.09 (0.06)	-0.09 (0.04)**	-0.09 (0.05)
$CF/(p^kK)_{-1}$	0.03 (0.06)	0.09 (0.07)	0.03 (0.06)	0.07 (0.07)
$(D/A)_{-1}$	-0.16 (0.04)***	-0.21 (0.09)**	-0.16 (0.05)***	-0.24 (0.08)***
$Default_{-1}$	-0.11 (0.19)	-0.26 (0.17)		
BIS			0.37 (1.88)	0.09 (0.30)
Sample period	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000
Observations	6,871	1,617	6,871	1,617
Firms	856	222	856	222
σ	0.079	0.092	0.079	0.096
Sargan	123.5 [0.22]	117.7 [0.34]	126.7 [0.16]	137.2 [0.27]
AR(2)	-0.50 [0.62]	-0.24 [0.81]	-0.60 [0.55]	-0.21 [0.84]

1. See notes for Table 2.
2. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-8}/K_{t-9})$, $\Delta y_{t-2,...,t-8}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$, Δj_t, Δj_{t-1}. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$. For column (4), BIS_t and BIS_{t-1} are added to the instrument set for the first-differenced equations.

Table 5: ADL

	(1) All industries	(2) All industries	(3) Manufacturing	(4) Manufacturing
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	Yes	Yes	Yes	Yes
		Long-Run Coefficients		
Δy	0.08 [0.00]***	0.01 [0.64]	0.07 [0.00]***	0.04 [0.76]
Δj	-0.10 [0.19]	-0.41 [0.00]***	0.09 [0.37]	-0.15 [0.27]
$CF/(p^k K)_{-1}$	0.06 [0.28]	0.11 [0.08]*	0.05 [0.40]	0.15 [0.07]*
$(D/A)_{-1}$	-0.21 [0.00]***	-0.16 [0.08]*	-0.22 [0.00]***	-0.25 [0.01]***
Cap	0.05 [0.73]	0.44 [0.08]*	0.27 [0.08]*	0.58 [0.07]*
		Full Specification		
I_{-1}/K_{-2}	0.08 (0.02)***	0.03 (0.05)	0.07 (0.02)***	0.03 (0.06)
I_{-2}/K_{-3}	0.04 (0.02)**	0.01 (0.03)	0.05 (0.02)**	0.03 (0.03)
Δy	-0.002 (0.03)	0.03 (0.05)	-0.01 (0.03)	0.05 (0.05)
Δy_{-1}	0.04 (0.01)***	0.001 (0.02)	0.04 (0.01)***	-0.01 (0.03)
Δy_{-2}	0.03 (0.01)***	-0.02 (0.02)	0.03 (0.01)***	-0.01 (0.03)
Δj	-0.03 (0.02)*	-0.09 (0.03)***	-0.01 (0.03)	-0.12 (0.06)*
Δj_{-1}	-0.04 (0.02)**	-0.11 (0.05)**	0.003 (0.03)	0.004 (0.08)
Δj_{-2}	-0.01 (0.03)	-0.19 (0.13)	0.09 (0.05)*	-0.02 (0.10)
$CF/(p^k K)_{-1}$	0.05 (0.05)	0.11 (0.06)*	0.04 (0.05)	0.14 (0.08)*
$(D/A)_{-1}$	-0.18 (0.04)***	-0.15 (0.09)*	-0.19 (0.04)***	-0.23 (0.09)***
Cap	0.05 (0.14)	0.43 (0.24)*	0.23 (0.13)*	0.54 (0.30)*
Sample period	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000	FY1993-FY2000
Observations	6,735	1,565	4,285	1,136
Firms	881	226	557	164
σ	0.069	0.077	0.060	0.080
Sargan	149.2 [0.39]	148.6 [0.40]	149.9 [0.37]	145.6 [0.47]
AR(2)	-1.22 [0.22]	0.39 [0.70]	-1.50 [0.13]	0.35 [0.73]

1. See notes for Table 2.
2. See footnote 19 for calculation of the long-run coefficients. Figures in squared brackets are p-values calculated from a Wald-test.
3. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-8}/K_{t-9})$, $\Delta y_{t-2,...,t-11}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$, Δj_t, Δj_{t-1}, Cap_t, Cap_{t-1}. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$.

Looking first of all at the differences: First, for all industrial firms, the coefficient on D/A for the bond-issuing firms takes a larger negative value than for non-bond-issuing firms (column (1) vis-à-vis column (2))—although this is within the margin of standard error. Next, the coefficients on the cash flow term are significant for non-bond-issuing firms (columns (2) and (4)).

However, the estimation results of the ADL confirm the main points found using the ECM: First, the coefficients on D/A are negative and significant in all cases. Second, the coefficients on Cap are significant for non-bond-issuing firms. Third, amongst manufacturing firms, although the coefficient on Cap is significant for bond-issuing firms, it is much smaller than that of non-bond-issuing firms. These results support the view that the plunge in asset prices hampered firm investment, because it tightened financial constraints by causing a deterioration in firm and bank balance-sheet conditions.

The estimation results of the ADL also confirm the results of the ECM with respect to the user cost. As far as the long-run coefficients are concerned, the user cost is significant only in column (2). However, in the lower panel, Δj and/or Δj_{-1} are negative and significant except for column (3). This is consistent with the results obtained by the ECM in that a change in the user cost, and hence a change in the interest rate, has an impact on firm investment.

For the sake of comparison, the long-run coefficient on the user cost is estimated from a pooled sample of both bond-issuing and non-bond-issuing firms.[20] The coefficient obtained (-0.15) is less negative than that for Germany (-0.56), but is about the same size as those for France (-0.10) and Italy (-0.09).[21]

4.3 Contribution of the User Cost and Balance-sheet Variables

Table 6 tries to obtain a sense regarding to what extent the user cost and the balance-sheet variables account for the changes in I/K_{-1} by bond-issuing and non-bond-issuing firms.

In the ECM case, the sample average of I/K_{-1} declined by 3.2 percentage points for bond-issuing firms (from 6.4 percent at the end of FY1992 to 3.2 percent at the end of FY2000) and by 2.5 percentage points for non-bond-issuing firms (from 6.4 percent to 3.8

[20]Estimation results are as below (all industries):

Δy	0.05 [0.00]***
Δj	-0.15 [0.04]**
$CF/(p^k K)_{-1}$	-0.00 [0.99]
$(D/A)_{-1}$	-0.16 [0.00]***
Cap	0.22 [0.07]*

Sample period: 1993-2000, Observations: 8,315, Firms: 1,082, σ: 0.069, Sargan: 163.9 [0.13], AR(2): -1.08 [0.28]. As for instruments, see notes for Table 5.

[21]Although they use a slightly different specification, Chirinko, Fazzari, and Meyer (1999) estimate the long-run coefficient on the user cost as -0.25, based on U.S. panel data.

percent). In the ADL case, the corresponding figures differ somewhat from the above, since the ADL employs a slightly different sample. The contributions to the changes in I/K_{-1} are calculated from the sample averages of the variables of interest (Δj, Δj_{-1} D/A, and Cap) and from the coefficients on them (obtained from Tables 2 and 5).

From panel "(A) FY1993-FY2000," we can see the following: while the decline in the user cost worked towards increasing firm investment, this positive effect is more than counteracted by the negative impact from the deterioration in balance-sheet conditions. Furthermore, the negative impact from deteriorating balance-sheet conditions is found to be relatively large for non-bond-issuing firms compared to bond-issuing firms. This difference is particularly noticeable in the bank balance-sheet condition Cap.[22]

From the lower three panels, we see how the results discussed above can be decomposed into the contributions made during each of three subperiods.

The positive effects from the user cost are concentrated in the first subperiod (FY1993-FY1995). This can be explained by the fact that the interest rate (and hence the user cost) declined more in the first subperiod—for instance, the call rate declined from around four percent at the beginning of 1993 to less than 0.5 percent at the end of 1995. After that, given the small margin within which to make further interest rate cuts, the user cost actually exerted downward pressure on investment, reflecting the decline in the price of capital goods.[23]

Relatively large negative effects are found coming from the firm balance-sheet variable in each subperiod. This reflects movements in asset prices. For instance, land prices continued to decline in the 1990s and thus maintained their pejorative influence on firms' balance-sheet conditions.

The negative effects coming from the bank balance-sheet variable are particularly large for non-bond-issuing firms in the second subperiod, FY1996-FY1998, which spans the occurrence of the financial crisis in Japan. However, even during the first subperiod, a nonneglible negative impact is observed for non-bond-issuing firms. Also, even in the third subperiod, despite the injections of public funds made to banks, this negative impact remains.[24]

5 Conclusion

It is sometimes argued that the monetary easing in the 1990s was largely ineffective, because it failed to work either through the interest rate channel or through the credit

[22]As far as firm balance-sheet condition is concerned, in the ADL specification, the negative impact is roughly the same size for both the bond-issuing and the non-bond-issuing firms.

[23]The lag structure of the ECM introduces volatility in the contribution of the user cost—the positive contribution of 0.52 percentage points during FY1999-FY2000 should be considered a rebound from the negative contribution of 1.02 percentage points in the preceding period.

[24]Owing to the increase in risk management assets, Cap fell to -2.2 percent in FY2001 (the average of city and long-term credit banks except for Aozora bank) from 1.1 percent in FY2000.

Table 6: Contributions of the User Cost and Balance-Sheet Variables

Bond issue	I/K_{-1} (Change)	$\Delta j + \Delta j_{-1}$	D/A_{-1} (Contribution)	Cap
		(A) FY1993-FY2000		
Yes	-3.20	0.56	-1.18	-0.26
Yes	(-3.29)	(0.29)	(-1.31)	(-0.20)
No	-2.51	0.54	-2.27	-2.09
No	(-2.52)	(0.47)	(-1.37)	(-1.61)
		(B) of which FY1993-FY1995		
Yes	-2.09	0.63	-0.64	-0.06
Yes	(-2.10)	(0.33)	(-0.72)	(-0.05)
No	-2.98	1.04	-1.25	-0.50
No	(-2.76)	(0.72)	(-0.72)	(-0.39)
		(C) of which FY1996-FY1998		
Yes	-0.45	-0.06	-0.30	-0.18
Yes	(-0.32)	(-0.04)	(-0.33)	(-0.13)
No	-0.70	-1.02	-0.53	-1.50
No	(-0.92)	(-0.12)	(-0.40)	(-1.15)
		(D) of which FY1999-FY2000		
Yes	-0.65	-0.01	-0.24	-0.02
Yes	(-0.86)	(0.00)	(-0.26)	(-0.02)
No	1.17	0.52	-0.49	-0.09
No	(1.16)	(-0.13)	(-0.25)	(-0.07)

Note: In percentage points. Calculated from columns (1)-(2) in Table 2 (ECM). Figures in parentheses are calculated from columns (1)-(2) in Table 5 (ADL).

channel. The interest rate channel is said to have less effective as the nominal short-term interest rate approached the zero bound. The credit channel is also said to have become less effective as non-performing loan problems prevented banks from expanding credit.

By estimating firm investment functions based on corporate panel data, this paper finds that the monetary easing worked through the interest rate channel, but not through the credit channel. It finds that the coefficients on the user cost, which reflects the interest rate, are similar to those found for other industrial countries such as Italy and France. Moreover, by quantifying the impact of changes in the user cost upon firm investment, it shows that the interest rate channel was effective at least in the first half of the 1990s.[25] It then demonstrates that the credit channel was blocked by showing that the deterioration in balance-sheet conditions, especially in bank balance-sheet conditions, hampered the investment of smaller non-bond-issuing firms more severely than that of larger bond-issuing firms.

Looking ahead, in order to restore the functioning of the credit channel, the balance-sheet conditions of both firms and banks need to be repaired.[26] This requires either a reduction in outstanding debts or an increase in market-valued assets, which can be achieved by, say, pursuing enterprise reform and disposing of non-performing loans.

Although the paper does not look at the lending data, the finding that investment was hampered by the deterioration in bank balance-sheet conditions is consistent with the view that investment was depressed by a 'capital crunch.' However, our findings are somewhat at odds with Woo (1999), who approaches the problem by looking at bank lending data: he finds that the capital crunch became evident only after the financial crisis in 1997. This differs from our analysis which suggests that the capital crunch was depressing firm investment even before the crisis period. More empirical research is warranted to resolve this issue.[27]

This paper has implications for the debate concerning the asymmetric effects of monetary policy. Due to the presence of a 'financial accelerator,' monetary policy is thought to be more effective when firms face tighter financial constraints.[28] However, in the light of our findings in this paper, we believe that this theory requires a degree of modification in order to accommodate recent Japanese experience. Where tighter financial constraints have resulted from a fall in asset prices after the collapse of the bubble, it is far from clear that an easy monetary policy is as effective as the theory suggests.

[25]This does not necessarily mean that the cuts in the interest rate during this period were adequate. In fact, Okina and Shiratsuka (2001) argue that, with hindsight, the Bank of Japan should have lowered the interest rate more aggressively. A question like whether or not the interest rate was cut sufficiently is beyond the scope of this paper, which does not endogeneize asset prices.

[26]As for the interest rate channel, given the zero bound on the nominal interest rate, there is little room left for 'orthodox' monetary policy.

[27]Our finding—that firm with a higher debt-asset ratio tends to squeeze investment more—does not contradict Kobayashi, Saita, and Sekine (2002) who claim that 'forbearance lending' was made to a firm with high debt-asset ratio. This is because most of the forbearance lending was short-term lending. Thus, these firms were unlikely to spend the forbearance lending on capital investment.

[28]In fact, Hosono and Watanabe (2002) find empirical evidence to support this proposition using Japanese data.

Appendix 1: Estimation without Bank Balance-Sheet Variables

This appendix reports estimation results of alternative specifications. Our primary alternative specifications are those that do not include bank balance-sheet variables. Leaving out these variables enables us to estimate investment functions during the bubble period, in which Cap and BIS are not available.[29] It also enables us to estimate investment functions for firms for which we do not possess bank information.

Estimations made after dropping the balance-sheet variables produce the following results. First, dropping the bank balance-sheet variable does not result in any significant changes in the coefficients on the remaining variables (Table 8, columns (1) and (2) vis-à-vis Table 2, columns (1) and (2)). Second, dropping the firm balance-sheet variable causes the coefficients on the cash flow term to become significant (Table 8, columns (3) and (4)). However, we still do not consider cash flow to be a good proxy for financial constraints, because the insignificance of the error correction term $(k-y)_{-2}$ makes us skeptical about the specification of columns (3) and (4). We also recall, as seen above, that cash flow becomes insignificant once the model incorporates either of the balance-sheet variables.[30]

Next, carrying out estimations of the same specifications for the bubble period, FY1987-FY1992 allows us to make the following observations (Table 8, columns (5)-(8)).

All the coefficients on the user costs become insignificant, as do those on the error correction term $(k-y)_{-2}$, except for column (6). we can interpret these to suggest that euphoric sentiment prevailing in the economy at that time led firms to carry out aggressive investment projects without due attention to either the user cost or the excess capacity.

The coefficients on the cash flow terms become significant for bond-issuing firms (columns (5) and (7)). The result is consistent with the findings of Nakamura (2000) in that investment by supposedly less financially constrained firms was more sensitive to cash flow than that by more financially constrained firms. This can be interpreted as an indication of the free cash flow problem: since managers have incentives to over-invest, firms with relatively abundant internal funds tend to invest more aggressively.[31]

[29] Since $Default$ is available, we can estimate investment functions with $Default$ during the bubble period. $Default$ turns out to be insignificant (Table 7).

[30] Cash flow tends to be insignificant because of the relatively high correlation between cash flow and real output (Table 1). This can be confirmed by the fact that the cash flow term becomes significant once Δy_{it} is excluded from the specification of column (2) in Table 2. However, it is difficult to say whether such a significant cash flow term represents financial constraints, since the absence of Δy_{it} might force the cash flow term to pick up some demand-side factors or expected growth.

[31] Although similar findings are reported for the U.S. (Cleary, 1999), we have some reservations over this interpretation. First, in order to claim that investment during the bubble era was 'over-investment,' we must show that this investment was inefficient. Moreover, we should also reconcile the interpretation with the theoretical prediction. The theory suggests that an increase in debt, as we observed during the bubble period, disciplines managers more strongly so that they cannot engage in over-investment (Jensen, 1986).

The coefficient on the firm balance-sheet variable takes a larger negative value for non-bond-issuing firms than for the bond-issuing firms (columns (5) and (6))—the contrast is more evident than in the post-bubble period. Since the debt-asset ratio is thought to reflect the land collateral ratio, the finding is consistent with the notion that banks provided aggressive financing for investment by small firms during the bubble period, determining whether or not a firm qualified for a bank loan merely by looking at its land collateral ratio. Because large firms became able to finance their projects directly from the securities market, thanks to the financial deregulation that took place in the 1980s, it has been said that banks were forced to expand their business with small firms (Hoshi and Kashyap, 1999). Since these small firms were new customers for banks, the land collateral ratio was used to compensate for the limitations of their information.

Finally, estimations of the above specifications for firms for which we have no bank information are as follows (Table 9):

For the post-bubble period (columns (1)-(4)), there are a few differences from the results reported in the corresponding columns of Table 9: the coefficient on the firm balance-sheet variable becomes insignificant for bond-issuing firms (column (1)); and the coefficient on the cash flow term becomes insignificant for non-bond-issuing firms (column 2). This is contrary to the prior expectation that firms without main banks face tighter financial constraint.

Interpretation of the above findings is subject to debate, and we would like to reserve judgment until further analysis allows a firmer conclusion to be reached. Currently, a number of possible conclusions suggest themselves. Some might argue that these results emerge because the main bank relationship ceased to exist after the bubble burst, as banks ceased to be able to influence the governance of firms. Others may argue that they emerge because our criterion for determining main banks (i.e. city and long-term credit banks that have the top three shares in long-term lending to each firm) is questionable. Still others may argue that these results provide supporting evidence for the financial accelerator, because firms for which we have no bank information appear less financially constrained—these firms have higher cash flow-asset ratios and lower debt-asset ratios (Table 1).

As for the bubble period (columns (5)-(8)), while most of the coefficients are insignificant, the coefficients on the cash flow term are significant only for bond-issuing firms (columns (5) and (7)), as seen in Table 8. Although we once again note the caveat described in footnote 31, this might be open to interpretation as another indication of the free cash flow problem.

Table 7: Estimation with $Default$ during the Bubble Era

	(1)	(2)	(3)	(4)
	All industries	All industries	Manufacturing	Manufacturing
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	Yes	Yes	Yes	Yes
I_{-1}/K_{-2}	-0.05 (0.06)	-0.12 (0.09)	-0.19 (0.08)**	-0.03 (0.10)
Δy	0.01 (0.07)	0.13 (0.05)**	0.17 (0.09)*	0.08 (0.04) *
Δy_{-1}	-0.03 (0.05)	0.12 (0.05)**	0.09 (0.06)	0.08 (0.05)
$(k-y)_{-2}$	-0.02 (0.03)	-0.15 (0.08)*	-0.15 (0.06)**	-0.09 (0.06)
y_{-2}	-0.01 (0.01)	-0.03 (0.05)	-0.001 (0.01)	-0.004 (0.03)
Δj	-0.07 (0.06)	0.08 (0.14)	0.03 (0.10)	-0.09 (0.11)
Δj_{-1}	-0.01 (0.08)	0.04 (0.12)	0.05 (0.12)	-0.07 (0.10)
j_{-2}	0.10 (0.07)	-0.04 (0.11)	0.12 (0.10)	-0.08 (0.16)
$CF/(p^kK)_{-1}$	0.77 (0.19)***	0.03 (0.11)	0.75 (0.21)***	0.18 (0.15)
$(D/A)_{-1}$	-0.09 (0.05)*	-0.29 (0.10)***	-0.10 (0.05)*	-0.27 (0.12)**
$Default_{-1}$	0.73 (0.50)	0.02 (0.52)	0.31 (0.55)	0.03 (0.72)
Sample period	FY1987-FY1992	FY1987-FY1992	FY1987-FY1992	FY1987-FY1992
Observations	3,306	1,304	2,159	958
Firms	539	251	356	185
σ	0.060	0.095	0.087	0.068
Sargan	61.2 [0.50]	63.9 [0.41]	59.9 [0.55]	58.7 [0.60]
AR(2)	0.20 [0.84]	-1.55 [0.12]	-0.19 [0.85]	-1.62 [0.11]

1. See notes for Table 2.
2. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-8}/K_{t-9})$, $\Delta y_{t-2,...,t-8}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$.

Table 8: ECM without Bank Balance-Sheet Variables (1)

	All industries	All industries	All industries	All industries
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info	Yes	Yes	Yes	Yes
	(A) Sample period: FY1993-FY2000			
	(1)	(2)	(3)	(4)
I_{-1}/K_{-2}	-0.01 (0.03)	-0.002 (0.04)	0.03 (0.03)	0.03 (0.03)
Δy	0.003 (0.04)	0.05 (0.05)	-0.04 (0.04)	0.02 (0.06)
Δy_{-1}	0.07 (0.03)**	0.02 (0.04)	0.02 (0.03)	-0.001 (0.05)
$(k-y)_{-2}$	-0.06 (0.03)**	-0.07 (0.04)*	-0.02 (0.02)	-0.02 (0.03)
y_{-2}	-0.02 (0.01)	-0.05 (0.03)	-0.02 (0.01)*	-0.02 (0.02)
Δj	-0.04 (0.02)**	-0.10 (0.03)***	-0.02 (0.02)	-0.12 (0.05)***
Δj_{-1}	-0.06 (0.03)**	-0.08 (0.03)**	-0.02 (0.03)	-0.07 (0.03)**
j_{-2}	-0.09 (0.04)**	-0.10 (0.07)	-0.02 (0.04)	-0.09 (0.06)
$CF/(p^kK)_{-1}$	0.03 (0.06)	0.11 (0.07)	0.16 (0.06)**	0.18 (0.09)**
$(D/A)_{-1}$	-0.16 (0.04)***	-0.26 (0.08)***		
Observations	6,871	1,617	6,871	1,617
Firms	856	222	856	222
σ	0.079	0.095	0.071	0.077
Sargan	127.1 [0.17]	128.6 [0.15]	103.6 [0.33]	113.8 [0.13]
AR(2)	-0.57 [0.57]	-0.39 [0.70]	-0.56 [0.57]	-0.39 [0.70]
	(B) Sample period: FY1987-FY1992			
	(5)	(6)	(7)	(8)
I_{-1}/K_{-2}	-0.05 (0.05)	-0.16 (0.09)*	-0.04 (0.05)	-0.06 (0.09)
Δy	-0.01 (0.07)	0.14 (0.05)***	-0.01 (0.07)	0.10 (0.06)*
Δy_{-1}	-0.01 (0.04)	0.12 (0.05)***	-0.02 (0.03)	0.06 (0.05)
$(k-y)_{-2}$	-0.02 (0.03)	-0.17 (0.09)*	-0.02 (0.02)	-0.07 (0.08)
y_{-2}	-0.01 (0.01)	-0.05 (0.06)	-0.01 (0.01)	-0.01 (0.05)
Δj	-0.03 (0.02)	-0.001 (0.04)	-0.03 (0.02)	0.001 (0.04)
Δj_{-1}	-0.04 (0.03)	-0.01 (0.05)	-0.04 (0.03)	-0.04 (0.04)
j_{-2}	0.001 (0.04)	-0.01 (0.07)	0.003 (0.04)	-0.05 (0.06)
$CF/(p^kK)_{-1}$	0.61 (0.15)***	0.01 (0.11)	0.60 (0.15)***	0.09 (0.15)
$(D/A)_{-1}$	-0.08 (0.04)*	-0.26 (0.09)***		
Observations	3,306	1,304	3,306	1,304
Firms	539	251	539	251
σ	0.056	0.110	0.054	0.076
Sargan	88.8 [0.13]	77.9 [0.39]	78.7 [0.10]	63.8 [0.49]
AR(2)	0.31 [0.76]	-1.64 [0.10]	0.37 [0.71]	-1.63 [0.10]

1. See notes for Table 2.

2. Instruments for first-differenced equations are $(I_{t-2}/K_{t-3}), ..., (I_{t-8}/K_{t-9})$, $\Delta y_{t-2,...,t-8}$, $(D/A)_{t-1}$, $(D/A)_{t-2}$, Δj_t, Δj_{t-1}. Those for level equations are $\Delta(I_{t-1}/K_{t-2})$. $(D/A)_{t-1}$ and $(D/A)_{t-2}$ are dropped from the instrument set in columns (3), (4), (7) and (8).

Table 9: ECM without Bank Balance-Sheet Variables (2)

	All industries	All industries	All industries	All industrie
Dependent	I/K_{-1}	I/K_{-1}	I/K_{-1}	I/K_{-1}
Bond issue	Yes	No	Yes	No
Bank info.	No	No	No	No
	(A) Sample Period: FY1993-FY2000			
	(1)	(2)	(3)	(4)
I_{-1}/K_{-2}	0.03 (0.04)	-0.06 (0.05)	0.05 (0.04)	-0.06 (0.05)
Δy	0.13 (0.05)***	0.03 (0.06)	0.06 (0.05)	0.06 (0.06)
Δy_{-1}	0.06 (0.04)*	0.08 (0.04)**	0.04 (0.03)	0.09 (0.03)**
$(k-y)_{-2}$	-0.04 (0.03)	-0.12 (0.05)***	-0.02 (0.03)	-0.11 (0.04)**
y_{-2}	0.01 (0.01)	-0.07 (0.03)*	0.0005 (0.01)	-0.04 (0.03)
Δj	-0.09 (0.04)**	-0.12 (0.07)*	-0.05 (0.04)	-0.12 (0.09)
Δj_{-1}	-0.03 (0.05)	-0.19 (0.07)**	0.01 (0.05)	-0.14 (0.07)**
j_{-2}	-0.04 (0.06)	-0.18 (0.08)**	0.01 (0.05)	-0.17 (0.08)**
$CF/(p^kK)_{-1}$	-0.11 (0.08)	-0.003 (0.07)	0.03 (0.10)	-0.03 (0.07)
$(D/A)_{-1}$	-0.03 (0.05)	-0.25 (0.09)***		
Observations	3,647	1,484	3,647	1,484
Firms	497	217	497	217
σ	0.079	0.117	0.071	0.112
Sargan	129.2 [0.14]	116.5 [0.39]	108.6 [0.22]	92.9 [0.63]
AR(2)	1.54 [0.13]	-0.46 [0.65]	1.68 [0.09]	-0.59 [0.56]
	(B) Sample Period: FY1987-FY1992			
	(5)	(6)	(7)	(8)
I_{-1}/K_{-2}	-0.11 (0.07)*	-0.12 (0.08)	-0.11 (0.09)	-0.10 (0.08)
Δy	0.09 (0.05)	0.05 (0.04)	0.10 (0.06)*	0.03 (0.05)
Δy_{-1}	0.08 (0.05)	0.05 (0.05)	0.07 (0.05)	0.05 (0.06)
$(k-y)_{-2}$	-0.07 (0.05)	-0.02 (0.02)	-0.06 (0.05)	-0.02 (0.02)
y_{-2}	0.02 (0.02)	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)
Δj	-0.05 (0.04)	0.04 (0.04)	-0.04 (0.06)	0.01 (0.04)
Δj_{-1}	-0.02 (0.06)	0.01 (0.06)	-0.01 (0.09)	0.01 (0.07)
j_{-2}	0.04 (0.06)	-0.06 (0.07)	0.05 (0.08)	-0.03 (0.06)
$CF/(p^kK)_{-1}$	0.45 (0.13)***	0.03 (0.16)	0.42 (0.15)***	0.08 (0.15)
$(D/A)_{-1}$	-0.07 (0.06)	0.07 (0.12)		
Observations	1,376	543	1,376	543
Firms	228	99	228	99
σ	0.086	0.071	0.083	0.063
Sargan	73.6 [0.53]	78.4 [0.37]	66.6 [0.39]	68.3 [0.34]
AR(2)	0.25 [0.80]	-1.28 [0.20]	0.31 [0.76]	-1.24 [0.22]

1. See notes for Table 8.

Appendix 2: Data Appendix

Figures starting with 'K' correspond to the code number in the Corporate Finance Data Set.

Capital stock

Capital stock K consists of inventory, land, machinery, and non-residential buildings and structures. Their market values are calculated by perpetual inventory methods, which are often used for calculating average q for investment functions (see, inter alia, Hoshi and Kashyap (1990) and Hayashi and Inoue (1991)).

The perpetual inventory method can be expressed as:

$$K_{it} = \frac{P_t^K}{P_{t-1}^K} K_{i,t-1}(1-\delta) + I_{it}. \tag{4}$$

The first term in the right-hand-side is the capital stock remaining from the previous period (δ is the depreciation rate), which is re-evaluated at current prices by multiplying by the change in capital stock prices, P_t^K/P_{t-1}^K. The current capital stock is obtained by adding the newly invested capital stock I_{it} to the existing capital stock. As for the initial market-value, it is assumed to be the same as the book-value in 1970 or the earliest available book-value after 1970.[32]

Based on equation (4), we conduct the following calculation for each capital stock (see Sekine (1999) for more details).

1. **Inventory**: The book-value of inventory stock is obtained as the sum of items K1030, K1040, K1050, K1060, K1070, K1080, K1090, K1100, K1110 and K1120. If a firm uses a LIFO, the market-value is calculated by the perpetual inventory method. Otherwise, the market-value is set equal to the book-value. For equation (4), we assume $\delta = 0$ and I_{it} is the change in the book-value of stocks. P_t^K is obtained from the Wholesale Price Index (WPI), the Input-Output Price Index and the SNA.

2. **Land**: The book-value is K1390. The Land Price Index (all purposes, six major cities) is used for P_t^K. We assume $\delta = 0$ and I_{it} is the change in the book value of stocks. When I_{it} becomes negative, we multiply it by (P_t^K/P_{t*}^K) where P_{t*}^K is the price at which land was last purchased (i.e. when book value of land stock last increased). As for the firms that re-evaluated land stock based on the Law on Land Revaluation (March, 1998), we reclaim a simulated book-value by deducting the deferred tax liabilities (K2504) and the profit on the land revaluation (K2672) from K1390.

[32]For land stock, since its market-value differs considerably from the book-value, we adjust the initial market-value by multiplying it by the market-to-book ratio obtained from the SNA and the Corporate Statistics.

3. **Depreciable assets (machinery, non-residential buildings and structures)**: The book-value is the sum of items K1300, K1310, K1320, K1330, K1340, K1350, K1360, K1370 and K1380. P_t^K is chosen from the appropriate items of the WPI. Following Hayashi and Inoue (1991), we set the depreciation rate δ as 4.7% (non-residential buildings), 5.64% (structures), 9.489% (machinery), 14.70% (transportation equipment), and 8.838% (instruments and tools). I_{it} is the sum of changes in the book value of stock and depreciation in the current period (K6630-K6700). Since the current period depreciations for each item are only available from 1977, for the pre-1977 data, we calculate them as

$$\frac{\text{Accumulated depreciation for each item}}{\text{Total accumulated depreciation (K6520)}} \times \text{Total current depreciation (K6610)},$$

where accumulated depreciation for each item corresponds to K6530-K6600.

Real output

$$\text{Real output } (Y_{it}) = \frac{\text{Total sales (K2820)} + \text{Changes in inventories of finished goods}}{\text{Output deflator } (p_{it})},$$

where p_{it} is obtained from the Input-Output Price Index and the SNA.

User cost of capital

Following Hall and Jorgenson (1967), J_{it} is defined as:

$$J_{it} = \frac{p_{it}^k}{p_{it}} \frac{(r_t + \delta_{it} - \dot{p}_{it}^k)(1 - \tau_t \mu_{it})}{(1 - \tau_{it})},$$

where p_{it}^k is the price of depreciable assets and $\dot{p}_{it}^k$ is its rate of change (we do not take into account the land price in order to exclude any impact from the bubble); p_{it} is the output deflator; r_t is the yield on 10-year Japanese Government Bonds; τ_t is the corporate tax rate; and μ_{it} is the depreciation allowance. See Sekine (1999) for the calculation of τ_t and μ_{it}.

Cash flow

The cash flow based on after tax earning (CF_{it}) is defined as:

$$CF_{it} = \text{After tax earning (K3950)} + \text{Depreciation (K6610)}.$$

The cash flow based on operating profit (CF'_{it}) is defined as:

$$CF'_{it} = \text{Operating profit (K3370)} - \text{Before tax earning (K3890)} + CF_{it}.$$

Debt-asset ratio

$$\text{Debt-asset ratio } (D_{it}/A_{it}) = \frac{\text{Debt (K2630)}}{\text{Market-valued assets}},$$

where the market-value of assets is obtained by substituting the market-value of capital stocks K for the corresponding items in total assets (K1880).

References

ANGELONI, I., A. KASHYAP, B. MOJON, AND D. TERLIZZESE (2002): "Monetary Transmission in the Euro Area: Where Do We Stand?," European Central Bank Working Paper, No. 114.

AOKI, M., AND H. PATRICK (1994): *The Japanese Main Bank System—Its Relevence for Developing and Transforming Economies*. Oxford University Press, New York.

ASAKO, K., M. KUNINORI, T. INOUE, AND H. MURASE (1989): "Tochi Hyouka to Tobin no q/Multiple q no Keisoku (Land Valuation and Tobin's q: Estimation by Multiple q)," *Japan Development Bank, Keizai Keiei Kenkyu*, 10-3, (in Japanese).

BERNANKE, B. S. (1983): "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Journal*, 73(3), 257–276.

BERNANKE, B. S., AND M. GERTLER (1995): "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *Journal of Economic Perspectives*, 9, 27–48.

BERNANKE, B. S., M. GERTLER, AND S. GILCHRIST (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework," in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and M. Woodford, vol. 1, chap. 21, pp. 1341–1393. Elsevier Science.

BLUNDELL, R., AND S. BOND (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, 87, 115–143.

BOND, S., J. ELSTON, J. MAIRESSE, AND B. MULKAY (1997): "Financial Factors and Investment in Belgium, France, Germany and the UK: A Comparison Using Company Panel Data," NBER Working Paper, No. 5900.

BUTZEN, P., C. FUSS, AND P. VERMEULEN (2001): "The Interest Rate and Credit Channels in Belgium: An Investigation with Micro-Level Firm Data," European Central Bank Working Paper, No. 107.

CHATELAIN, J. B., A. GENERALE, I. HERNANDO, U. VON KARCKREUTH, AND P. VERMEULEN (2001): "Firm Investment and Monetary Transmission in the Euro Area," European Central Bank Working Paper No. 112.

CHATELAIN, J. B., AND A. TIOMO (2001): "Investment, the Cost of Capital, and Monetary Policy in the Nineties in France: A Panel Data Investigation," European Central Bank Working Paper, No. 106.

CHIRINKO, R. S., S. M. FAZZARI, AND A. P. MEYER (1999): "How Responsive Is Business Capital Formation to Its User Cost? An Exploration with Micro Data," *Journal of Public Economics*, 74, 53–80.

CLEARY, S. (1999): "The Relationship Between Firm Investment and Financial Status," *Journal of Finance*, LIV(2), 673–692.

Doornik, J. A., M. Arellano, and S. Bond (2001): "Panel Data Estimation Using DPD for Ox," available from http://www.nuff.ox.ac.uk/users/doornik/.

Fukao, M. (2001): *Nippon Hatan (Bankrupt Japan)*. Koudan-sha Gendai Shin-sho, Tokyo, (in Japanese).

Fukao, M., and Japan Center for Economic Research (2000): *Kinyuu Fukyou no Jissyou Bunseki (Empirical Analyses of Financial Recession)*. Nihon Keizai Shimbun-sha, Tokyo, (in Japanese).

Gaiotti, E., and A. Generale (2001): "Does Monetary Policy Have Asymmetric Effect? A Look at the Investment Decisions of Italian Firms," European Central Bank Working Paper, No. 110.

Gibson, M. S. (1997): "More Evidence on the Link Between Bank Health and Investment in Japan," *Journal of the Japanese and International Economies*, 11, 296–310.

Hall, R. E., and D. W. Jorgenson (1967): "Tax Policy and Investment Behavior," *American Economic Journal*, 57(3), 391–414.

Hayashi, F., and T. Inoue (1991): "The Relation Between Firm Growth and Q with Multiple Capital Goods: Theory and Evidence from Panel Data on Japanese Firms," *Econometrica*, 59, 731–753.

Hoshi, T., and A. Kashyap (1990): "Evidence on q and Investment for Japanese Firms," *Journal of the Japanese and International Economies*, 4, 371–400.

——— (1999): "The Japanese Banking Crisis: Where Did It Come From and How Will It End?," NBER Working Paper, No.7250.

Hosono, K., and T. Watanabe (2002): "Kigyou Balance-Sheet to Kinyuu Seisaku (The Transmission of Monetary Policy Through Borrowers' Balance Sheets)," *Economic Review*, 53(2), 117–133, The Institute of Economic Research, Hitotsubashi University, (in Japanese).

Hubbard, R. G. (1996): *Money, the Financial System, and the Economy, Seconod Edition*. Addison Wesley Longman.

——— (1998): "Capital-Market Imperfections and Investment," *Journal of Economic Literature*, XXXVI, 193–225.

Jensen, M. C. (1986): "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review Papers and Proceedings*, 76(2), 323–329.

Jorgenson, D. W. (1963): "Capital Theory and Investment Behavior," *American Economic Journal*, 53(2), 247–259.

Kobayashi, K., Y. Saita, and T. Sekine (2002): "Forbearance Lending: A Case for Japanese Firms," Bank of Japan Research and Statistics Deparment Working Paper, No. 02-2.

Krugman, P. (1998): "It's Baaack: Japan's Slump and the Return of the Liquidity Trap," *Brookings Papers on Economic Activity*, 2, 137–205.

Lünnemann, P., and T. Methä (2001): "Monetary Transmission: Empirical Evidence from Luxembourg Firm Level Data," European Central Bank Working Paper, No. 111.

Nakamura, J. (2000): "Nihon Kigyou no Setsubi Toushi Koudou wo Furikaeru (Looking Back at Japanese Firm Investment Behavior)," *Chousa*, No. 17, Development Bank of Japan, (in Japanese).

Oda, N. (1999): "Estimating Fair Premium Rates for Deposit Insurance Using Option Pricing Theory: An Empirical Study of Japanese Banks," *Bank of Japan Monetary and Economic Studies*, 17(1), 133–170.

Ogawa, K., and S. Kitasaka (1998): *Shisan Shijou to Keiki Hendou (Asset Markets and Economic Fluctuations)*. Nihon Keizai Shimbun-sha, Tokyo, (in Japanese).

Ogawa, K., S. Kitasaka, H. Yamaoka, and Y. Iwata (1996): "Borrowing Constraints and the Role of Land Assets in Japanese Corporate Investment Decision," *Journal of the Japanese and International Economies*, 10, 122–149.

Ogawa, K., and K. Suzuki (2000): "Demand for Bank Loans and Investment under Borrowing Constraints: A Panel Study of Japanese Firm Data," *Journal of the Japanese and International Economies*, 14, 1–21.

Okina, K., and S. Shiratsuka (2001): "Asset Price Bubbles, Price Stability, and Monetary Policy: Japan's Experience," Bank of Japan IMES Discussion Paper, No. 2001-E-16.

Oliner, S. D., and G. D. Rudebusch (1996): "Is There a Broad Credit Channel for Monetary Policy?," *Federal Reserve Bank of San Francisco, Economic Review*, 1, 3–13.

Sekine, T. (1999): "Firm Investment and Balance-Sheet Problems in Japan," IMF Working Paper, WP/99/111.

Suzuki, K. (2001): *Setsubi Toushi to Kinyuu Shijou (Capital Investment and Financial Markets)*. University of Tokyo Press, Tokyo, (in Japanese).

Valderrama, M. (2001): "Credit Channel and Investment Behavior in Austria: A Micro-Econometric Approach," European Central Bank Working Paper, No. 108.

Van den Heuvel, S. J. (2001): "The Bank Capital Channel of Monetary Policy," mimeo.

von Kalckreuth, U. (2001): "Monetary Transmission in Germany: New Perspectives on Financial Constraints and Investment Spending," European Central Bank Working Paper, No. 109.

Windmeijer, F. (2000): "A Finite Sample Correction for the Variance of Linear Two-Step GMM Estimators," Institute for Fiscal Studies Working Paper, W00/19.

Woo, D. (1999): "In Search of "Capital Crunch": Supply Factors Behind the Credit Slowdown in Japan," IMF Working Paper, WP/99/3.