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Firm Investment and Balance-Sheet Problems in Japan

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Abstract

This paper investigates whether balance-sheet conditions of firms and their main banks matter for firm investment behavior using dynamic corporate panel data in Japan for the period 1985-95. It finds that smaller non-bond issuing firms were facing liquidity constraints; these firms' balance-sheet conditions (the debt asset ratios) affected their investment from the midst of the bubble era by influencing main banks' lending to them; and the deterioration of their main banks' balance-sheet conditions constrained these firms' investment from about 1993. These findings highlight the potential macroeconomic impact and importance of the credit channel of monetary policy, and support the case of a credit crunch facing small Japanese firms during this period.

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I. Introduction

This paper investigates whether balance-sheet conditions or financial situations of firms and their main banks are important determinants of firm investment behavior in Japan for the period 1985 to 1995. Because of asymmetric information between borrowers and lenders, observable balance-sheet conditions of borrowers such as the debt asset ratio might become a determinant of the investment of firms that depend on bank borrowing. Moreover, firms with deteriorated balance-sheets might become cautious in carrying out risky projects due to a decrease in their risk tolerance. For a similar reason, banks with deteriorated balance-sheets resulting from an increase in non-performing loans might reduce their lending, deterring, in turn, active investment of their corporate borrowers.

There seems to be some consensus in support of the view that large fluctuations in asset prices, in particular, land prices, from the late 1980s had an impact on firm investment behavior in Japan through a change in land collateral valuations, i.e., firm balance-sheet conditions matter (Bank of Japan (1994); Ogawa and Suzuki (1996); Ogawa, Kitasaka, Yamaoka and Iwata (1996)).

However, there seems to be some controversy about the impact of a change in bank balance-sheet conditions on firm investment behavior. Couched in terms of the more recent debate, the question arises as to whether a credit crunch or credit rationing emerged in Japan after collapse of the bubble economy. For example, according to Krugman (1998), "An informal search of news archives finds few allegations of credit rationing in Japan before the second half of 1997; even well into the fall of last year [i.e., 1997] a number of observers questioned whether there was really any credit crunch or at least whether it was serious." However, this search seems to have overlooked anecdotes covered in the Japanese media, which suggested that credit rationing by banks might be relevant for small companies. For instance, after the collapse of the asset price bubble, branch managers of banks were reported to squeeze credits to small companies reflecting credit reduction via quantity targets set by their headquarters (This phenomena was dubbed the 'branch manager crunch').

While results of empirical work so far are mixed as reviewed by Woo (1999), there is some evidence in support of the credit crunch hypothesis. For example, Miyagawa, Nosaka and Hashimoto (1995) show that there is a correlation between bank lending and banks' financial conditions as measured by capital adequacy ratios or the stock of non-performing loans. Woo (1999) estimates similar cross-sectional functions and finds strong evidence of a credit crunch impact in 1997, while that relationship is not evident in the early 1990s. Finally, Gibson (1995, 1996) discovers that a main bank soundness indicator—individual bank credit rating—is significant in the estimation of cross sectional Q-type investment functions.

This paper examines Gibson's findings by using a more rigorous methodology. That is:

- Instead of cross sectional data, panel data is used in order to obtain more precise estimates by removing individual firm specific effects.
- In addition to Q-type investment functions, error correction models are also estimated. Q-type investment functions are often said to suffer from severe measurement errors in calculating Q. By estimating alternative models, the robustness of the findings can be tested.[1]
- The impacts of both firm and main bank balance-sheet conditions are examined simultaneously, instead of focusing either on firm balance-sheet conditions (Ogawa et.al.) or on main bank balance-sheet conditions (Gibson). The approach followed reduces the risk of omitted variable problems.

The empirical analysis broadly confirms the findings of previous studies in that both firm and main bank balance-sheet conditions are found to be statistically significant variables in explaining firms' investment behavior at least in recent years. More specifically, the results suggest that investment by larger bond issuing firms was not affected either by these firms' own balance-sheet conditions nor by their main banks' balance-sheet conditions. However, investment by smaller firms which face liquidity constraints was affected by changes in their own balance-sheet conditions from 1989. In addition, investment by smaller firms was discouraged by the deterioration of their main bank balance-sheet conditions from 1993.

These findings are consistent with the existence of a 'credit channel' of monetary policy. For instance, in their survey, Bernanke and Gerter (1995) distinguish a *balance sheet credit channel* and a *bank lending credit channel.*[2] Conceptionally evidence on firm balance-sheet effects would support the former channel and that on main bank balance-sheet effects would support the latter channel.

[1]There are several studies which estimate Q-type investment functions by using Japanese micro data sets such as Asako, Kuninori, Inoue and Murase (1991, 1997); Hayashi and Inoue (1991); Hoshi and Kashyap (1990); Hoshi, Kashyap and Sharfstein (1991); and Hayashi (1997). However, to the best of the author's knowledge, this paper is the first attempt to fit Japanese micro data to error correction models of investment functions.

[2]The balance-sheet credit channel stresses importance of borrowers' balance-sheets and the bank lending credit channel focuses on the supply of loans by depository institutions. For example, tight monetary policy weakens borrowers' financial positions through an increase in interest expenses and a decline in the value of borrowers' collateral (balance-sheet credit channel). It also weakens banks' financial positions through a decline in deposits and an increase in non-performing loans (bank lending credit channel). The weakened financial positions of both borrowers and banks increase external finance premium or intensify credit rationing, and thus deter active investment of borrowers. In the recent Japanese case, even though the Bank of Japan has relaxed monetary policy, its impact on the economy has been restricted to the extent that the credit channels have been affected by deterioration of both borrowers' and banks' financial positions as aftermath of the collapse of the bubble.

Moreover, the findings in the paper have an important policy implication: cleaning up of bank balance-sheets or restoring bank health, say, by injecting public money, might remove an important restriction on firm investment. In addition, as the deterioration of bank balance-sheets has been widely observed not only in Japan, but also in other Asian countries which were recently hit by crises, this study provides a rationale for the emphasis of Fund-supported programs on bank restructuring reforms in these countries.

The remainder of this paper is organized as follows: Section II introduces the models used to estimate the impact of firm balance-sheet and main bank balance sheet conditions on firms' investment behavior; Section III outlines our micro data set; Section IV summarizes the estimation results; and Section V presents conclusions and suggests extensions. The data appendix describes details of data construction, followed by the chronology appendix of non-performing loan problems in Japan.

II. Models

A basic objective of the empirical work is to investigate the significance of both firm and main bank balance-sheet variables in reasonably well specified investment functions. Specifically, in the case of an economic downturn of the economy, we would seek to establish (i) whether as a firm's balance-sheet weakens (strengthens), it tends to reduce investment more (less), and (ii) whether a firm's main bank with a weaker (healthier) balance-sheet tends to weaken its investment more (less) severely. In particular, by controlling for both firm and main bank balance-sheets, if we observe the relationship between firm investment and its main bank's balance-sheet conditions, we can conclude that even a firm with healthy balance-sheet reduces its investment in response to deterioration of its main bank's balance-sheet, i.e., a case for credit crunch.

A Q-type investment function and an error correction specification of an enhanced neo-classical investment function lend themselves well for distinguishing and testing the effects described above.

First, the Q model cum balance-sheet variables is specified here as:

$$\left(\frac{I_{it}}{K_{i,t-1}}\right) = \rho\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \beta Q_{it} + \psi_0\left(\frac{CF}{p^k K}\right)_{it} + \psi_1 BSf_{i,t-1} + \psi_2 BSb_{it} + d_t + \eta_i + \nu_{it}. \tag{1}$$

where I is real investment in depreciable capital; K is its real capital stock, Q is Tobin's average Q; CF is the nominal cash flow defined as after tax earnings plus accounting depreciation; p^k is the price of capital goods; BSf is the balance-sheet condition of a firm; and BSb is the balance-sheet condition of corresponding main banks. Here d_t is a time-specific effect, η_i is a firm-specific effect and ν_{it} is an idiosyncratic effect. The first line of the equation without a cash flow term is a standard specification of a Q model as developed by Hayashi (1982). A significant cash flow term is often observed and interpreted as evidence of a liquidity constraint.[3] Tests of significance of ψ_1 and ψ_2 constitute tests of the balance-sheet problems.

Next, the error correction model cum balance-sheet variables is specified here as:

$$\begin{aligned}\left(\frac{I_{it}}{K_{i,t-1}}\right) &= \rho\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \beta\Delta y_{it} \\ &+ \phi_0(k_{i,t-1} - y_{i,t-1}) + \phi_1 y_{i,t-1} + \phi_2 j_{i,t-1} + \phi_3\left(\frac{CF}{p^k K}\right)_{it} \\ &+ \phi_4 BSf_{i,t-1} + \phi_5 BSb_{it} + d_t + \eta_i + \nu_{it}, \qquad (2)\end{aligned}$$

where y is real output; k is real depreciable capital stock; and j is user cost of capital defined in the data appendix. All these three variables are in logarithms and Δ denotes a first difference operator.

An error correction model of a macro investment function was first derived and estimated by Bean (1981). More recently, Bond, Elston, Mairesse and Mulkay (1997) applied this model to micro investment functions of Belgium, France, Germany and the UK. The basic specification (i.e., the first two lines of the equation without a cash flow term) is consistent with profit maximization subject to a constant returns to scale, constant elasticity of substitution (CES) production function. In that neo-classical set up, we can derive the desired capital stock as:

$$k_{it} = a + y_{it} - \sigma j_{it}, \qquad (3)$$

and the basic specification implies that this relationship holds in a long-run equilibrium. The assumption of constant returns to scale can be tested by examining the significance of ϕ_1. As is frequently found in time series analysis, by retaining a long-run equilibrium, deviation from which is corrected (hence expected sign of ϕ_0 is negative), we can expect more efficient and unbiased estimation results. As before, a cash flow term is included in order to test the liquidity constraint. Also, BSf and BSb are added to tests of the balance-sheet problems.[4]

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[3]Other than those cited before for Japanese Q-type investment functions, see, *inter alia,* Fazarri, Hubbard and Petersen (1988) for the US, and Blundell, Bond, Devereux and Schiantarelli (1992) for the UK.

[4]Both equations (1) and (2) are reduced forms and estimated coefficients on balance-sheet variables are not so-called deep parameters (the same critique can be applied to a cash flow term). It is also possible to derive a structural Euler equation model which incorporates balance-sheet variables. However, estimation results so far (including a basic specification without balance-sheet variables) are neither satisfactory or robust, and are omitted from this paper. This is probably because the Euler equation model is too sensitive for any misspecifications. In the words of Nickell and Nicolitsas (1996): "[T]he Euler equation model is simply not robust enough to be useful."

III. Data

The use of a micro panel data set is indispensable for discriminating between the balance-sheet effects of firms and their banks, since with more aggregated data, balance-sheet conditions of firms and those of main banks fluctuate more or less in a similar way and it is almost impossible to distinguish roles of these two conditions. At the level of diversified micro data set, the effects of these two conditions can be separated if the data set includes enough observations of weaker balance-sheet firms banking with healthier balance-sheet banks, and vice versa.

This paper uses micro corporate finance data from the Japan Development Bank (JDB) Corporate Finance Data Set, which includes balance-sheets and income statements for non-financial Japanese firms (i) whose stocks are listed on either the Tokyo, Osaka or Nagoya Stock Exchange Market; or (ii) whose stocks are traded in the over-the-counter market. The data set is one of the most comprehensive panel data sets (2,258 firms in FY1995; the series commence in FY1955) among available financial data sets in Japan.[5] In particular, the data set has an advantage of covering the over-the-counter market firms, which are on average younger and smaller than those listed on the major stock exchange markets. Thus, our sample includes those who might suffer from information asymmetry problems more severely than the established large firms. The data set contains both consolidated and unconsolidated data. The unconsolidated data was selected since the model is arguably better suited to smaller individual units than to a collection of companies headed by the parent company (see Hayashi and Inoue (1991)).

In order to obtain consistent data, the following sample selection rule is applied to all records from FY1977 to FY1995:

1. Select firms which continued to exist at least seven years from FY1981 to FY1995. This excludes from the sample newly stock listed firms which do not survive beyond seven years.
2. Drop firms that changed accounting terms (accounting year etc.) during the above interval.
3. In order to eliminate outliers, drop firms whose (I/K), J, and (B/A) are in the upper 1% of each observation. Also drop firms whose Q, (CF/p^kK) and Δy are a maximum or minimum 0.5% of each observation. Also, drop firms whose J takes negative values.

[5] Accounting years of most companies coincide with fiscal year (April-March). For firms whose accounting years end between April and September, we treat their accounting years as the fiscal year that ends in March in the same year. For firms whose accounting years end between October and the subsequent March, we treat their accounting year as the fiscal year that ends in the subsequent March. Below, annual average means that on the fiscal year basis.

4. *Do not* exclude acquisitions: Conceptually, there is no reason to distinguish between investment and takeover. However, the above sample selection rule 3 serves to screen out major acquisitions, since they tend to have extreme values of these variables.

5. Choose manufacturing firms only: It is often argued that non-manufacturing firms suffer more severely from the balance-sheet problems than manufacturing firms (Bank of Japan (1994, 1997)), and hence it is very interesting to estimate the above investment functions for non-manufacturing firms. However, probably because of heterogeneity of the sample, preliminary estimates did not reveal any sensible results. For this reason, this paper focuses on manufacturing firms only.

Applying the above selection criteria, 1,121 of the available 2,788 firms, of which 1,611 are manufacturing firms, are selected. As noted the sample selection rule 1 excludes many younger firms which do not survive more than seven years. This presumably results in conservative estimates of balance-sheet problems, because these firms are supposed to have been confronted by more severe balance-sheet problems due to information asymmetries.

Turning to the balance-sheet condition of a firm, BSf, this is proxied by the debt asset ratio, B/A, i.e., debt outstanding divided by the market value of assets.[6] It is said that banks particularly relied on a certain debt indicator such as the land collateral ratios (bank borrowing divided by the market value of land asset), when aggressively providing finance for investment of small firms during the bubble era. Because large firms became able to finance their projects directly from the securities market owing to the financial deregulation in the 1980s, banks became aggressive in providing finance for investment of small firms in the middle of 1980s. Since these small firms were new customers for banks, there was relatively limited information available to banks compared to that for large firms whose information had been accumulated in banks through long-term main bank relationships. During that period, banks were said to sometimes just examine the land collateral ratio of new customers. If the ratio was below a certain threshold, then they financed projects without careful calibration of profitability of the projects. The debt asset ratio is supposed to capture the movement of the land collateral ratio since bank borrowing and the land asset are subsets of debt and asset of the calculated debt asset ratio. Moreover, since it covers debt burden of bonds, it captures more precisely balance-sheet condition of bond issuing firms.

In comparison, the balance-sheet variable of main banks of each firm, BSb, requires more careful consideration. First, there is a need to identify the main banks. Following the arguments advocated by Aoki and Patrick (1994), main banks are defined to be three

[6]In addition to balance-sheet variables, those in the investment functions are more or less standard and additional explanation of them is not extended to the main text. The data appendix summarizes details of their calculation.

principal banks[7] whose lending shares to any given firm are the largest. Three banks are chosen because there are some cases where the top three banks have the same share and because some large firms tend to have two or more main banks at the same time. In addition, not only the top main bank but also the 'sub-main banks,' whose shares are the second or the third largest, play an important role in financing firms and alternatives to their bank finance are often difficult to find.

Next, an indicator which reasonably captures the *true* condition of these banks' balance-sheets needs to be identified. Natural candidates are the capital adequacy ratio or the ratio of non-performing loans to total assets. However, measurement of both the published capital adequacy ratio and the amount of non-performing loans are subject to a certain degree of arbitrariness given varying accounting techniques. Accordingly, this paper uses a revised capital adequacy ratio ($RCAPR$) and an effective capital adequacy ratio ($ECAPR$) calculated as:

$$RCAPR = \frac{EQT + RSV + UCG}{AST}, \tag{4}$$

$$ECAPR = \frac{EQT + RSV + UCG - NPL}{AST - NPL}, \tag{5}$$

where EQT is total shareholders' equity (book value); RSV is reserves for possible loan losses; UCG is unrealized capital gains of securities (so-called hidden reserves); NPL is non-performing loans; and AST is total assets. Equity is adjusted by adding reserves including 100 percent of hidden reserves of securities (note that only 45 percent of the unrealized capital gains are allowed by the BIS rule). Furthermore, $ECAPR$ subtracts non-performing loans (assuming they are completely irrecoverable). Admittedly, these are crude measures. For example, some non-performing loans are recoverable. Also, it is quite likely that banks take account of not only unrealized capital gains of securities but also those of land assets. Nevertheless, as described below, these variables outperformed published capital adequacy ratio.[8] Accordingly, BSb is calculated using weighted averages of the top three banks' revised or effective capital ratios where the weights represent these three banks' normalized lending shares in each firms liabilities.

Estimations of four sub-samples are undertaken in the next section. These are (i) all bond issuing manufacturing firms (All Bond); (ii) all non-bond issuing firms (All Non-bond); (iii) bond issuing firms which have main bank relationships (Bank Bond); and (iv) non-bond issuing firms which have main bank relationships (Bank Non-bond). Firms are defined as bond issuing firms if they issued bonds at least once since FY1977.

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[7]Principal banks are defined as city banks and long-term credit banks. We drop trust banks since their loans are said to be tied with related city banks and rarely play a role of main bank such as monitoring firm behavior (Aoki and Patrick (1994)).

[8]Bank of Japan (1998) finds a negative correlation between interest margins on loans and $RCAPR$ using dynamic bank panel data from the period 1992-1997.

Table 1 describes sample properties of the main variables for each category. As evident in rows of y, non-bond issuing firms tend to be small in terms of outputs. These firms tend to have higher debt asset ratios. Cash flow is lower on average for firms with main banks.

IV. Estimation Results

All the estimations are conducted using the system GMM (Generalized Method of Moments) developed by Blundell and Bond (1997).[9] A "system" consists of first-differenced and level equations. Taking an example of a simple AR(1) model, and omitting exogenous variables and a time specific effect for simplicity, we can write a level equation as

$$x_{it} = \alpha x_{i,t-1} + \eta_i + \nu_{it}. \tag{6}$$

Then, a first differenced equation is

$$\Delta x_{it} = \alpha \Delta x_{i,t-1} + \Delta \nu_{it}. \tag{7}$$

As proposed by Arelleno and Bond (1991), we can exploit instrument variables, $x_{i,t-2}$, $x_{i,t-3}$, ... for estimation of α in the first differenced equation, since they are not correlated with $\Delta\nu_{it}$. In addition, Blundell and Bond (1997) suggest using $\Delta x_{i,t-1}$ for estimation of α in the level equation since it is not correlated with η_i or ν_{it}. Thus, by estimating a system of these two equations simultaneously, the Blundell-Bond system GMM estimator is further exploiting additional instrument variables to the Arelleno-Bond GMM estimator. It is reported that the system GMM estimator is more efficient and robust.

Validity of the above estimation is checked by two important diagnostic tests. First, AR(2) tests the second order residual serial errors. Lack of the second order serial correlation (i.e., accept null hypothesis) validates the use of $x_{i,t-2}$ as an instrument. Next, Sargan tests whether overidentifying instruments are independent of the estimated errors. The null hypothesis is independence and hence acceptance of it validates used instruments. As we see below, the estimations perform very well except for All Non-bond firms which fail AR(2) tests.[10]

A. Basic Specifications

Table 2 summarize estimation results of the basic specifications.

[9] All the estimations in this paper are conducted using the package of DPD98 on Gauss (Arelleno and Bond (1998)).

[10] Qualitative results presented in this paper do not change even $(I/K)_{t-2}$ is dropped from the instrument sets for All Non-bond firms.

Columns (1) to (4) are estimates of Q models.[11] They reproduce what we frequently find in the literature such as small positive coefficients on Q, which imply very slow adjustment speed. Cash flows are significant and indicate the possibility of the liquidity constraint, another point frequently found in the literature. Coefficients on cash flows are relatively larger for (1) and (2) compared to (3) and (4). This might imply that firms which have main bank relationships are less severely liquidity constrained, an observation of which is consistent with Hoshi et.al. (1991). Meanwhile, these coefficients are almost same between (1) and (2), and between (3) and (4). That is, the degree of liquidity constraints does not depend on whether firms have issued bonds or not. However, this observation will be challenged below by adding more informative variables to the model.

Columns (5) to (8) are estimates of error correction models. Signs and magnitudes of all coefficients other than on j_{t-1} of All Non-bond firms (column (6)) are as expected. For example, all coefficients for the error correction term, $(k - y)_{t-1}$, are significantly negative. Coefficients for y_{t-1} are in general insignificant, and indicate the existence of constant returns to scale. User costs are not significant as frequently found in the literature on accelerator models.[12] One interesting point is that cash flows are relatively larger for non-bond issuing firms ((6) vis-à-vis (5), and (8) vis-à-vis (7)), which might imply that these firms face more severe liquidity constraints than bond-issuing firms.

B. Firm Balance-Sheet Variables

Table 3 present results for the specification including firm balance-sheet variables to the above basic specifications.

After several experiments, it is found that firm balance-sheet variables in terms of the debt asset ratio, B/A, become significant for non-bond issuing firms from around FY1989, in the midst of the bubble era (columns (10), (12), (14) and (16)). D_{89}^{95} is a step dummy that takes one in and after FY1989, otherwise naught. The finding is consistent with the hypothesis that banks started to use extensively the debt asset ratio or the land collateral ratio from the bubble era as a criterion for financing projects of smaller firms.[13]

Adding B/A to the model changes coefficients on cash flows in Q model. While cash flows of firms with main banks tend to have smaller coefficients ((11) against (9), and (12) against (10)), cash flows of non-bond issuing firms turn out to have larger coefficients

[11] Q is not included as an instrument, because significant violations of the diagnostic tests are often found when Q is included in the above instrument sets.

[12] Below, we will drop user costs from error correction models. Qualitative results do not change on this exclusion.

[13] Table 6 contains specifications of alternative timings for non-bond issuing firms which have main banks. Columns (A1) and (A5) are estimate results by using full sample of B/A. Although they are significant, their signs are contrary to prior expectation. Columns (A2) and (A6) show that firm balance-sheet variables negatively affected investment in more recent time interval.

((10) against (9), and (12) against (11)). Together with outcomes of error correction models, whose cash flow coefficients are essentially same as those of basic specifications, we might conclude that non-bond issuing firms are more severely liquidity constrained.

In sum, a change in firm balance-sheet conditions would affect the investment of non-bond issuing firms, which seems to be subject to the more severe liquidity constraints.

C. Bank Balance-Sheet Variables

Further addition of main bank balance-sheet variables to the above specifications (only firms which have main banks are investigated) are summarized in Table 5.[14]

Again, after several experiments, bank balance-sheet variables, *ECAPR* or *RCAPR*, are found to become significant from around FY1993 (columns (26), (28), (30) and (32)).[15] D_{93}^{95} is a step dummy that takes one in and after FY1993, otherwise naught. From January 1993, CCPC (Cooperative Credit Purchasing Company) began operation and banks sold or charged-off their non-performing loans to the CCPC (see Appendix II for historical perspective of non-performing loan problems in Japan). Moreover, from March 1993, banks started to publish outstanding non-performing loans in accordance with the disclosure rule set by *Zenginkyo* (Federation of Bankers Associations). Therefore, it is likely that banks became more nervous concerning their balance-sheet conditions and gradually tried to clean up balance-sheets from around this year.[16]

The contrast between bond issuing firms and non-bond issuing firms is eye catching. The bank balance-sheet variable tends to be significant for non-bond issuing firms, but not for bond issuing firms.[17] Hence, the above evidence suggests that from around 1993 banks become reluctant to expand credits to those companies, which had no alternative to bank borrowing and liquidity constrained, because of concerns about their own balance-sheets, which, in turn, discouraged investment by these firms.

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[14]Table 4 summarizes estimation of including main bank balance-sheet variables, but not firm balance-sheet variables. Coefficients on main bank balance-sheet variables are almost identical with those in Table 5.

[15]Table 6 contains specifications of alternative bank balance-sheet variables. *OCAPR* in columns (A3) and (A7) is published risk adequacy ratio. Although their signs are correct, their significance levels are somewhat lower than those of *ECAPR* and *RCAPR*. *RATE* in columns (A4) and (A8) are the average of main banks' ratings from Moody's, where the rating is counted as 1 for Aaa, 2 for Aa1... (the lower the number is, the better the rating is). However the variable is not significant.

[16]Table 7 contains specification search of alternative timings of bank balance-sheet variables. Since *ECAPR* and *RCAPR* are available in a consistent manner only after FY1992, we cannot investigate their significance before FY1992. Although significance level of *ECAPR* drops somewhat during FY1994-FY1995 period (in particular, an ECM model of column (A14)), it is clear that bank balance-sheet variables become significant after FY1993.

[17]*RCAPR* in column (31) is significant, but has a wrong sign.

V. Conclusion

This paper investigates whether balance-sheet conditions of firms and their main banks matter for firm investment using dynamic corporate panel data in Japan for the period 1985-1995. It finds that:

- smaller non-bond issuing firms were facing liquidity constraints;
- these firms' balance-sheet conditions as reflected by their debt asset ratios served as the main criterion for main banks' lending to them and then this channel affected their investment from the midst of the bubble era; and
- deterioration of their main banks' balance-sheet conditions constrained these firms' investment from around 1993.

These findings highlight the importance of the credit channel of monetary transmission and supports the case for a credit crunch in constraining small Japanese firms' investment behavior during the period.

Balance-sheet problems potentially have a significant macro impact on the Japanese economy. In our sample, investment by non-bond issuing firms (of which those with main banks) accounts for only 23 (14) percent of investment in FY1995. However, these shares are downward biased because our sample is, in turn, biased toward larger firms although it covers over-the-counter market firms. In fact, there are a much larger number of smaller firms whose shares are not captured even by the over-the-counter market or which do not even issue stocks. According to Bank of Japan (1997), macro statistics indicates investment by small firms (most of which have not issued bonds) accounts for about 60 percent of investment in Japan including investment by non-manufacturing firms, suggesting a potentially larger impact of the credit crunch on firm investment behavior.

The impact of bank and firm balance-sheet conditions on firm investment behavior examined in this paper also excludes observations for FY1996 and 1997. According to the Tankan survey, banks' lending attitude became very severe from 4th quarter of 1997, when one major bank, Hokkaido Takushoku, and two major security firms, Yamaichi and Sanyo, went into bankruptcy. In fact, Woo (1999) finds evidence of severe credit crunch in this year. It would be interesting to re-estimate the above investment functions to include the more recent data now available.

Finally, it would be worthwhile to further test other factors, which are often referenced as causes of disappointing outcomes of firm investment in the 1990s. These include, for example, appreciation of the yen particularly around 1995, a substitution from domestic investment to foreign direct investment in Asian countries, (possibly) lower expectations of growth, and uncertainty about the economic environment.[18]

[18]Significant $k-y$ terms in error correction models imply that excess capacity vis-à-vis output discourages firm investment. This excess capacity (or lack of demand) might be another reason for discouraged investment in the 1990s.

Table 1: Sample Properties

Sample	Mean	Std. Dev.	Minimum	Maximum
(1) (I_t/K_{t-1})				
All Bond	0.23	0.19	-0.40	1.52
All Non-bond	0.22	0.21	-0.68	1.69
Bank Bond	0.23	0.18	-0.40	1.52
Bank Non-bond	0.22	0.22	-0.56	1.64
(2) y_{t-1}				
All Bond	11.34	1.29	8.08	16.01
All Non-bond	9.76	0.90	6.79	13.64
Bank Bond	11.51	1.35	8.28	15.29
Bank Non-bond	9.87	0.88	7.18	13.33
(3) $(CF/p^kK)_t$				
All Bond	0.31	0.22	-1.31	1.52
All Non-bond	0.31	0.31	-1.45	4.36
Bank Bond	0.27	0.19	-0.85	1.91
Bank Non-bond	0.25	0.24	-1.45	2.15
(4) $(B/A)_{t-1}$				
All Bond	0.96	0.44	0.12	4.74
All Non-bond	1.00	0.53	0.08	4.61
Bank Bond	1.00	0.43	0.17	4.21
Bank Non-bond	1.13	0.54	0.17	4.61

Table 2: Basic Specifications

	Q Model				Error Correction Model			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	Bank	Bank	All	All	Bank	Bank
Bond	Yes	No	Yes	No	Yes	No	Yes	No
Firms	759	362	383	189	759	362	383	189
Obs.	5,794	2,420	2,904	1,227	5,794	2,420	2,904	1,227
(I_{t-1}/K_{t-2})	0.05	0.01	-0.01	-0.01	0.06	0.01	0.05	0.01
	(1.42)	(0.12)	(0.04)	(0.65)	(2.68)	(1.11)	(1.37)	(0.43)
Q_t	0.003	0.004	0.010	0.006				
	(1.63)	(1.10)	(2.13)	(1.87)				
Δy_t					0.15	0.16	0.40	0.09
					(0.85)	(0.74)	(2.21)	(0.37)
$(k-y)_{t-1}$					-0.25	-0.04	-0.39	-0.12
					(2.80)	(2.13)	(3.55)	(2.11)
y_{t-1}					-0.03	0.01	-0.04	0.02
					(1.11)	(0.43)	(0.98)	(0.36)
j_{t-1}					-0.20	0.57	-0.27	-0.19
					(0.53)	(0.21)	(0.73)	(1.36)
$(CF/p^kK)_t$	0.39	0.37	0.25	0.26	0.16	0.29	0.05	0.20
	(4.77)	(3.88)	(2.03)	(3.89)	(1.50)	(3.32)	(0.28)	(2.66)
σ^2	0.029	0.050	0.032	0.049	0.046	0.048	0.074	0.054
w_1	[0.000]	[0.000]	[0.009]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.000]	[0.004]	[0.000]	[0.079]	[0.000]	[0.006]	[0.000]	[0.168]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.168]	[0.008]	[0.462]	[0.294]	[0.264]	[0.026]	[0.954]	[0.384]
Sargan	[0.275]	[0.410]	[0.234]	[0.318]	[0.263]	[0.107]	[0.153]	[0.173]

Notes

1. Manufacturing. All estimation is conducted from 1985 to 1995 by the system GMM. Constants and time dummies are included, but their coefficients are omitted.

2. Figures in parentheses are t-values obtained from one-step estimators. Estimated coefficients are from two-step estimators.

3. w_1 is a test of the joint significance of the reported coefficients other than the time dummies; w_2 is a test of the joint significance of the time dummies; and AR(1) and AR(2) are tests of the first and second order of residual serial errors (all of them are obtained from one-step estimation). Sargan is the test of the overidentifying restrictions (obtained from two-step estimation). Figures in square brackets are p-values.

4. Instruments are as follows: (i) for All Bond and Bank Bond, $(I/K)_{t-2,\ldots,t-5}$, $(CF/p^kK)_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (ii) for All Non-bond (Q model), $(I/K)_{t-2,\ldots,t-5}$, $y_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (iii) for All Non-bond (ECM), Bank Non-bond, $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, for level equations.

Table 3: Firm Balance-Sheet Variables

	Q Model				Error Correction Model			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	All	All	Bank	Bank	All	All	Bank	Bank
Bond	Yes	No	Yes	No	Yes	No	Yes	No
Firms	759	362	383	189	759	362	383	189
Obs.	5,794	2,420	2,904	1,227	5,794	2,420	2,904	1,227
(I_{t-1}/K_{t-2})	0.05	-0.02	-0.004	-0.05	0.06	0.004	0.04	-0.01
	(1.45)	(0.32)	(0.07)	(1.50)	(2.65)	(0.60)	(1.28)	(0.33)
Q_t	0.003	0.004	0.011	0.010				
	(1.60)	(1.39)	(2.35)	(2.68)				
Δy_t					0.16	0.26	0.43	0.13
					(0.83)	(1.21)	(2.21)	(0.65)
$(k-y)_{t-1}$					-0.24	-0.08	-0.38	-0.11
					(2.68)	(2.45)	(3.64)	(2.27)
y_{t-1}					-0.04	-0.01	-0.03	-0.01
					(1.20)	(1.22)	(0.59)	(0.40)
$(CF/p^kK)_t$	0.39	0.47	0.22	0.29	0.17	0.29	0.05	0.24
	(4.64)	(4.35)	(1.78)	(4.27)	(1.52)	(3.66)	(0.21)	(3.10)
$(B/A)_{t-1} \cdot D_{89}^{95}$	0.03	-0.09	0.23	-0.05	0.02	-0.06	0.04	-0.04
	(0.35)	(3.01)	(1.46)	(2.37)	(0.12)	(3.18)	(0.36)	(1.42)
σ^2	0.030	0.055	0.046	0.053	0.045	0.050	0.070	0.049
w_1	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.000]	[0.001]	[0.000]	[0.068]	[0.000]	[0.028]	[0.000]	[0.066]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.173]	[0.003]	[0.518]	[0.091]	[0.296]	[0.007]	[0.867]	[0.177]
Sargan	[0.244]	[0.287]	[0.326]	[0.569]	[0.222]	[0.160]	[0.169]	[0.349]

Notes

1. Instruments are as follows: (i) for All Bond and Bank Bond, $(I/K)_{t-2,\ldots,t-5}$, $(CF/p^kK)_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (ii) for All Non-bond (Q model), $(I/K)_{t-2,\ldots,t-5}$, $y_{t-2,\ldots,t-4}$, $(B/A)_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (iii) for All Non-bond (ECM), Bank Non-bond, $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, $(B/A)_{t-2}$, $(B/A)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, $\Delta(B/A)_{t-1}$, for level equations.
2. Also, see notes for Table 2.

Table 4: Bank Balance-Sheet Variables

	Q Model				Error Correction Model			
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bond	Yes	No	Yes	No	Yes	No	Yes	No
Firms	383	189	383	189	383	189	383	189
Obs.	2,904	1,227	2,904	1,227	2,904	1,227	2,904	1,227
(I_{t-1}/K_{t-2})	-0.005	-0.02	-0.005	-0.02	0.05	0.01	0.05	0.01
	(0.04)	(0.72)	(0.05)	(0.75)	(1.28)	(0.23)	(1.30)	(0.18)
Q_t	0.010	0.006	0.010	0.006				
	(2.13)	(1.87)	(2.13)	(1.88)				
Δy_t					0.43	0.07	0.44	0.07
					(2.21)	(0.26)	(2.23)	(0.23)
$(k-y)_{t-1}$					-0.38	-0.11	-0.38	-0.11
					(3.66)	(2.04)	(3.69)	(2.00)
y_{t-1}					-0.03	0.01	-0.03	0.01
					(0.50)	(0.29)	(0.49)	(0.30)
$(CF/p^kK)_t$	0.25	0.26	0.25	0.25	0.05	0.20	0.05	0.20
	(2.03)	(3.83)	(2.04)	(3.83)	(0.22)	(2.80)	(0.22)	(2.82)
$ECAPR_t \cdot D_{93}^{95}$	0.001	0.02			-0.003	0.01		
	(0.27)	(1.81)			(0.48)	(1.21)		
$RCAPR_t \cdot D_{93}^{95}$			-0.005	0.03			-0.01	0.02
			(0.70)	(1.64)			(1.52)	(1.41)
σ^2	0.032	0.049	0.032	0.049	0.069	0.049	0.069	0.049
w_1	[0.021]	[0.000]	[0.018]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.000]	[0.022]	[0.000]	[0.032]	[0.000]	[0.060]	[0.000]	[0.059]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.453]	[0.326]	[0.477]	[0.326]	[0.873]	[0.455]	[0.849]	[0.456]
Sargan	[0.233]	[0.271]	[0.239]	[0.279]	[0.181]	[0.198]	[0.185]	[0.194]

Notes

1. Instruments are as follows: (i) for Bank Bond, $(I/K)_{t-2,\ldots,t-5}$, $(CF/p^kK)_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (ii) Bank Non-bond, $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, $(B/A)_{t-2}$, $(B/A)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, $\Delta(B/A)_{t-1}$, for level equations.

2. Also, see notes for Table 2.

Table 5: Firm and Bank Balance-Sheet Variables

	Q Model				Error Correction Model			
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bond	Yes	No	Yes	No	Yes	No	Yes	No
Firms	383	189	383	189	383	189	383	189
Obs.	2,904	1,227	2,904	1,227	2,904	1,227	2,904	1,227
(I_{t-1}/K_{t-2})	-0.004	-0.05	-0.004	-0.05	0.03	-0.01	0.04	-0.01
	(0.07)	(1.58)	(0.07)	(1.59)	(1.28)	(0.39)	(1.30)	(0.42)
Q_t	0.011	0.010	0.011	0.010				
	(2.35)	(2.68)	(2.35)	(2.68)				
Δy_t					0.62	0.13	0.44	0.12
					(2.20)	(0.66)	(2.22)	(0.64)
$(k-y)_{t-1}$					-0.38	-0.11	-0.38	-0.11
					(3.64)	(2.27)	(3.66)	(2.26)
y_{t-1}					-0.03	-0.01	-0.03	-0.01
					(0.60)	(0.40)	(0.59)	(0.40)
$(CF/p^kK)_t$	0.22	0.28	0.22	0.28	0.03	0.24	0.05	0.24
	(1.78)	(4.23)	(1.79)	(4.23)	(0.20)	(3.08)	(0.21)	(3.09)
$(B/A)_{t-1} \cdot D_{89}^{95}$	0.23	-0.05	0.23	-0.05	0.07	-0.04	0.05	-0.04
	(1.46)	(2.46)	(1.47)	(2.39)	(0.37)	(1.46)	(0.37)	(1.43)
$ECAPR_t \cdot D_{93}^{95}$	0.000	0.02			-0.004	0.01		
	(0.03)	(1.90)			(0.47)	(1.23)		
$RCAPR_t \cdot D_{93}^{95}$			-0.003	0.04			-0.01	0.02
			(0.61)	(1.67)			(1.48)	(1.42)
σ^2	0.046	0.053	0.046	0.053	0.070	0.049	0.071	0.049
w_1	[0.010]	[0.000]	[0.011]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.000]	[0.028]	[0.000]	[0.029]	[0.000]	[0.024]	[0.000]	[0.020]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.515]	[0.150]	[0.532]	[0.106]	[0.838]	[0.191]	[0.816]	[0.193]
Sargan	[0.324]	[0.533]	[0.327]	[0.497]	[0.165]	[0.340]	[0.169]	[0.323]

Notes

1. Instruments are as follows: (i) for Bank Bond, $(I/K)_{t-2,\ldots,t-5}$, $(CF/p^kK)_{t-2,\ldots,t-4}$, for difference equations, and $\Delta(I/K)_{t-1}$ for level equations; (ii) Bank Non-bond, $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, $(B/A)_{t-2}$, $(B/A)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, $\Delta(B/A)_{t-1}$, for level equations.
2. Also, see notes for Table 2.

Table 6: Alternative Specifications (1)

	Q Model				Error Correction Model			
	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)	(A7)	(A8)
	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bond	No	No	No	No	No	No	No	No
Firms	189	189	189	189	189	189	189	189
Obs.	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227
(I_{t-1}/K_{t-2})	-0.04	-0.04	-0.05	-0.05	-0.01	-0.01	-0.01	-0.01
	(1.31)	(1.40)	(1.62)	(1.50)	(0.39)	(0.23)	(0.41)	(0.33)
Q_t	0.008	0.009	0.010	0.010				
	(2.16)	(2.38)	(2.70)	(2.68)				
Δy_t					0.08	0.20	0.12	0.13
					(0.46)	(0.96)	(0.62)	(0.66)
$(k-y)_{t-1}$					-0.07	-0.11	-0.11	-0.12
					(1.26)	(2.22)	(2.25)	(2.30)
y_{t-1}					-0.01	-0.01	-0.01	-0.01
					(0.30)	(0.48)	(0.42)	(0.41)
$(CF/p^kK)_t$	0.27	0.29	0.29	0.29	0.24	0.24	0.24	0.24
	(3.95)	(4.40)	(4.27)	(4.30)	(3.02)	(2.97)	(3.13)	(3.10)
$(B/A)_{t-1}$	0.08				0.08			
	(1.64)				(1.65)			
$(B/A)_{t-1} \cdot D_{93}^{95}$		-0.08				-0.12		
		(2.48)				(3.18)		
$(B/A)_{t-1} \cdot D_{89}^{95}$			-0.05	-0.05			-0.04	-0.04
			(2.42)	(2.31)			(1.43)	(1.38)
$OCAPR_t \cdot D_{93}^{95}$			0.03				0.01	
			(1.47)				(1.20)	
$RATE_t \cdot D_{93}^{95}$				-0.004				0.004
				(0.32)				(0.16)
σ^2	0.053	0.052	0.053	0.053	0.050	0.050	0.049	0.049
w_1	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.087]	[0.031]	[0.029]	[0.073]	[0.066]	[0.081]	[0.048]	[0.125]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.182]	[0.132]	[0.098]	[0.091]	[0.293]	[0.252]	[0.185]	[0.179]
Sargan	[0.568]	[0.602]	[0.612]	[0.572]	[0.302]	[0.338]	[0.358]	[0.335]

Notes

1. Instruments are $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, $(B/A)_{t-2}$, $(B/A)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, $\Delta(B/A)_{t-1}$, for level equations.

2. Also, see notes for Table 2.

Table 7: Alternative Specifications (2)

	Q Model				Error Correction Model			
	(A9)	(A10)	(A11)	(A12)	(A13)	(A14)	(A15)	(A16)
	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bond	No	No	No	No	No	No	No	No
Firms	189	189	189	189	189	189	189	189
Obs.	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227
(I_{t-1}/K_{t-2})	-0.05	-0.05	-0.05	-0.05	-0.01	-0.01	-0.01	-0.01
	(1.54)	(1.55)	(1.56)	(1.60)	(0.35)	(0.36)	(0.39)	(0.39)
Q_t	0.010	0.010	0.010	0.010				
	(2.70)	(2.70)	(2.71)	(2.70)				
Δy_t					0.13	0.11	0.13	0.11
					(0.66)	(0.66)	(0.65)	(0.65)
$(k-y)_{t-1}$					-0.12	-0.11	-0.11	-0.11
					(2.31)	(2.27)	(2.30)	(2.28)
y_{t-1}					-0.01	-0.01	-0.01	-0.01
					(0.38)	(0.41)	(0.35)	(0.40)
$(CF/p^kK)_t$	0.29	0.29	0.28	0.29	0.24	0.24	0.24	0.24
	(4.24)	(4.26)	(4.23)	(4.25)	(3.08)	(3.10)	(3.10)	(3.10)
$(B/A)_{t-1} \cdot D_{89}^{95}$	-0.05	-0.05	-0.05	-0.06	-0.04	-0.04	-0.04	-0.04
	(2.44)	(2.45)	(2.44)	(2.40)	(1.50)	(1.45)	(1.52)	(1.44)
$ECAPR_t \cdot D_{92}^{95}$	0.01				0.01			
	(0.89)				(0.62)			
$ECAPR_t \cdot D_{94}^{95}$		0.02				0.01		
		(1.43)				(0.82)		
$RCAPR_t \cdot D_{92}^{95}$			0.02				0.01	
			(0.83)				(0.88)	
$RCAPR_t \cdot D_{94}^{95}$				0.04				0.03
				(1.61)				(1.27)
σ^2	0.053	0.053	0.053	0.053	0.049	0.049	0.049	0.049
w_1	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
w_2	[0.073]	[0.042]	[0.073]	[0.027]	[0.065]	[0.047]	[0.045]	[0.028]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.099]	[0.090]	[0.097]	[0.086]	[0.187]	[0.191]	[0.185]	[0.165]
Sargan	[0.534]	[0.551]	[0.218]	[0.481]	[0.347]	[0.340]	[0.329]	[0.333]

Notes

1. Instruments are $(I/K)_{t-2,\ldots,t-4}$, y_{t-2}, y_{t-3}, $(CF/p^kK)_{t-2}$, $(CF/p^kK)_{t-3}$, $(B/A)_{t-2}$, $(B/A)_{t-3}$, for difference equations, and $\Delta(I/K)_{t-1}$, Δy_{t-1}, $\Delta(CF/p^kK)_{t-1}$, $\Delta(B/A)_{t-1}$, for level equations.

2. Also, see notes for Table 2.

Data Appendix

A. Prices

Price Indices (FY1990=100) for output and investment goods are calculated as follows:

Price of Output (p_t) Prices of outputs are calculated at the industry level using the annual average of the gross output price constructed using the Wholesale Price Index (WPI) and the 1990 input-output table (Bank of Japan, Input-Output Price Index).

Price of Capital Goods (p_t^k) Prices of capital goods are calculated by dividing the nominal depreciable capital stock by the real depreciable capital stock for each firm. As seen below, nominal/real depreciable capital stocks are obtained by summing components of depreciable assets in nominal/real terms. Therefore, a change in p_t^k reflects not only a change in the price of each component, but also a change in the shares of components.

B. Capital Stock and Investment

This is the most complicated part. In order to obtain the market value of capital stock, we try the following calculation for each breakdown of capital goods. The procedure is based on Hayashi and Inoue (1991) and/or Hoshi and Kashyap (1990).

Inventories First, we further breakdown inventories as (a) inventories of raw materials, (b) inventories of work in progress, inventories of finished goods, and (d) other inventories.

As for (a)-(c), if a firm does not use LIFO, we assume that the market-value is equal to the book-value. If a firm uses LIFO, the market-value is calculated by the following perpetual inventory method.

$$MS_t = \frac{PS_t}{PS_{t-1}} MS_{t-1} + (BS_t - BS_{t-1}), \tag{8}$$

where MS denotes the market-value of nominal inventory stock, BS is its book-value, and PS is the corresponding price deflator. Used price deflators are the raw material of WPI (for (a)), the output prices (for (c)) and their average (for (b)). The initial value of MS_t is obtained from BS_t at the earliest available year after FY1977 for each firm.

As for (d), we simply assume that the market-value is equal to the book-value, because there is no information on which type of accounting methods (i.e., LIFO, FIFO etc.) are used.

Land Similar to LIFO adjustment for inventories, we use the perpetual inventory method. When $BL_t - BL_{t-1} \geq 0$.

$$ML_t = \frac{PL_t}{PL_{t-1}} ML_{t-1} + (BL_t - BL_{t-1}), \tag{9}$$

where ML is the market-value of nominal land stock, BL is its book-value, and PL is the land price (Japan Real Estate Research Institute, the Land Price Index for urban districts, all purposes, six major cities). The initial value of ML_t is obtained from BL_t at the earliest available year after FY1977 for each firm. For the initial market-value, we made adjustment by multiplying the market-to-book ratio obtained from the SNA (Economic Planning Agency) and the Corporate Statistics Annual (Ministry of Finance). When $BL_t - BL_{t-1} < 0$, we make the following adjustment.

$$ML_t = \frac{PL_t}{PL_{t-1}} ML_{t-1} + \frac{PL_t}{PL'_{t-1}} (BL_t - BL_{t-1}), \tag{10}$$

PL'_{t-1} is the price at which land was last bought (i.e., when the book-valued land stock increased.) The idea behind this adjustment is to consider a firm sells the land which was last bought.

Depreciable Assets Taking account of depreciation, the perpetual inventory method is modified as follow.

$$MK_t = \frac{PK_t}{PK_{t-1}} MK_{t-1}(1 - \delta) + PK_t \cdot I_t, \tag{11}$$

where MK is the market-value of nominal depreciable assets and PK is the corresponding prices. Prices are

- Non-residential buildings and structures: the construction good of the WPI,
- Machinery: the capital goods of the WPI,
- Transportation equipment: the transportation machinery of the WPI,
- Instruments and tools: the capital goods of the WPI,
- Others (the other tangible fixed assets): the capital goods of the WPI is used, because there is no appropriate deflator.

Nominal investment $(PK_t \cdot I_t)$ is obtained by the following equation.

$$PK_t \cdot I_t = ACQ_t - MRK_t, \tag{12}$$

where ACQ_t is acquisition of assets during year t, and MRK_t is the market-value of assets sold or retired during year t. The latter is estimated as

$$MRK_t = \frac{MK_{t-1}}{BK_{t-1}} BRK_t. \tag{13}$$

BK is the book-value of capital stock. BRK is the remaining book-value of assets sold or retired and it can be obtained by

$$BRK_t = ACQ_t - (BK_t - BK_{t-1}) - DEP_t, \tag{14}$$

where DEP_t is the accounting depreciation during period t. See Hayashi-Inoue for the derivation of the above equation.

As for the physical depreciation rate (δ), we follow Hoshi-Kashyap. When a firm uses exponential depreciation, the depreciation rate is obtained as a sample average of DEP_t/BK_t for each firm. When a firm uses straight-line depreciation,

$$\delta = 1 - (\alpha)^{1/L}, \tag{15}$$

where α, the ratio of the salvage value of the capital to its initial value, is assumed to be 0.1, and L, the average life of capital, is derived as a sample average of BK_t/DEP_t for each firm.

C. Others

Debt stocks (D_t) The market-value is assumed to be equal to the book-value.

Output (Y_t) Sales plus the change in finished goods inventories.

Variable costs (w_tN_t) Variable costs consist of

1. Cost of goods sold,
2. Selling expenses (shipment fees, storage fees, etc.),
3. Wages and salaries (for employees and for executives),
4. Sales taxes.

D. Tax Variables

Corporate tax rate (τ_t) In Japan, there are four types of corporate profit taxes: (a) the national corporate income tax, (b) the prefectural inhabitants tax, (c) the municipal inhabitants tax, and (d) the enterprise tax. As Hayashi-Inoue describes, the enterprise tax can be deducted from tax payment in the subsequent year. We follow their adjustments as

$$\tau_t = \frac{(u_t + v_t)(1 + r_t)}{1 + r_t + v_t}, \tag{16}$$

where v_t, u_t and r_t denotes the enterprise tax, the other three corporate taxes, and the interest rate respectively. We take statutory tax rates as u_t and v_t.[19] The interest rate on 10-year government bond is used for r_t.

Depreciation allowance (μ_t) Following Hoshi-Kashyap, μ_t is defined as:

$$\mu_t = \sum_{s=t}^{\infty} DEP(t,s)(1+r)^{-(s-t)}, \tag{17}$$

where DEP_t is the depreciation that the firm can claim at year s for the investment made at year t. For a firm using the exponential depreciation, $DEP(t,s) = \delta(1-\delta)^{s-t}$, and hence

$$\mu_t = \frac{\delta(1+r_t)}{r_t+\delta}. \tag{18}$$

For a firm using the straight-line depreciation, $DEP(t,s) = 1/L$ for $0 \le s-t \le L$, and $DEP(t,s) = 0$ for $s-t > L$. Then,

$$\mu_t = \frac{(1+r_t)\left(1-(1+r_t)^{-L}\right)}{r_t L}. \tag{19}$$

Dividend tax (m_t) An investor in Japan can choose either (a) paying tax which is 35%[20] of dividend, or (b) paying tax whose rate is same as his/her income tax. Because of a steep tax ladder for the progressive income tax, an investor, who is thought to earn high income, tend to choose the option (a). Hence we set m_t as 35%.

Capital gain tax (z_t) In Japan, there are two types of capital gain taxes: (a) the capital gain tax, and (b) the security transaction tax. (a) has been levied since FY1989, and before that year there had been only (b). First, as for (a), an investor can choose either (a-1) declaring the actual capital gain and paying tax whose rate is 26%, or (a-2) instead of declaring the capital gain, paying tax which is equivalent to 1.05% of his/her sales of stocks. As for (b), similar to (a-2), it is charged on stock sales (0.21% as of FY1997) but not the actual capital gain. In general, (a-2) is considered as a tax loophole, because an investor can reduce his/her tax burden when he/she has considerable amount of capital gain (more than 4% of actual sales). For this reason, the capital gain tax in Japan is more or less similar to sales tax.

Considering an arbitrage condition between one-year holding of stock and that of a

[19] More precisely, $u_t = 1.173 \times$ (statutory national rate (a)). The statutory national tax has been revised several times. 1.173 comes from approximation for inhabitant taxes (b)-(c), whose rates depend on firms' location. On the other hand, the rate of enterprise tax (d) is set to 12%.

[20] When dividend income is small (less than 50 thousand yen per dividend payment), the tax rate is reduced to 20%.

riskless asset, the above sales tax rate component can be transformed to the capital gain tax equivalence by

$$z_t = \begin{cases} \frac{MF_t}{MF_t - MF_{t-1}}(0.0105 + s_t), & \text{for } \frac{MF_t - MF_{t-1}}{MF_t} \geq 0.04 \\ 0.26 + \frac{MF_t}{MF_t - MF_{t-1}} s_t, & \text{for } 0 < \frac{MF_t - MF_{t-1}}{MF_t} < 0.04 \\ 0, & \text{for } 0 \geq \frac{MF_t - MF_{t-1}}{MF_t} \end{cases} \tag{20}$$

where MF_t is the market price of stock and s_t is the security transaction tax at year t.[21] 0.0105 and 0.26 are replaced zero before FY1989. We use the Nikkei Average for MF_t.

E. User Cost of Capital

Following Hall and Jorgenson (1967), the user cost of capital is defined as

$$J_t = \frac{p_t^k}{p_t} \frac{(r_t + \delta_t - \dot{p}_t^k)(1 - \tau_t \mu_t)}{(1 - \tau_t)}, \tag{21}$$

where $\dot{p}_t^k = (p_t^k - p_{t-1}^k)/p_{t-1}^k$.

F. Average Q

We calculate average Q of depreciable assets as

$$Q_{t-1} = \frac{V_{t-1} + D_{t-1} - p_{t-1}^s S_{t-1} - p_{t-1}^l L_{t-1} - OA_{t-1}}{(1 - \tau_t \mu_t) p_{t-1}^k K_{t-1}}, \tag{22}$$

where OA is other assets such as deferred cost, construction in progress, intangible assets (using book values of them). V is obtained from multiplying the number of issued stocks and share prices, which are average of the maximum and minimum prices during the period.

[21] The last line of the above equation is slightly imprecise, because the security transaction tax is charged even when there is capital loss.

Non-Performing Loan Problems: Chronology

1990.08 The Bank of Japan raises the official discount rate by 0.75 percentage point to 6.0 percent.

1990.10 The tax advisory council to the government proposes heavier taxation on land, including an introduction of a national land-holding tax effective from 1992.

1991.07 The Bank of Japan cuts the official discount rate by 0.5 percentage point to 5.5 percent. Subsequently, it cuts the official discount rate up to 0.5 percent as of September 1995.

1991.08 The Japan Securities Business Association reveals the loss-compensation payments made by medium-sized security houses up to March 1990.

1991.12 The government decides to lift the cap on banking loans related to real estate, which was introduced in April 1990.

1992.01 A national land holding tax is enacted at a tax rate of 0.2 percent of land value (0.3 percent from 1993).

1993.01 **The Cooperative Credit Purchasing Company (CCPC), to which banks are to sell their bad loans, commences operation.**

1993.02 The Ministry of Finance requests private financial institutions to expand loans to small and medium-sized companies at lower interest rates.

1994.12 **An agreement by the Bank of Japan, private financial institutions, and the Tokyo Metropolitan Government to establish Tokyo Kyodo Bank to take over the assets and liabilities of Tokyo Kyowa Credit Association and Anzen Credit Association is announced.**

1995.07 The Tokyo Metropolitan Government orders Cosmo Credit Cooperative to suspend operations involving new loans and deposits.

1995.08 The Osaka Prefectural Government orders Kizu Credit Cooperative to suspend operations. The authorities announces a plan for the liquidation of Hyogo Bank and the establishment of Midori Bank.

1995.12 **The Cabinet approves measures to solve the Jusen (Housing Loan Corporation) problems.**

1996.03 The authorities announces a plan to dispose of the Taiheiyo Bank. The basic deposit insurance rate is raised to 0.048 percent.

1996.06 **The Diet passes six financial laws, which establish the Housing Loan Administration Corporation and the Resolution Collection Bank (RCB, which takes over resources from Tokyo Kyodo Bank), reform the Deposit Insurance Scheme, and introduce Prompt Corrective Action to ensure the sound management of financial institutions.** The additional deposit insurance rate, for the newly-established special fund, is set to 0.036 percent by a Cabinet ordinance.

1996.11 The Ministry of Finance orders Hanwa Bank to suspend operations.

1997.03 The government announces an overall package for stimulating liquidity in the real estate market, aiming at resolving bad loan problems and promoting urban development. The merger of Hokkaido Takushoku Bank and Hokkaido Bank is announced. Japan Credit Bank presents a substantial restructuring plan.

1997.04 The Ministry of Finance orders Nissan Life Insurance to suspend operation.

1997.06 A law establishing the Supervisory Agency for Financial Entities is adopted by the Diet.

1997.10 Kyoto Kyoei Bank releases its liquidation plan.

1997.11 **Sanyo Securities applies to the courts for legal restructuring procedures, which incurs default of its borrowing at the call money market. Hokkaido Takushoku Bank announces its inability to continue operating and the transfer of its operation in Hokkaido to Hokuyo Bank. Yamaichi Securities announces closure of its business.** Tokuyo City Bank announces its closure and the transfer of its operation to other regional banks. The Ministry of Finance announces that deposit insurance will pay off not only covered deposits but also financial assets which are not covered by the insurance such as bank debentures, loan trusts etc.

1997.12 The Diet passes the revised Deposit Insurance Law, giving the Deposit Insurance Corporation the right to cover loan losses of merging banks. The Ministry of Finance announces measures to deal with the "credit crunch".

1998.01 The Ministry of Finance announces measures to stabilize the stock market. Mr. Mitsuzuka, the Minister of Finance, resigned, taking responsibility for the Ministry's bribery scandal.

1998.02 **The Diet passes two finance-related laws, which enables the government to use 30 trillion yen of public money to bail out banks and protect depositors.**

1998.03 Twenty-one banks applied for public capital injections, virtually all of which are fully approved by the Financial Crisis Management Committee. Mr. Matsushita, Governor of the Bank of Japan, resigned, taking responsibility for the Bank's bribery scandal.

1998.05 Hanshin Bank announces a merger with Midori Bank as of April 1999.

1998.06 **The Financial Supervisory Agency was set up, taking over the functions of supervision and inspection of the financial system from the Ministry of Finance.** The Long Term Credit Bank of Japan announces a merger with the Sumitomo Trust Bank as of April 1999.

1998.09 The Bank of Japan lowers its target rate to 0.25 percent, leaving the official discount rate unchanged. Nippon Leasing Corporation, an affiliate of the Long Term Credit Bank, applies for the Corporate Reorganization Law, with liabilities worth about 2.2 trillion yen, a record in the post-war era.

1998.10 **The Diet passes eight bills to revive the banking system, including the terms under which a bridge bank could be set up and temporary nationalization can occur. The bills also establishes the Financial Revitalization Committee to oversee the process and to take over responsibility for financial regulation and planning from the Ministry of Finance as from January 2000. Furthermore, the bills establishes the Resolution Collection Corporation (RCC), which is merging the Housing Loan Administration Corporation and the RCB as of April 1999. Separately, it passes a bill to allow the government to inject capital into banks on request even if they are solvent. The Diet also adopts the second FY1998 budget, thereby providing government loan guarantees amounting 43 trillion yen in total on Bank of Japan's loans to the Deposit Insurance Corporation to implement the recapitalization of the banks. The Long Term Credit Bank applies for temporary nationalization.**

1998.12 **Japan Credit Bank applies for temporary nationalization.**

1999.02 The Bank of Japan announces further ease of monetary policy so as to lower overnight call rate as low as possible.

1999.03 **Fifteen banks applied for public capital injections, which are approved by the Financial Revitalization Committee.**

Sources: Various issues of *OECD Economic Surveys: Japan*, *Bank of Japan Monthly Bulletin*, etc.

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