Analyzing Determinants of Corporate Investment Behavior: Progress in Investment Diversification and Roles of Internal Funds*

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Abstract

This paper uses panel data from Japanese manufacturing companies to estimate a plant and equipment investment function and a broadly defined investment function and to empirically analyze two hypotheses regarding investment. The first hypothesis is that Japanese companies are too safety-oriented when promoting investment. The second hypothesis is that broadly defined investment, including mergers and acquisitions, research and development investment, and plant and equipment investment are not necessarily as restricted as M&A and R&D investment is increasing, even though with plant and equipment investment being restricted. The empirical analysis has produced three findings. First, the broadly defined investment function's explanatory power is generally strong, indicating that companies give priority to broadly defined investment in making business decisions. Second, investment behavior at the time of the Lehman Shock differed from that before and after the shock. Third, companies with financial surpluses, as well as those with financial deficits, base investment level decisions on their internal funds levels. Companies with financial deficits, which are relatively proactive towards investment, give priority to internal fund factors as well as real factors in making investment decisions. Given the above, the both hypotheses subjected to this analysis are apparently supported to some extent.

Key words: Plant and equipment investment, broadly defined investment, internal funds constraints

JEL Classification: D22, G31

I. Introduction

Plant and equipment investment was obviously the main engine of Japan's high economic growth from the late 1950s to the early 1970s. The multiplier effect in investment had been emerging during this period. After, two oil crises in the 1970s caused a slump in investment through bad performance in business sectors. Investment was vigorous again in the 1980s, and the ratio of investment in nominal GDP reached 20.4% in the 1990s for the

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first time since the high economic growth period of the early 1970s.

Investment plunged after the Japanese economic bubble burst in the early 1990s. The slump in investment has been prolonged. The current level of investment is far lower than the peak level during the 1991 fiscal year.

There are two hypotheses as to why the slump in investment has been prolonged. Firstly, Japanese companies are too safety-oriented to promote investment. Namely, since the economic bubble burst, most Japanese companies have preferred retained earnings (cash equivalents, etc.) rather than investments, which carry a high risk. This mindset has caused a long-term slump in investment. Secondly, Japanese companies have rationally been making broadly defined investment. Broadly defined investment includes mergers and acquisitions (M&A), research and development (R&D) investment, and plant and equipment investment; however, plant and equipment investment has been increasing and is not necessarily as restricted as M&A and R&D.

This paper aims to examine two hypotheses empirically by estimating the plant and equipment investment function and the broadly defined investment function. The empirical analysis based on financial information from the 2002 to 2014 fiscal years has produced three findings. First, the explanatory power in broadly defined investment is generally more accurate, and the magnitude of coefficients in the broadly defined investment function is larger are more explanatory than coefficients in the plant and equipment investment, indicating that companies give priority to broadly defined investment when making business decisions.

Second, investment behavior during the Lehman Brothers Crisis differed from that before and after. Investment plunged during the Lehman Brothers Crisis because company cash flow plummeted. Similarly, a psychological factor, which could not be measured in investment functions, became negative. Thus, each explanatory variable showed high sensitivity during the Lehman Brothers Crisis.

Third, we estimate investment functions of companies with financial surpluses and financial deficits to analyze how liquid factors affect corporate investment behavior. We discovered that there is little difference in the coefficient of cash flow between companies with financial surpluses and those with financial deficits. We can interpret this result as meaning that companies give priority to the current expected cash flow level when making investment decisions and that the coefficient of cash flow does not necessarily relate to the degree of internal financing constraints. The coefficients of two kinds of liquidity in hand in companies with financial deficits are higher than those in companies with financial surpluses, which indicates that companies with financial deficits give priority to liquidity when making a broadly defined investment for which they need external finances. Additionally, all dummy variables during World Financial Crisis in companies with financial deficits are insignificant, while dummy variables in companies with financial surpluses are significantly negative, which indicates that the investment level in companies with financial deficits did not significantly decrease, even during World Financial Crisis. Similarly, companies with financial deficits, which are relatively proactive towards investment, give priority to liquid factors

(cash flow and liquidity in hand) as well as real factors (return of capital, etc.) when making investment decisions. Given the above, both hypotheses subjected to this analysis are supported to some extent.

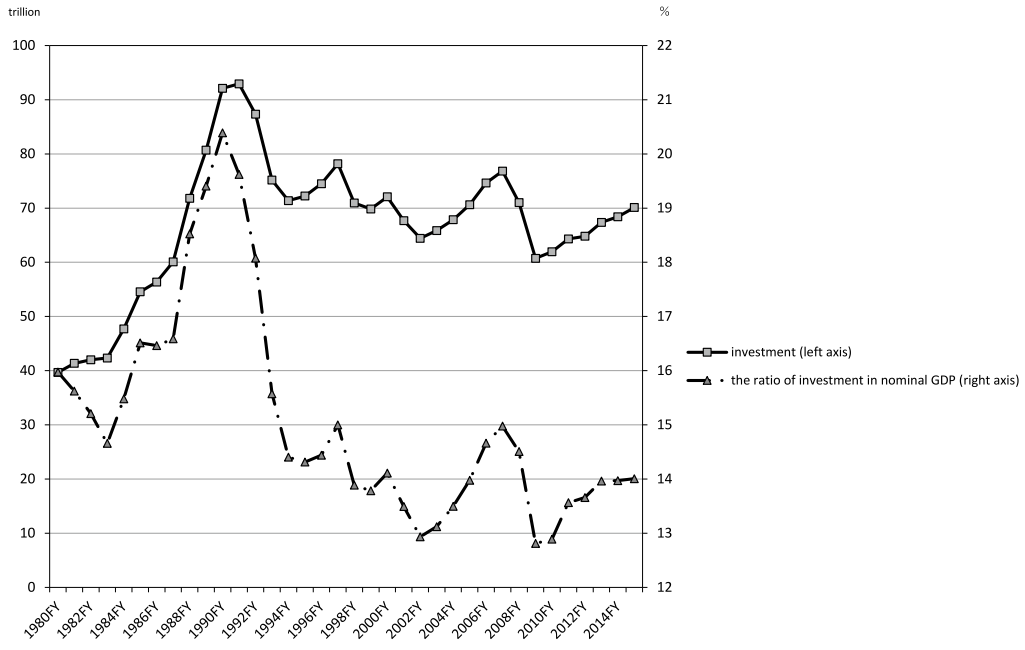
The rest of this paper is organized as follows. Section II reviews the long-term behavior of plant and equipment investment and broadly defined investment, including M&A and R&D, using macro data and GDP. Section III surveys previous studies about investment and the availability of funds. Section IV explains the framework of empirical analysis and data construction and presents the results of our estimation and an interpretation. Finally, Section V provides a conclusion and describes the implications of our findings.

II. The slump of plant and equipment investment and the long-term behavior of broadly defined investment

II-1. The long-term behavior of plant and equipment investment and corporate finance

The long-term slump in investment is one of the reasons why the Japanese economy has been stagnant on the macro demand side. According to Figure 1, investment in nominal GDP increased from 39.7 trillion Japanese yen in FY 1980 to 54.6 trillion yen in FY 1985. Finally, it reached 92.9 trillion yen in 1991. We have no doubt that the vigor of investment in late the 1980s is from an economic bubble. In view of that, the slump in investment after

Figure 1. Long-term behavior of investment in GDP



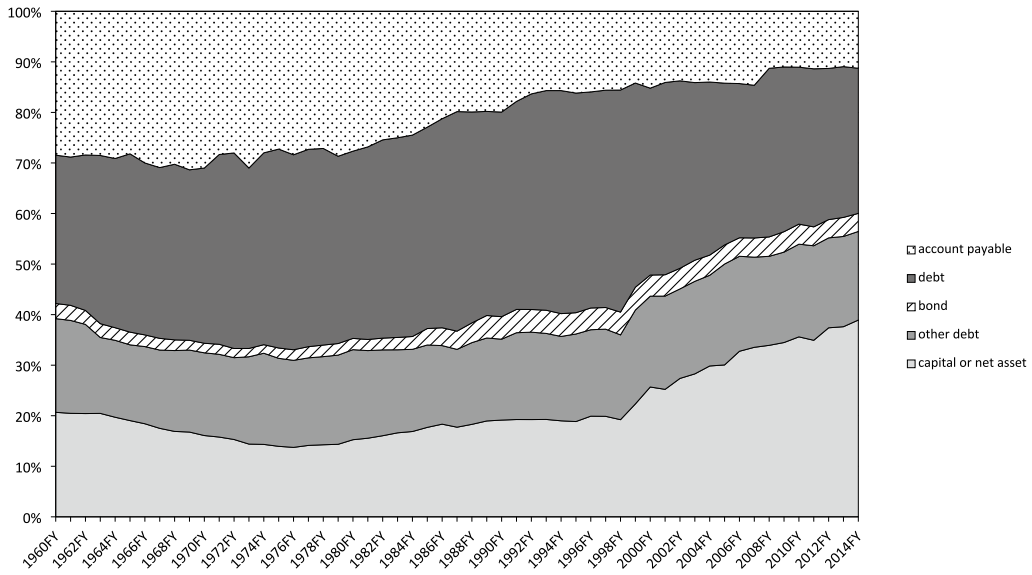
(Sources) GDP statistics

the economic bubble burst was devastating. Investment decreased to 67.7 trillion yen in 2001. It bottomed out in 2002 and gradually climbed to 76.8 trillion yen in 2007. However, after the Lehman Brothers Crisis, it plunged to 60.7 trillion yen in 2009. Investment has recovered slowly, just reaching 70.1 trillion yen in 2015. This 70.1 trillion yen amount is below the level of investment in 1998 (about 30 years ago), which indicates that the long-term slump in investment has been undoubtedly ongoing.

According to Figure 1, the ratio of investment in GDP was recorded at around 15% in the early 1980s and reached its highest point in 1990 at 20.4%. However, the ratio plunged to 12.9% in 2002 after the economic bubble burst. In 2009, the ratio reached 12.8%, which was lowest level since World War II. The ratio has been restricted at only 14.0%, though it has gradually improved.

There is the point of view that Japanese companies are inclined to accept financial safeness without business and financial risk instead of being willing to perform a challenge that comes with some business risks. This view is considered the background of this slump in investment. According to Figure 2, equity capital (= net assets)[1] accounted for 20.7% of total assets in the 1960s. The ratio of net assets to total assets gradually decreased to 13.7% in 1976. It then bottomed out and managed to recover to 19.1% in 1990. The ratio reached 22.3% in 1999 for the first time since 1960. Equity capital was recorded at 30.1% in 2005 for the first time as the pace of growth accelerated. Finally, the ratio reached 38.9% in 2014.

Figure 2. Long-term component ratio in balance sheet of corporation



(Sources) Financial Statement statistics of corporation

[1] An equity capital account was traditionally called an equity section. After the Companies Act was enacted in 2006, equity capital accounts, including equity warrants and minority equity (non–controlling equity after 2015), which are intermediate account between equity and debt, has been called a net asset section.

This increase in net assets is considered to be mainly from ample retained earnings that exceeded investment every fiscal year, not from public offers.

II-2. The long-term behavior of M&A

Investment plays a key role for companies because it promotes company availability, contributes to sustainability of long-term growth, and gives effective demand to the economy. It is not too much to say that the long-term growth of a company depends on investment. But companies have to gradually overcome many difficulties, including the formation of overseas subsidiaries and land acquisition, construction arrangement, hiring local staff, establishment of sales channel, enhancing customer relationships, and investing in new plants overseas.[2] It clearly takes a long time to make such investments and bear its fruit, which is the improvement of company value.

We have an alternative measure, M&A, that promotes company sustainability and saves time. Companies can bear fruit sooner using this measure compared to green-field styled investment. M&A can realize improvement of a company's value by indicating the need for new equipment and managerial resources.[3] While mega M&A[4] was focused on, as Japanese companies were not active in M&A until the 1970s, the number of cases and volume in M&A was far fewer than now, and the volume in M&A was far fewer than that in plant and equipment investment.

Japanese companies became active in M&A in the 1980s. According to Figure 3, the number of cases in M&A increased step by step in the late 1980s (during the economic bubble) and recorded 561 cases for the first time during the 1999 fiscal year. The number of cases in M&A temporarily plunged after economic bubble burst, but it bottomed out in mid-1990s and reached 1011 cases in 1998 for the first time. In 2003, it recorded 2059 cases. Finally, it peaked to 3101 cases. After the Lehman Brothers Crisis, the number of cases in M&A decreased, and it stayed at around 2500 cases from 2010 to 2012. However, it has been recovering since 2013, and 3074 cases were recorded in 2015.

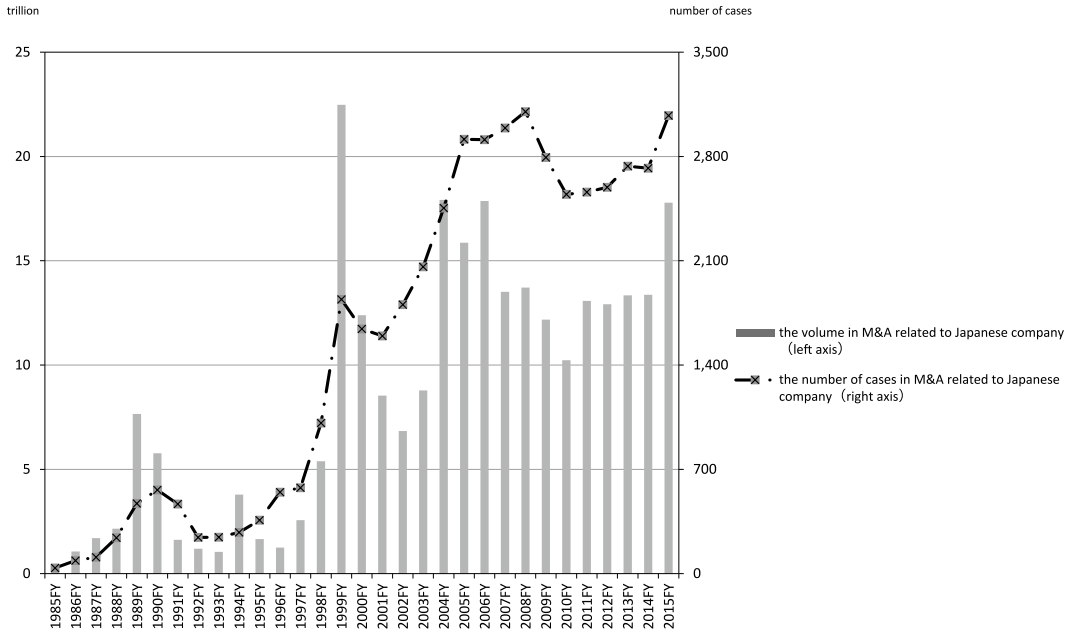
We can see the volume in M&A in Figure 3. Though the volume in M&A would not show the trend of M&A exactly compared to the number of cases because the volume is dependent on big deals, the volume in M&A has also been increasing. The volume in M&A was only 170 billion yen in the 1985 fiscal year, but it exceeded 7 trillion yen in 1989 (during economic bubble). After the economic bubble burst, M&A was sluggish for a while before recovering and peaking at 22.5 trillion yen. In 2015, it has maintained 17.7 trillion

[2] This investment is called a green-field investment because companies have to purchase land and construct plants, etc.

[3] There are two key factors to improving a company's value through M&A. One is economies of scale in M&A with peers. Another is economies of scope in M&A without peers.

[4] There were some mega M&A from World War IIto the 1970s as follows: Mitsubishi Heavy Industries. Ltd. merged with three companies of Mitsubishi Industry Groups (in 1964), Mitsui O.S.K. Lines merged with OSK Lines and Mitsui Steamsjip Co. Ltd. (in 1964 fiscal year), Nissan Motor Corporation merged with Nissan Motor and Prince Motor (in 1967), Nippon Steel Corporation merged with Fuji Steel and Yahata Steel (in 1970), and Daiichi Kangyo Bank merged with Daiichi Bank and Japan Kangyo Bank (in 1971).

Figure 3. Long-term behavior of M&A of Japanese companies



(Sources) THOMSON REUTERS

yen.

II-3. The long-term behavior of R&D

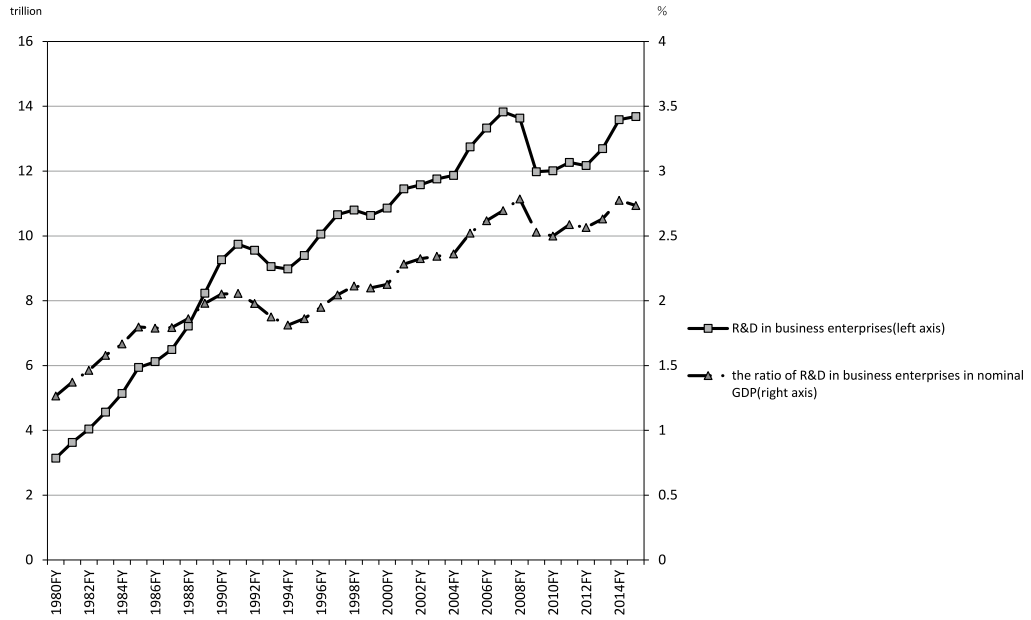
While plant and equipment investment aims to improve a company's availability and promote its sustainability by accumulation of tangible assets, R&D aims to promote a company's sustainability by various processes as follows: fundamental research ⇒ applied research ⇒ development research ⇒ commercial viability ⇒ launch strategy of a new product. Given the above, R&D and plant and equipment investment are both kinds of capital expenditure.

However, there is a big difference between R&D and plant and equipment investment. Plant and equipment is a hard investment because companies try to accumulate tangible fixed assets, such as the construction of plants and purchase of machines. Conversely, R&D is a soft investment because companies record most R&D as expenses such as payroll, purchase costs of tangible and intangible fixed assets, lease fees, and other expenses.[5]

We can see the long-term behavior of R&D in macro data from the Survey of Research and Development. According to updated data from the Survey of Research and Development released on December in 2016, R&D in business enterprises[6] in the 2015 fiscal year was recorded at 13.7 trillion yen, which was historically the second highest level, just be-

[5] We referred to Horiuchi, Suzuki, Hanazaki, and Otaki (1984)

Figure 4. Long-term behavior of R&D expenditure of Japanese companies



(Sources) Survey of Research and Development

hind 13.8 trillion yen in 2007.[7]

According to Figure 4, R&D in business enterprises in 1980 was only 3.1 trillion yen, and it has maintained its increasing trend. R&D reached 10 trillion yen in 1996 for the first time. Though its pace gradually slowed, R&D spending continued to increase until 2007. After 2008, growth was sluggish until 2012 due to adverse impacts of the Global Financial Crisis, Greece Crisis, Great East Japan Earthquake, and unprecedented Japanese yen appreciation.

The ratio of R&D in business enterprises in GDP increased from 1.3% in 1980 to 2% in 1990 for the first time. The ratio remained stagnant for a while but started to increase again in the 2000s, peaking at 2.8% in 2008. After 2008 it was sluggish, but it has been vigorous recently and was recorded 2.7% in 2014 and 2015.

II-4. The long-term behavior of broadly defined investment

Given the above, M&A to improve a company's availability and technical capabilities by merging target companies and R&D, which is a kind of soft investment, are the same be-

[6] Research in Survey of Research and Development means to put in creative effort and inquiry to obtain new knowledge about things, functions, phenomena, etc. or to develop application of existing knowledge. Research in business enterprises additionally includes actions to improve technologically and development of products and production, the process of manufacturing.

[7] R&D including non-profit institutions, public organizations, universities and colleges was 18.9 trillion yen in the 2015 fiscal year.

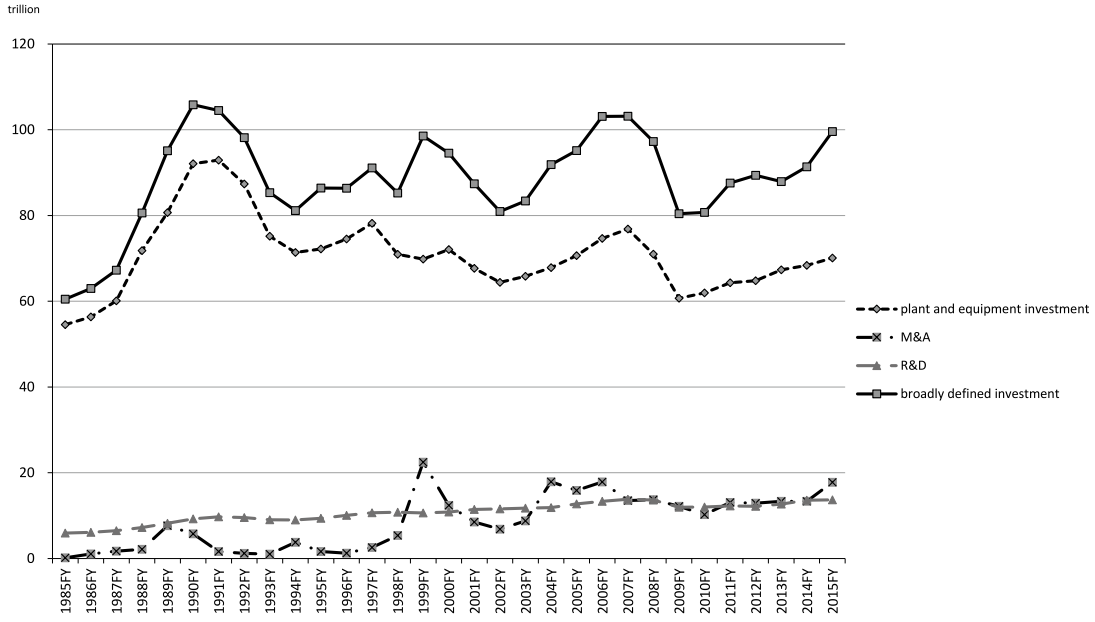
havior as plant and equipment investment, for which a company accumulates tangible fixed assets. Figure 5 shows the long-term behavior of three kinds of investments from 1985 to 2015.

According to Figure 5, while plant and equipment investment peaked during the economic bubble and has been sluggish since the bubble burst, M&A and R&D have been increasing the entire time. Broadly defined investment, which includes three kinds of investments,[8] peaked at 107.1 trillion yen in the 1990 fiscal year (during the economic bubble). Plant and equipment investment also peaked during the same time. However, broadly defined investment has been keeping a constant level, whereas plant and equipment investment has continued to grow and was recorded at 105.8 trillion yen in 2006. Though it was sluggish during Lehman Brothers Crisis, plant and equipment investment recovered and reached 101.6 trillion yen in 2015, close to peak levels in 2006.

Figure 6 shows the long-term behavior of component ratio of three kinds of investment as band chart. According to Figure 6, plant and equipment investment accounted about 90% in 1985, and it gradually decreased its share. Plant and equipment investment went below 80% after 1999 and accounted for only 69% in 2015 (compared 17.5% for M&A and 13.5% for R&D in 2015).

Japanese companies recently have been subduing plant and equipment investment; how-

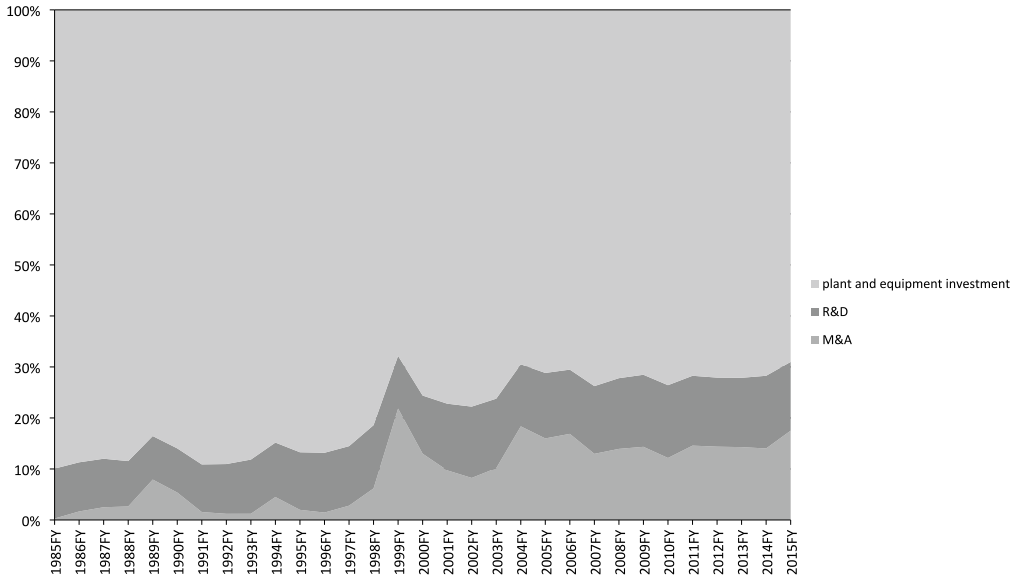
Figure 5. Long-term behavior of broadly defined investment



(Sources) GDP statistic, THOMSON REUTERS, Survey of Research and Development

[8] To be exact, R&D includes purchase costs of tangible goods, which account for around 10% of R&D. Purchase costs for tangible goods is double in plant and equipment investment than R&D. According to Survey of Research and Development, purchase costs of tangible goods accounted for 7.9% in 2015 fiscal year.

Figure 6. Long-term behavior of component ratio of broadly defined investment



(Sources) GDP statistic, THOMSON REUTERS, Surevey of Research and Development

ever, they are still supportive of M&A and R&D investment. Given the above, in the rest of paper we examine three questions as follow: How is broadly defined investment determined? Are those determinants changing chronologically? What is the different behavior between companies with financial surpluses and companies with financial deficits?

III. Plant and equipment investment and the availability of funds

III-1. Internal financing constraints in financing plant and equipment investment

Modigliani and Miller (1958) suppose a perfect financial capital market without any financing constrains. Investment is independent from capital structure in a perfect financial market. However, once information imperfection and asymmetry are brought into a perfect financial market, its completeness is lost and the character of the financial market dramatically changes. When there is information asymmetry between the principal, which is an outside investor, and the agent, which is the management of companies (as they cannot foresee their future), outside funds are more expensive than internal funds (cash flow) by agency cost, which is from moral hazard behavior of management. Thus, the investment level is different between companies with cash flow surpluses and those with cash flow deficits because the level of cash flow can affect investment.

Fazzari, Hubbard and Petersen (in what follows FHP) (1988) was the first study to for-

mulate internal financing constraints and analyze the relationship between plant and equipment investment and internal financing constrains. They embraced a financing hierarchy in which a company should finance plant and equipment investment using cheap sources. Since the cost to finance investment is different for each source, they found that the level of cash flow whose cost was cheapest affected investment.

They classified manufacturers, which grow sales according to attributes about their dividends, into three groups over a decade. The first group constitutes manufacturers whose dividend ratio is below 10%. The second group constitutes manufacturers whose dividend ratio is between 10% and 20%. The third group constitutes other manufacturers. They believed that manufacturers whose dividend ratio is low would like to save internal fund as much as possible since they need expensive outside funds to finance plant and equipment investment.

FHP (1988) estimated plant and equipment investment functions, including Tobin's q and cash flow, for each group and discovered that the coefficient of cash flow in the first group was highest among three groups and that the cash flow in the second and third groups was gradually getting lower. They interpreted the results as follows: plant and equipment investment by manufacturers that had exhausted internal funds (whose cost was cheaper than outside funds) and with a relatively low dividend ratio was more sensitive to the fraction of internal funds because their investment was restricted by internal funds. Conversely, investment by manufacturers whose internal funds was ample and whose dividend ratio was relatively high was less sensitive.[9]

Hoshi, Kashyap and Scharfstein (1991) studied the theory of internal financing constraints using data from Japanese companies. They classified Japanese companies as companies belonging to Keiretsu as well as some other companies, and they argued that the sensitivity of investment to cash flow in companies belong to Keiretsu was low compared to other companies. They interpreted these results as meaning that the plant and equipment investment of companies belonging to Keiretsu was not restricted much by the level of liquidity or internal funds because they can easily finance investment through Keiretsu Bank. Their analysis indicated quantitatively that the Japanese-styled finance system, which meant Keiretsu and the main-bank system, was effective for promoting investment. Moreover, the Japanese-styled finance system had advantages regarding economic development using corporate governance and corporate finance compared to the American-styled finance system, which was not popular in Keiretsu and the main-bank system.

Hanazaki and Thuy (2003) empirically analyzed whether or not investment behavior of Japanese companies indicated Japanese original behavior, and they empirically analyzed internal financial constraints too. They estimated the plant and equipment investment function with panel data based on financial information[10] and using cross-national research in Japan, America and France. They estimated the plant and equipment investment function in three countries and found the difference in investment behavior among three countries by compar-

[9] FHP (1988) also estimated the model including rug of cash flow and Tobin's q, the model included sales, and the model included capital cost after tax as robustness analyses and indicated same results about the coefficient of cash flow.

ing each parameter.

The basic type of plant and equipment investment function is as follows:

$I/K = F\ (ROFA,\ R,\ CF/K,\ DEBT)$

I：plant and equipment investment
$ROFA$：rate of capital return
R：cost of capital
CF：cash flow
$DEBT$：debt ratio
K：stock of capital

According to Hanazaki and Thuy (2003), the results for internal financing constrains were as follows: all parameters of cash flow in the three countries significantly showed positive values, as the theory suggested. They interpreted the results as meaning that companies in the three countries gave priority to internal funds when making investment decisions.

Since the absolute figure (around 0.7) of parameter of cash flow in Japanese companies was higher than the figure for American (0.2) and French (0.1) companies, internal financing constraints in financing plant and equipment investment in Japan is more severe than those in the U.S. or France. This result is different from what Hoshi, Kashyap and Scharfstein (1991) asserted about the Japanese-styled financial system, Keiretsu, and the main-bank system. They argued that the relaxing capability for internal financing constraints in the Japanese-styled financial system has not been necessarily working as well as the financial systems in Europe and America.

III-2. Criticism against the FHP model

In direct opposition, Kaplan and Zingales (in what follows KZ) (1997) criticized the assertion of FHP (1988) that the high sensitivity of investment to the fraction of internal funds corresponded to the degree of internal financing constraints in financing plant and equipment investment. They classified companies in FHP (1988) into five groups according to the degree to which the companies faced internal financing constraints in financing investment. For classification, they used information released by complying with the S-K regulation that set disclosure rules about non-financial information by SEC and financial information on dividends and cash, unused credit lines, leverage, etc.

KZ (1997) estimated the same investment function as FHP (1988) for each group and derived the coefficient of cash flow. The coefficient of cash flow for the group that did not face internal financing constraints was the highest among all groups, while the coefficient of cash flow for that group that faced internal financing constraints was the lowest. This result completely debunked the theory by FHP (1988) that the sensitivity of investment to internal funds corresponded to the degree of internal financing constraints.

[10] To be precise, Japanese companies' data was from Industrial Financial Data released by Development Bank of Japan, American companies' data was from COMPUSTAT database released by S&P Inc., and French companies' data was from Groupe DAFSA Inc.

FHP (2000) made a countercharge against KZ (1997). FHP (2000) asserted that their approach in FHP (1988) had still been working because management statements complying with the S-K regulation did not necessarily show exact information about internal financing constraints. Furthermore, FHP (2000) suggested that samples in KZ (1997) were very homogeneous and that their grouping of variables by cash balance and leverage was inadequate.

Following this, KZ (2000) made a further countercharge against FHP (2000). The controversy between FHP and KZ indicated that while they agreed that the coefficient of their cash flow was low even though distressed companies suffered from internal financing constraints, they disagreed to three perspectives as follows:

The first perspective involves whether the coefficient of cash flow shows the degree of financing constraints related to outside financing. According to FHP, the absolute figure of coefficient of cash flow enables estimation of the degree of internal financing constraints in financing plant and equipment investment because there is monotonicity between the degree of difficulty in financing constraints related to outside financing and the sensitivity of cash flow to investment. On the other hand, according to KZ, there is non-monotonicity between the degree of financing constraints and the sensitivity of cash flow to investment. The degree of financing constraints is instead dependent on the cost of internal funds, and the additional cost of outside funds compared to internal funds impacts the magnitude of the coefficient of cash flow such that it cannot be used to estimate the degree of financing constraints.

The second perspective involves whether management statements focused on by KZ are useful for judging the degree of financing constraints. FHP assert that we cannot judge the degree of financing constraints in qualitative analysis with management statements because management statements related to financing plant and equipment investment only indicate the amendment to and cancellation of investment plans. On the other hand, according to KZ, management statements can confirm whether their holding cash is preemptive motive, and therefore qualitative analysis with management statements enables judgement of the degree of financing constraints.

The third perspective involves the methods of empirical analysis. According to FHP, KZ's empirical analysis would not precisely analyze the relationship between the degree of financing constraints and the sensitivity of cash flow to plant and equipment investment because their sample is very homogeneous. KZ's empirical analysis also has a problem in classifying distressed companies as companies which suffer from financing constraints despite the fact that the sensitivity of cash flow to investment in distressed companies is low.[11]

[11] Similarly, in Hori, Saito and Ando (2006), which analyzed Japanese companies, it was inadequate to interpret the results as financing constrains related to outside financing even though the coefficient of cash flow, which was one of explanatory variables in plant and equipment investment function, was often significantly positive. The reason why it was inadequate to do so was that the results in the subgroup that suffered from financing constraints related to outside financing showed reverse results against the hypothesis of financing constraints. Likewise, the sensitivity of cash flow in method of instrumental variables was lower than one in the fixed-effect and random-effect models.

IV. Empirical analysis

IV-1. Point of view we examine using empirical analysis

In this chapter, we empirically analyze the financial information of companies. We estimate both the plant and equipment investment function as well as the broadly defined investment function and compare the differences in the results of the two functions.

Given the above, we examine the validity of two hypotheses that seek to explain why investment by Japanese companies has been sluggish since economic bubble burst. The first hypothesis is that Japanese companies have avoided taking excessive risks and have preferred retaining internal funds and preserving cash to making an investment. In other words, this means that "Enjoying the Quiet Life" referred to by Bertrand and Mullainathan (2003) has prevailed in Japanese companies. The second hypothesis is that broadly defined investment, including M&A and R&D as well as plant and equipment investment, is not necessarily restricted because M&A and R&A have been increasing even though plant and equipment investment is restricted. According to the second hypothesis, Japanese companies have rationally decided on a broadly defined investment level using rate of capital return and carried it out.

We focus on four specific points of view in empirical analysis. First, we examine similarities and differences between the determinants of plant and equipment investment and those of broadly defined investment. Second, we estimate the sensitivity of liquidity in hand (cash and short-term investment securities) to investment as a variable of the stock of internal funds as well as cash flow as a variable of flow of internal funds. Third, we examine the features of each period and the determinants of slump of investment during the Lehman Brothers Crisis by estimating the periods before, during, and after the Lehman Brothers Crisis using an investment function. Fourth, we discern companies which hold enough internal funds from companies which need outside finances because they do not hold enough internal funds to finance investment. We estimate these subsamples in the investment function and compare the differences in the results.

Finally, we multilaterally estimate determinants of corporate investment behavior on the basis of empirical analysis and comprehensively examine the validity of two hypotheses: that companies are too safety-oriented and that companies have made a shift from plant and equipment investment to broadly defined investment.

IV-2. Theoretical specification

We estimate both the plant and equipment investment function and the broadly defined investment function with panel data in this paper.

The theory of plant and equipment investment started from the acceleration principle and advanced step by step (adjusted capital stock styled ⇒ neoclassical styled ⇒ Tobin's q

styled). We employ a t-bin q-styled model that includes liquid and financial factors. Tobin's q theory represents the ratio of valuation in equity market to book value of capital combined with the concept of adjustment cost in investment, so that Tobin's q advanced investment theory includes a microeconomic basis. We develop the expression for Tobin's q by modeling optimization of a company's investment behavior.[12]

Companies output goods under a simplified production function:

$$Y = F\ (K,\ L) \tag{1}$$

Y, K, and L represent output, capital stock and labor.

If the price of output and capital goods is p, the rate of wage is w, the interest rate is r, the depreciation ratio is δ and the expected inflation rate is π,

The earnings of companies, Π, is represented as follows:

$$\Pi = pF\ (K,\ L) - wL - (r + \delta - \pi)\ pK \tag{2}$$

$(r + \delta - \pi)$ equals capital cost in equation (2). The first-order condition of equation (2), in the case that labor is maximized under a given capital stock, is as follows:

$$\partial \Pi / \partial L = pF_L\ (K,\ L) - w = 0$$
$$\therefore F_L(K,\ L) = w/p \tag{3}$$

When capital stock cannot be adjusted instantly by adjustment cost, the problem that accumulates capital overtime is represented as follows:

$$dK/dt \equiv I = I(\ (F_K - (r + \delta - \pi))\ /\ (r - \pi)\ ) \tag{4}$$

Equation (4) means represents plant and equipment investment as accumulation of finite capital to bridge the gap between the marginal productivity of capital (F_K) and the cost of capital. Equation (4) can be transformed as follows:

$$I = I\ (q - 1),\quad I' > 0 \tag{5}$$

q is defined as follows:

$$q = \frac{F_K - (r + \delta - \pi)}{r - \pi} + 1$$
$$\fallingdotseq \frac{F_K}{r + \delta - \pi} \tag{6}$$

Given the above, q is approximated by the ratio of marginal productivity of capital to the cost of capital. The optimal investment volume is determined at the point where the marginal cost of investment calculated by convex adjustment cost function equals Tobin's q. Although q is affected by the taxation and depreciation system, we ignore those factors for simplicity.

We apply a basic investment function given the above to broadly defined investment as well as to plant and equipment investment, and we formulate the model in this paper as follows:

[12] The development the expression for Tobin's q is based on Sargent (1987) as a facile model.

$$I/K = F\ (ROFA, R, CF/K, CASH/TA, DEBT, YD) \quad (7)$$

or

$$BI/K = F(ROFA, R, CF/K, CASH/TA, DEBT, YD) \quad (8)$$

I：plant and equipment investment
BI：broadly defined investment
（plant and equipment investment + M&A + R&D）
ROFA：rate of capital return（operating profits/average fixed assets）
R：cost of capital（interest and discount expense/average interest-bearing debt）
CF：cash flow
（profit after tax + depreciation expense − dividend − share repurchase）
CASH：cash and deposits or cash and deposits and short-term investment securities
DEBT：debt to total assets ratio
K：average fixed asset
TA：total assets
YD：year dummy during World Financial Crisis（2008 and 2009 fiscal years）

Variables in equation (7) and (8) equation are defined as follows: rate of capital return and the cost of capital are proxy variables for the marginal productivity of capital and the capital cost composed of Tobin's q, respectively. Cash flow and liquidity in hand (cash and deposits or cash and deposits and short-term investment securities) are proxy variables that indicate the problem of internal financing constraints in an imperfect financial market. The debt to total assets ratio can attest for several hypotheses. The first hypothesis is related to credit risk. Stockholders have two risks: business risk and financial risk. The debt to total assets ratio is proxy variable for the latter. Companies whose debt to total assets ratio is high have a lot of difficulties in outside financing qualitatively and quantitatively, and there is a high possibility that they face internal financing constraints in financing investment.

The second hypothesis is related to the debt-overhang problem.[13] Companies whose debt to total assets ratio is too high cannot make an investment because they must give a priority to repayment of debt instead of investment, even if they can get positive net present value from a new project. As companies whose debt to total assets ratio is high often face debt-overhang problem, it will give their investment adverse effects based on this point of view.

The third hypothesis is related to the free cash flow hypothesis.[14] This hypothesis indicates the mechanism about management discipline given by a debt contract. It is not until management of companies whose free cash flow is ample is monitored by a creditor that its management can be efficient. As efficient management promotes investment, companies whose debt to total assets ratio is high will make a high investment level by discipline given by debt.

[13] We referred to Myers (1997) and Myers and Majluf (1984).
[14] We referred to Jensen (1986, 1989).

Given this, regarding the relationship between debt and investment, there are several alternative hypotheses. While the sign condition of parameter of debt to total assets ratio should be negative because of the first and second hypothesis, one parameter should be positive because of the third hypothesis. We expect the results to indicate which hypothesis is supported.

IV-3. Statistical specification and data

According to equations (7) and (8), we estimate the models as follows:

$$I_{it}/K_{it} = a + b\times ROFA_{it-1} + c\times R_{it-1} + d\times (CF_{it}/K_{it}) + e\times CASH_{it-1}/TA_{it-1} + f\times DEBT_{it-1} + YD_t + u_{it} \quad (9)$$

$$BI_{it}/K_{it} = a + b\times ROFA_{it-1} + c\times R_{it-1} + d\times (CF_{it}/K_{it}) + e\times CASH_{it-1}/TA_{it-1} + f\times DEBT_{it-1} + YD_t + u_{it} \quad (10)$$

The subscript $_t$ represents the chronological factor and subscript $_i$ represents the cross-section factor.

We employ a fixed-effect and random-effect model and select the more appropriate model according to the results of a Hausman-test.

The validation panel data is calculated as follows. Plant and equipment data is calculated according to current increment in tangible fix asset pluses current depreciation expense in consolidated financial information and deducts current increment related to M&A in tangible asset. Regarding M&A, it is calculated according to current increment of shares in affiliates in non-consolidated financial information.[15] Regarding R&D, we employ R&D data in notes to consolidated financial statements. Broadly defined investment is calculated by totaling plant and equipment investment for M&A and R&D.

We get and process financial information from Industrial Financial Data released by Development Bank of Japan. The horizon to analyze is from the 2002 to 2014 fiscal years, which is in total 13 years. 2002 is the year when economic expansion started for the first time in the 21st century. There are 939 companies to analyze, which belong to general purpose, production & business oriented machinery, electric & electronic products, transportation equipment, textiles, chemicals & related products and metal & related products, as listed at all stock exchange markets in Japan.[16]

[15] The shares in affiliates in non-consolidated financial sectors consists of the shares in subsidiary, which is mainly controlled substantively by holding 50% over in voting shares, and of the shares in affiliates, which is mainly influenced seriously by holding 20% over in voting shares. We employ the data from non-consolidated financial information because we cannot check it for consolidated financial information.

[16] Coverage in industry segments to analyze accounts around 90% in Export Price Index released by the Bank of Japan. According to Survey on Planned Capital Spending released by industrial research department in the Development Bank of Japan (2015), these industry segments accounted around 25.4% in domestic plant and equipment investment of all Japanese companies and accounted for around 47.6% in overseas plant and equipment investment of all Japanese companies in the 2014 fiscal year. According to the Survey of Research and Development released by Ministry of Internal Affairs and Communications, these industry segments, which excluded textiles, metal, and related products, accounted for around 52.7% in R&D of all Japanese companies in the 2014 fiscal year.

Table 1. Descriptive statistics

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.1028	0.1830	0.0671	0.0130	0.1215	0.0288	0.1299	0.1231	0.1360	0.5219
Mean	0.0839	0.1536	0.0457	0.0000	0.1013	0.0210	0.1249	0.1073	0.1186	0.5294
Standard Deviation	0.0813	0.1327	0.0748	0.0541	0.1322	0.0247	0.1249	0.0795	0.0883	0.1804
Minimum	0.0000	0.0000	0.0000	-0.4340	-0.7027	0.0010	-2.5828	0.0002	0.0002	0.0638
p25	0.0475	0.0924	0.0178	0.0000	0.0493	0.0150	0.0777	0.0638	0.0694	0.3902
p75	0.1357	0.2380	0.0887	0.0132	0.1716	0.0332	0.1786	0.1652	0.1848	0.6531
Maximum	1.0747	1.6828	1.0188	0.9977	0.9994	0.1955	2.2373	0.7204	0.7224	1.2502
Number of Observations	8179	8179	8179	8179	8179	8179	8179	8179	8179	8179

(Note) plant and equipment investment,broadly defined investment,R&D,M&A and CF are deflated by the average fixed assets, cash and deposits, and short term investment securities are deflated by total assets.

Table 2. Correlation matrix

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
plant and equipmant investment	1.0000									
broadly defined investment	0.7284	1.0000								
R&D	0.1235	0.6353	1.0000							
M&A	0.1115	0.4698	-0.0082	1.0000						
rate of capital return	0.2470	0.2660	0.1660	0.0540	1.0000					
cost of capital	0.0030	0.0870	0.1378	0.0176	0.1267	1.0000				
cash flow	0.2923	0.2461	0.0889	0.0433	0.4354	0.0466	1.0000			
cash and deposits	0.0653	0.1405	0.1547	0.0336	0.2205	0.1510	0.1204	1.0000		
cash and deposits and short-term investment securities	0.0501	0.1610	0.2025	0.0417	0.2450	0.1539	0.1072	0.9161	1.0000	
debt to total assets ratio	-0.0515	-0.0841	-0.0709	-0.0303	-0.2736	-0.0597	-0.0862	-0.3556	-0.4400	1.0000

(Note) plant and equipment investment,broadly defined investment, R&D, M&A and CF are deflated by the average fixed assets, cash and deposits, and short term investment securities are deflated by total assets.

Descriptive statistics and the correlation matrix of each variable to analyze are represented in Tables 1 and 2.

IV-4. Estimation results

Table 3 represents the estimation results as a function of plant and equipment investment, M&A, R&D, and broadly defined investment, which composes of plant and equipment investment, M&A, and R&D. According to Table 3, the coefficients of rate of capital return and cost of capital, which are components of Tobin's q, show significantly positive and negative values in plant and equipment investment and broadly defined investment function, respectively, as the theory supposed. First, in M&A and R&D the coefficients of rate of capital return are significantly positive as expected, those of cost of capital are not significantly negative. Second, the coefficients of cash flow and two kinds of liquidity in hand are significantly positive in most models, which can be interpreted as meaning that companies face internal financing constraints in financing investment. However, we must examine this interpretation cautiously given aforementioned dispute between FHP and KZ.

Table 3. Estimation results of investment functions

(1) Fixed-effct

Dependent variable / explanatory variable	plant and equipment investment		M&A		R&D		broadly defined investment	
rate of capital return(-1)	0.1548***	0.1548***	0.0167***	0.0165***	0.0212***	0.0207***	0.1932***	0.1925***
	(19.93)	(19.94)	(2.64)	(2.60)	(7.39)	(7.23)	(18.05)	(18.02)
cost of capital(-1)	−0.1365***	−0.1394***	0.0329	0.0311	−0.0154	−0.0153	−0.1226**	−0.1273**
	(-3.03)	(-3.09)	(0.89)	(0.84)	(-0.93)	(-0.92)	(-1.97)	(-2.05)
cash flow	0.0342***	0.0353***	0.0135**	0.0140**	0.0078***	0.0075***	0.0568***	0.0581***
	(4.54)	(4.69)	(2.19)	(2.29)	(2.82)	(2.69)	(5.46)	(5.61)
cash and deposits(-1)	0.1024***	-	0.0713***	-	0.0098	-	0.1858***	-
	(5.67)	-	(4.83)	-	(1.47)	-	(7.46)	-
cash and deposits and short term investment securities(-1)	-	0.0986***	-	0.0807***	-	0.0360***	-	0.2166***
	-	(5.82)	-	(5.84)	-	(5.77)	-	(9.29)
debt to total assets ratio(-1)	−0.0855***	−0.0822***	−0.0558***	−0.0518***	−0.0096**	−0.0056	−0.1509***	−0.1397***
	(-7.64)	(-7.28)	(-6.11)	(-5.63)	(-2.33)	(-1.34)	(-9.79)	(-9.00)
YD(2008 & 2009)	−0.0145***	−0.0146***	−0.0060***	−0.0059***	0.0012	0.0015*	−0.0193***	−0.0190***
	(-6.49)	(-6.51)	(-3.28)	(-3.23)	(1.47)	(1.79)	(-6.26)	(-6.17)
constant	0.1117***	0.1148***	0.0294***	0.0251***	0.0676***	0.0619***	0.2141***	0.2017***
	(16.25)	(16.22)	(5.22)	(4.35)	(26.53)	(23.75)	(22.49)	(20.71)
R^2	0.0522	0.0500	0.0028	0.0031	0.0293	0.0485	0.0600	0.0630
Number of Observations	8179	8179	8179	8179	8179	8179	8179	8179

(2) Random-effect

Dependent variable / explanatory variable	plant and equipment investment		M&A		R&D		broadly defined investment	
rate of capital return(-1)	0.1393***	0.1396***	0.0153***	0.0149***	0.0226***	0.0220***	0.1959***	0.1950***
	(19.19)	(19.23)	(2.74)	(2.66)	(7.91)	(7.73)	(18.94)	(18.87)
cost of capital(-1)	−0.1542***	−0.1554***	0.0319	0.0303	−0.0110	−0.0110	−0.1109*	−0.1156**
	(-3.87)	(-3.90)	(1.06)	(1.01)	(-0.66)	(-0.67)	(-1.89)	(-1.97)
cash flow	0.0584***	0.0591***	0.0066	0.0069	0.0077***	0.0074***	0.0598***	0.0607***
	(8.12)	(8.23)	(1.18)	(1.23)	(2.79)	(2.67)	(5.91)	(6.01)
cash and deposits(-1)	0.0447***	-	0.0281***	-	0.0126*	-	0.1475***	-
	(3.13)	-	(2.69)	-	(1.92)	-	(6.58)	-
cash and deposits and short term investment securities(-1)	-	0.0293**	-	0.0339***	-	0.0391***	-	0.1729***
	-	(2.19)	-	(3.48)	-	(6.37)	-	(8.26)
debt to total assets ratio(-1)	−0.0227***	−0.0233***	−0.0101**	−0.0075	−0.0094**	−0.0050	−0.0833***	−0.0720***
	(-3.21)	(-3.21)	(-2.03)	(-1.46)	(-2.37)	(-1.24)	(-6.80)	(-5.78)
YD(2008 & 2009)	−0.0114***	−0.0115***	−0.0062***	−0.0061***	0.0013	0.0016*	−0.0175***	−0.0172***
	(-5.10)	(-5.15)	(-3.51)	(-3.45)	(1.63)	(1.95)	(-5.69)	(-5.60)
constant	0.1301***	0.1316***	0.0163***	0.0139***	0.0583***	0.0528***	0.2199**	0.2091***
	(20.23)	(19.97)	(3.69)	(3.06)	(7.68)	(6.95)	(17.28)	(16.22)
R^2	0.1428	0.1426	0.0064	0.0067	0.1697	0.1759	0.1650	0.1668
Number of Observations	8179	8179	8179	8179	8179	8179	8179	8179

(Note1) estimated period: 2002-2014 fiscal years
(Note2) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively.The figures in parentheses are t-values in fixed-effect and z-values in random-effect.
(Note3) plant and equipment investment, broadly defined investment, R&D, M&A and CF are deflated by the average fixed assets, cash and deposits, and short term investment secirities are deflated by total assets.
(Note4) Random-effect model includes industry dummy.
(Note5) Fixed-effect is selected in all models according to results from the Hausman test.

We examine this interpretation in detail by comparison between companies with financial surpluses and companies with financial deficits in Chapter IV-6. Third, the ratio of the coefficients of debt to total assets are significantly negative in most models. This result can be interpreted as meaning that the high debt to total assets ratio is a high risk, according to the hypothesis that investment is restricted by the difficulty in obtaining outside financing. Fourth, the coefficients of YD (2008&2009) are significantly negative in all models except R&D. This means that investment was sluggish during the World Financial Crisis, except for R&D.

Next, we checked the comparison between plant and equipment investment and broadly defined investment and observed three differences between them. First, the R^2 adjusted value for the degrees of freedom in broadly defined investment is higher than in plant and equipment investment in all models. Second, the coefficients of rate of capital return, which

is the most important variables in broadly defined investment, are higher than those in plant and equipment investment in all models. Third, the absolute value of coefficients of cash flow and two kinds of liquidity in hand, which refer to the internal liquid factor and the coefficients of debt to total assets ratio (financial risk in broadly defined investment), are far higher than that in plant and equipment investment in all models.

Given the above, the fact that explanatory power of models in broadly defined investment is higher than that in plant and equipment investment and that the magnitude of most of coefficients of explanatory variables in broadly defined investment are higher than that in plant and equipment investment can be interpreted as meaning that companies give priority to broadly defined investment, including M&A and R&D, as well as plant and equipment investment when making business decisions.

IV-5. Period analysis

We estimate three periods in plant and equipment investment and broadly defined investment in this chapter. The first period is between the 2002-2007 fiscal years, when the Japanese economy expanded. The second period is the 2008 and 2009 fiscal years during the World Financial Crisis and Lehman Brother Crisis. The third period is between the 2010-2014 fiscal years after the World Financial Crisis.

According to Table 4, the coefficients of rate of capital return, which is a component of Tobin's q, are significantly positive during all three periods, while the coefficients of cost of capital are significantly negative in the plant and equipment investment function during the first period and not significant in the other models. Comparing the magnitude of coefficients of rate of capital return on the basis of the results in the fixed-effect model, the coefficients for the first period are similar to those for the third period, whereas the coefficients for the second period are far larger than the other first and third periods.

Additionally, the coefficients of two kinds of liquidity in hand are significantly positive at 1% level during the three periods in the fixed-effect model but are not significant in all random-effect models. The magnitude of coefficients of two kinds of liquidity in hand during second period is larger than those during the first and third periods. The coefficients of cash flow are significantly positive in all models during the first and third periods, while they are not significant in the fixed-effect during the second period. The magnitude of coefficients of cash flow during second period is larger than the coefficients for the first and third periods.

We can sum up the results of the three periods as follows. The results during the first period are similar to those during the third period, while the results during second period are different from those of first and third periods. The sensitivity of most explanatory variables during second period is higher than the corresponding variables during the first and third periods.

As you know, both plant and equipment investment and broadly defined investment during the World Financial Crisis, including the Lehman Brothers Crisis, were more slug-

gish than that before and after it. It is more effective to examine the term by term estimation results with descriptive statistics (Table 5) to find out more background. According to Table 5, the magnitude of cash flow during second period is far less than the magnitude during the first and third periods, while there is little difference in the rate of capital return and two kinds of liquidity in hand among the three periods. Big companies in manufacturing mainly curbed their investment in response to impaired cash flow when their profitability was far lower by weak external demand during the Lehman Brothers Crisis. Additionally, negative

Table 4. Term by term estimation results of investment functuons

The first period: 2002-2007 fiscal years

	Fixed-effect				Random-effect			
Dependent variable / explanatory variable	plant and equipment investment		broadly defined investment		plant and equipment investment		broadly defined investment	
rate of capital return(-1)	0.1456***	0.1461***	0.1841***	0.1842***	0.1381***	0.1406***	0.2147***	0.2163***
	(10.24)	(10.28)	(9.72)	(9.74)	(11.44)	(11.64)	(12.52)	(12.63)
cost of capital(-1)	−0.2253***	−0.2295***	−0.0767	−0.0839	−0.2131***	−0.2174***	−0.0850	−0.0957
	(-3.01)	(-3.06)	(-0.77)	(-0.84)	(-3.67)	(-3.74)	(-0.99)	(-1.11)
cash flow	0.0319**	0.0322**	0.0532***	0.0537***	0.0700***	0.0701***	0.0702***	0.0704***
	(2.56)	(2.58)	(3.21)	(3.24)	(6.24)	(6.25)	(4.49)	(4.50)
cash and deposits(-1)	0.1808***	-	0.3508***	-	0.0570**	-	0.1884***	-
	(5.08)	-	(7.41)	-	(2.50)	-	(5.25)	-
cash and deposits and short term investment securities(-1)	-	0.1728***	-	0.3519***	-	0.0238	-	0.1651***
	-	(5.08)	-	(7.77)	-	(1.12)	-	(4.90)
debt to total assets ratio(-1)	−0.1276***	−0.1268***	−0.2485***	−0.2470***	−0.0199*	−0.0222**	−0.0667***	−0.0612***
	(-5.4)	(-5.36)	(-7.89)	(-7.85)	(-1.93)	(-2.10)	(-3.79)	(-3.42)
constant	0.1340***	0.1325***	0.2473***	0.2425***	0.1329***	0.1365***	0.2093***	0.2065***
	(9.55)	(9.39)	(13.24)	(12.92)	(14.92)	(14.92)	(13.37)	(12.94)
R^2	0.0464	0.0411	0.0641	0.0609	0.1668	0.1667	0.1878	0.1870
Number of Observations	3931	3931	3931	3931	3931	3931	3931	3931

(Note1) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively. The figure in parentheses are t-values in fixed-effect and z-values in random-effect.
(Note2) plant and equipment investment,broadly defined investment and CF are deflated by the average fixed assets, cash and deposits, and short term investment secirities are deflated by total assets.
(Note3) Random-effect model includes industry dummy.
(Note4) Fixed-effect is selected in all models according to results from the Hausman test.

The second period: 2008-2009 fiscal years

	Fixed-effect				Random-effect			
Dependent variable / explanatory variable"	plant and equipment investment		broadly defined investment		plant and equipment investment		broadly defined investment	
rate of capital return(-1)	0.2152***	0.2175***	0.2600***	0.2660***	0.0873***	0.0884***	0.1071***	0.1069***
	(7.13)	(7.37)	(6.80)	(7.13)	(6.18)	(6.26)	(4.79)	(4.82)
cost of capital(-1)	−0.0191	0.0622	−0.2843	−0.2453	−0.0034	−0.0025	0.1043	0.1111
	(-0.08)	(0.03)	(-0.95)	(-0.83)	(-0.04)	(-0.03)	(0.68)	(0.73)
cash flow	0.0481	0.0508	0.0635	0.0663	0.0393**	0.0385**	−0.0040	−0.0023
	(1.41)	(1.51)	(1.47)	(1.55)	(2.42)	(2.37)	(-0.16)	(-0.09)
cash and deposits(-1)	0.3571***	-	0.4035***	-	−0.0175	-	0.1317**	-
	(3.57)	-	(3.18)	-	(-0.56)	-	(2.45)	-
cash and deposits and short term investment securities(-1)	-	0.4373***	-	0.5426***	-	−0.0055	-	0.2115***
	-	(4.71)	-	(4.62)	-	(-0.20)	-	(4.4)
debt to total assets ratio(-1)	−0.2519***	−0.2615***	−0.2800***	−0.2951***	−0.011	−0.0093	−0.0567**	−0.0337
	(-3.08)	(-3.24)	(-2.70)	(-2.89)	(-0.81)	(-0.67)	(-2.34)	(-1.36)
constant	0.1504***	0.1391***	0.2428***	0.2252***	0.0902***	0.0882***	0.1597***	0.1374***
	(3.56)	(3.33)	(4.54)	(4.26)	(7.96)	(7.58)	(7.88)	(6.68)
R^2	0.0226	0.0206	0.0365	0.0495	0.0570	0.0567	0.1329	0.1438
Number of Observations	1060	1060	1060	1060	1060	1060	1060	1060

(Note1) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively.The figure in parentheses are t-values in fixed-effect and z-values in random-effect.
(Note2) plant and equipment investment,broadly defined investment and CF are deflated by the average fixed assets, cash and deposits, and short term investment secirities are deflated by total assets.
(Note3) Random-effect model includes industry dummy.
(Note4) Fixed-effect is selected in all models according to results from the Hausman test.

The third period: 2010-2014 fiscal years

	Fixed-effect				Random-effect			
Dependent variable / explanatory variable"	plant and equipment investment		broadly defined investment		plant and equipment investment		broadly defined investment	
rate of capital return(-1)	0.1332***	0.1315***	0.1711***	0.1649***	0.1468***	0.1474***	0.2337***	0.2294***
	(8.63)	(8.53)	(7.85)	(7.61)	(11.75)	(11.79)	(12.37)	(12.27)
cost of capital(-1)	0.1162	0.1168	0.0761	0.0768	−0.0263	−0.0236	0.005	−0.0056
	(1.12)	(1.13)	(0.52)	(0.53)	(-0.36)	(-0.32)	(0.04)	(-0.05)
cash flow	0.0359**	0.0368**	0.0548***	0.0571***	0.0625***	0.0626***	0.0614***	0.0619***
	(2.50)	(2.56)	(2.71)	(2.83)	(5.07)	(5.08)	(3.36)	(3.39)
cash and deposits(-1)	0.1308***	-	0.2209***	-	0.0153	-	0.0736*	-
	(3.21)	-	(3.84)	-	(0.67)	-	(1.95)	-
cash and deposits and short term investment securities(-1)	-	0.1593***	-	0.3358***	-	0.0036	-	0.1376***
	-	(4.11)	-	(6.16)	-	(0.17)	-	(3.88)
debt to total assets ratio(-1)	−0.1686***	−0.1657***	−0.3189***	−0.3094***	−0.0074	−0.009	−0.026	−0.0108
	(-5.57)	(-5.48)	(-7.46)	(-7.27)	(-0.65)	(-0.78)	(-1.33)	(-0.54)
constant	0.1509***	0.1432***	0.2891***	0.2637***	0.1288***	0.1310***	0.2013***	0.1834***
	(8.82)	(8.30)	(11.97)	(10.87)	(13.05)	(12.37)	(11.85)	(12.37)
R^2	0.0191	0.0169	0.0193	0.0227	0.1595	0.1599	0.1876	0.1890
Number of Observations	3188	3188	3188	3188	3188	3188	3188	3188

(Note1) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively. The figure in parentheses are t-values in fixed-effect and z-values in random-effect.
(Note2) plant and equipment investment,broadly defined investment and CF are deflated by the average fixed assets, cash and deposits, and short term investment secirities are deflated by total assets.
(Note3) Random-effect model includes industry dummy.
(Note4) Fixed-effect is selected in all models according to results from the Hausman test.

Table 5. Term by term Descriptive statistics

The first period: 2002-2007 fiscal years

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.1011	0.1799	0.0661	0.0125	0.1265	0.0296	0.1321	0.1122	0.1235	0.5423
Mean	0.0812	0.1471	0.0446	0.0002	0.1031	0.0215	0.1242	0.0959	0.1053	0.5524
Standard Deviation	0.0842	0.1367	0.0758	0.0537	0.1308	0.0256	0.1282	0.0750	0.0837	0.1802
Minimum	0.0000	0.0000	0.0000	-0.2823	-0.5069	0.0010	-2.5828	0.0002	0.0002	0.0638
Maximum	1.0747	1.4310	1.0188	0.9977	0.9994	0.1942	2.2373	0.7204	0.7224	1.2502
Number of Observations	3931	3931	3931	3931	3931	3931	3931	3931	3931	3931

The second period: 2008-2009 fiscal years

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.0928	0.1742	0.0738	0.0077	0.1258	0.0326	0.0787	0.1146	0.1276	0.5116
Mean	0.0783	0.1447	0.0518	0.0000	0.1018	0.0242	0.0929	0.1001	0.1111	0.5220
Standard Deviation	0.0676	0.1160	0.0804	0.0479	0.1609	0.0256	0.1324	0.0756	0.0855	0.1774
Minimum	0.0002	0.0045	0.0000	-0.2418	-0.7027	0.0012	-0.7461	0.0008	0.0008	0.0784
Maximum	0.6359	0.8035	0.7188	0.5334	0.9689	0.1880	1.0051	0.4753	0.5914	0.9537
Number of Observations	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060

The third period: 2010-2014 fiscal years

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.1082	0.1898	0.0661	0.0154	0.1138	0.0266	0.1442	0.1394	0.1542	0.5002
Mean	0.0904	0.1636	0.0454	0.0000	0.0983	0.0194	0.1360	0.1238	0.1407	0.5031
Standard Deviation	0.0813	0.1328	0.0714	0.0563	0.1225	0.0230	0.1133	0.0835	0.0917	0.1790
Minimum	0.0007	0.0013	0.0000	-0.4340	-0.6227	0.0011	-0.9941	0.0013	0.0013	0.0709
Maximum	0.7264	1.6828	0.7447	0.8821	0.9497	0.1955	2.0294	0.5331	0.6174	1.2327
Number of Observations	3188	3188	3188	3188	3188	3188	3188	3188	3188	3188

(Note) plant and equipment investment, broadly defined investment, R&D, M&A and CF are deflated by the average fixed assets, cash and deposits, and short term investment securities are deflated by total assets.

factors that explanatory variables in models cannot explain, including a psychological factor of future uncertainty due to the World Financial Crisis, would simultaneously affect investment because year dummies during the second period are significantly negative, according to Table 3.

IV-6. Comparing companies with financial surpluses to those with financial deficits

Plant and equipment investment is predominantly affected by real factors, as Tobin's q theory indicates. We apply this theory to broadly defined investment in this paper. However, investment is also affected by liquid factors, including internal financing constraints and the cost differences for capital in financial investment. Thus, we adopted the concept that information incompleteness and asymmetry are present in the real world.

Given the above, the estimation results indicate that cash flow and two kinds of liquidity in hand affect broadly defined investment as well as plant and equipment investment, with statistical significance. However, these results do not necessarily indicate that investment is restricted by internal financing constraints related to difficulties with outside financing, according to the disputes between FHP and KZ referred to in Chapter III.

To solve the issue regarding availability of funds, we draw companies with financial surpluses and companies with financial deficits from all samples and estimate their investment functions individually. We then examine the problem of availability of funds using our results. Needless to say, deciding how to draw companies with financial surpluses and companies with financial deficits from all samples is very important. We classify companies with financial surpluses and companies with financial deficits according to the following conditions:

Company with financial surpluses: cash flow $>$ broadly defined investment, cash and deposits $>$ broadly defined investment

Company with financial deficits: cash flow $<$ broadly defined investment and cash and deposits $<$ broadly defined investment

As you know, a company with a financial surplus can make a broadly defined investment within cash flow or cash and deposits without the difficulty related to outside financing, whereas a company with financial deficits needs outside finances, even if it makes good use of cash flow or cash and deposits, because it is short of internal funds to finance investment.

The number of companies with a financial surplus is 2,526 (30.9% of all samples) and the number of companies with a financial deficit is 2,196 (26.9% of all samples). Table 6 represents the results of a t-test between companies with a financial surplus and companies with a financial deficit. The results indicate that the investment ratio in plant and equipment investment and broadly defined investment of companies with a financial deficit is higher than for companies with a financial surplus. This is also true for M&A and R&D, which are

Table 6. Descriptive statistics in companies with financial surpluses and companies with financail deficits

1. companies with financial surpluses

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.0667	0.1034	0.0364	0.0004	0.1368	0.0294	0.1739	0.1443	0.1552	0.5155
Mean	0.0560	0.0873	0.0245	0.0000	0.1089	0.0213	0.1499	0.1281	0.1388	0.5188
Standard Deviation	0.0503	0.0719	0.0441	0.0258	0.1462	0.0258	0.1185	0.0813	0.0890	0.1913
Minimum	0.0000	0.0000	0.0000	-0.4340	-0.4009	0.0011	0.0154	0.0133	0.0133	0.0638
Maximum	0.5364	0.6129	0.4792	0.2604	0.9994	0.1944	2.0294	0.6908	0.6978	1.2327
Number of Observations	2526	2526	2526	2526	2526	2526	2526	2526	2526	2526

2. companies with financial deficits

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
Average	0.1542	0.2748	0.0874	0.0329	0.1143	0.0261	0.1275	0.0701	0.0850	0.5509
Mean	0.1342	0.2392	0.0634	0.0065	0.1002	0.0196	0.1296	0.0623	0.0711	0.5633
Standard Deviation	0.1008	0.1541	0.0855	0.0850	0.1032	0.0221	0.0974	0.0420	0.0582	0.1586
Minimum	0.0021	0.0304	0.0000	-0.2823	-0.5043	0.0012	-0.8811	0.0008	0.0008	0.0954
Maximum	1.0747	1.6828	1.0188	0.9977	0.8974	0.1883	0.6012	0.4364	0.5914	1.1322
Number of Observations	2196	2196	2196	2196	2196	2196	2196	2196	2196	2196

3. Comparison of averages

	plant and equipmant investment	broadly defined investment	R&D	M&A	rate of capital return	cost of capital	cash flow	cash and deposits	cash and deposits and short-term investment securities	debt to total assets ratio
t-test	***	***	***	***	***	***	***	***	***	***

(Note) plant and equipment investment, broadly defined investment, R&D, M&A and CF are deflated by the average fixed assets, cash and deposits, and short term investment securities are deflated by total assets.
(Note2) The average is compared between companies with financial surpluses and companies with financail deficits by Welch's t-test. *** indicates statistical significance at 1% level.
(Note3) The condition of companies with financial surpluses each fiscal year is that cash flow ＞ broadly defined investment and cash and deposits at the end of the previous fiscal year ＞ broadly defined investment.
(Note4) The condition of companies with financial deficits each fiscal year is that cash flow ＜ broadly defined investment and cash and deposits at the end of the previous fiscal year ＜ broadly defined investment.

components of broadly defined investment. With regard to the ratio of cash flow and the two kinds of liquidity in hand, companies with a financial surplus exceed companies with a financial deficit. Additionally, regarding the rate of capital return and cost of capital, companies with a financial surplus exceed companies with a financial deficit. With regard to debt to total assets ratio, companies with a financial deficit exceed companies with a financial surplus. All of the above trends demonstrate strong statistical significance. Given these results, companies with a financial deficit appear relatively willing to make an investment even though they do not have enough cash flow and cash and deposits, while companies with a financial surplus are cautious about making an investment even though they have enough cash flow and cash and deposits.

Table 7 represents the estimation results for the plant and equipment investment function and the broadly defined investment function of companies with a financial surplus and of companies with a financial deficit. The level of R^2, or the explanatory power of the model in Table 7, is higher than the R^2 in Table 3 (estimation results of all samples) in all models. Comparing the results of companies with a financial surplus to companies with a financial deficit, the coefficients of rate of capital return show statistically significant positive values

Table 7. Estimation results of investment functuons in companies with financial surpluses and companies with financail deficits

1. companies with financial surpluses

	Fixed-effect				Random-effect			
Dependent variable / explanatory variable	plant and equipment investment		broadly defined investment		plant and equipment investment		broadly defined investment	
rate of capital return(-1)	0.0834***	0.0842***	0.0771***	0.0785***	0.0614***	0.0619***	0.0831***	0.0840***
	(11.26)	(11.38)	(9.14)	(9.29)	(9.41)	(9.49)	(10.81)	(10.92)
cost of capital(-1)	−0.0910*	−0.0910*	−0.0633	−0.0633	−0.0676*	−0.0715*	−0.0198	−0.0288
	(-1.89)	(-1.89)	(-1.15)	(-1.15)	(-1.84)	(-1.94)	(-0.45)	(-0.65)
cash flow	0.1310***	0.1314***	0.1966***	0.1976***	0.1552***	0.1569***	0.2617***	0.2632***
	(13.40)	(13.45)	(17.64)	(17.72)	(18.60)	(18.83)	(26.51)	(26.70)
cash and deposits(-1)	0.0878***	-	0.1409***	-	0.0422***	-	0.1186***	-
	(4.67)	-	(6.57)	-	(3.16)	-	(7.34)	-
cash and deposits and short term investment securities(-1)	-	0.0823***	-	0.1289***	-	0.0297**	-	0.1065***
	-	(4.61)	-	(6.32)	-	(2.36)	-	(7.01)
debt to total assets ratio(-1)	−0.0295***	−0.0277**	−0.0307**	−0.0285**	−0.0226***	−0.0231***	−0.0267***	−0.0235***
	(-2.64)	(-2.45)	(-2.42)	(-2.21)	(-3.82)	(-3.79)	(-3.62)	(-3.10)
YD(2008 & 2009)	−0.0104***	−0.0103***	−0.0105***	−0.0103***	−0.0076***	−0.0076***	−0.0067**	−0.0064**
	(-3.39)	(-3.93)	(-3.50)	(-3.44)	(-3.10)	(-3.09)	(-2.34)	(-2.23)
constant	0.0387***	0.0374***	0.0570***	0.0559***	0.0560***	0.0574***	0.0617***	0.0605***
	(5.30)	(5.00)	(6.86)	(6.54)	(9.75)	(9.79)	(8.57)	(8.23)
R^2	0.2923	0.2864	0.4927	0.4907	0.3423	0.3410	0.5401	0.5395
Nunber of Observations	2526	2526	2526	2526	2526	2526	2526	2526

(Note1) estimated period: 2002～2014 fiscal year.
(Note2) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively. The figure in parentheses are t-values in fixed-effect and z-values in Random-effect.
(Note3) plant and equipment investment, broadly defined investment and CF are deflated by the average fixed asset. cash and deposits and short term investment secirities are deflated by total asset.
(Note4) Random-effect model includes industry dummy.
(Note5) Fixed-effect is selected in all model according to results in Hausman test.
(Note6) The condition of companies with financaii surpluses fiscal year is that cash flow ＞ broadly defined investment and cash and deposits at the end of the previous fiscal year ＞ broadly defined investment.

2. companies with financail deficits

	Fixed-effect				Random-effect			
Dependent variable / explanatory variable	plant and equipment investment		broadly defined investment		plant and equipment investment		broadly defined investment	
rate of capital return(-1)	0.1371***	0.1267***	0.2163***	0.1903***	0.1383***	0.1317***	0.2098***	0.1882***
	(5.36)	(4.90)	(5.96)	(5.22)	(6.36)	(5.91)	(6.82)	(6.01)
cost of capital(-1)	−0.3178**	−0.3500***	−0.2346	−0.2878	−0.3019***	−0.3567***	−0.1820	−0.2722*
	(-2.53)	(-2.77)	(-1.32)	(-1.62)	(-32.92)	(-3.37)	(-1.25)	(-1.83)
cash flow	0.1058***	0.1180***	0.2018***	0.2229***	0.1489***	0.1659***	0.1998***	0.2380***
	(4.49)	(4.99)	(6.04)	(6.69)	(6.97)	(7.68)	(6.61)	(7.83)
cash and deposits(-1)	0.6263***	-	1.1926***	-	0.7660***	-	1.4477***	-
	(9.29)	-	(12.47)	-	(14.07)	-	(18.82)	-
cash and deposits and short term investment securities(-1)	-	0.4223***	-	0.9296***	-	0.4418***	-	1.0176***
	-	(7.89)	-	(12.31)	-	(10.09)	-	(16.55)
debt to total assets ratio(-1)	−0.1073***	−0.1038***	−0.1315***	−0.1136***	−0.0091	−0.0075	−0.0254	0.0036
	(-3.64)	(-3.48)	(-3.41)	(-2.70)	(-0.50)	(-0.38)	(-0.98)	(0.13)
YD(2008 & 2009)	−0.0072	−0.0079	−0.0064	−0.0072	−0.0037	−0.0051	−0.0076	−0.0086
	(-1.45)	(-1.57)	(-0.90)	(-1.02)	(-0.79)	(-1.06)	(-1.12)	(−1.27)
constant	0.1496***	0.1563***	0.2203***	0.2168***	0.1016***	0.1195***	0.1348***	0.1373***
	(7.96)	(8.21)	(8.26)	(8.07)	(6.71)	(7.38)	(6.32)	(6.05)
R^2	0.1442	0.0836	0.2552	0.1962	0.2500	0.1911	0.3230	0.2818
Nunber of Observations	2196	2196	2196	2196	2196	2196	2196	2196

(Note1) estimated period: 2002～2014 fiscal year.
(Note2) ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively. The figure in parentheses are t-values in fixed-effect and z-values in Random-effect.
(Note3) plant and equipment investment, broadly defined investment and CF are deflated by the average fixed asset. cash and deposits and short term investment secirities are deflated by total asset.
(Note4) Random-effect model includes industry dummy.
(Note5) Fixed-effect is selected in all model according to results in Hausman test.
(Note6) The condition of companies with financaii deficits fiscal year is that cash flow＜broadly defined investment and cash and deposits at the end of the previous fiscal year＜broadly defined investment.

in all models, and the magnitude of coefficients for companies with financial deficits are larger than for companies with financial surpluses in all models. The coefficients of cost of capital are negative, although they are not statistically significant. The absolute value of coefficients of cost of capital for companies with financial deficits is larger than that for companies with financial surpluses in all models.

Regarding liquid factors, the coefficients of cash flow and the two kinds of liquidity in hand is significantly positive in all models. The coefficients of cash flow in companies with financial surpluses are roughly similar to those in companies with financial deficits, while the coefficients of the two kinds of liquidity in hand in companies with financial deficits are far higher than those in companies with financial surpluses. Additionally, the coefficients of debt to total assets ratio is significantly negative in all fixed-effect models. The absolute value of coefficients of debt to total assets ratio in companies with financial deficits is larger than that in companies with financial surpluses.

Given the above, the estimation results in companies with financial surpluses and companies with financial deficits are indicated as follows. First, companies with financial deficits are relatively willing to make an investment based on real fundamentals, as the coefficients of rate of capital return and cost of capital, which are component of Tobin's q, in companies with financial deficits are higher than those in companies with financial surpluses.

Second, it is a shocking fact that there is little difference between the coefficients of cash flow in companies with financial deficits and those in companies with financial surpluses. This is shocking is because these coefficients for companies with financial deficits should be higher than those for companies with financial surpluses systematically, and those in companies with financial surpluses should not be significant statistically if these coefficients indicate the magnitude of internal financing constraints, as FHP model indicated. However, according to the estimation results in this paper, the magnitude of coefficients of cash flow for companies with financial surpluses, which should not suffer from internal financial constraints at all, is almost similar to the coefficients for companies with financial deficits. We can interpret these results as meaning that companies give priority to the level of current expected cash flow when making investment decisions, and the coefficient of cash flow in investment function does not necessarily correspond to the degree of internal financing constraints.

Third, the results indicate that the coefficients of two kinds of liquidity in hand for companies with financing deficits is far higher than those for companies with financing surpluses. Of course, all liquidity in hand is not necessarily made good use of in investment because companies hold liquidity for daily working capital, which includes payroll, etc. Nevertheless, the fact that the sensitivity of two kinds of liquidity in hand to investment for companies with financing deficits is very high indicates that they give priority to the level of liquidity in hand when making broadly defined investment decisions involving outside finances.

Fourth, the coefficients of the year dummy during the Global Financial Crisis for com-

panies with financing deficits do not show statistically significant values in all models, while those for companies with financing surpluses are significantly negative in all models. The investment level for companies with financing deficits did not decrease significantly, even during the Global Financial Crisis.

Of course, according to Figure 5, the reason why both the long-term level of plant and equipment investment and broadly defined investment in Japanese companies has not been vigorous must be that most Japanese companies, including companies which are relatively willing to make an investment, give priority to the level of cash flow and liquidity in hand when making investment decisions. Liquid factors seem to affect making an investment alongside real factors such as the rate of capital return; however, in our estimation results, the magnitude of coefficients of rate of capital return should be larger than those of other explanatory variables, and the coefficients of cash flow and liquidity in hand should not be statistically significant if real factors are major determinants of investment and if liquid factors do not affect investment decisions.

V. Major results and interpretation

We multilaterally estimated the plant and equipment investment function and the broadly defined investment function and examined the results. We found that the reason for the long-term slump of plant and equipment investment since economic bubble burst is that Japanese companies are too safety-oriented and tend to avoid taking risks by shifting investments from plant and equipment investment to M&A and R&D investment.

The major results are as follows. First, comparing the results in the plant and equipment investment function with those for the broadly defined investment function from FY 2002 to FY 2014, we found that the magnitude of R^2 in the broadly defined investment function is larger than the R^2 for the plant and equipment investment function. Moreover, most absolute values of coefficients of explanatory variables in the broadly defined investment function are larger than the corresponding coefficient value for the plant and equipment investment function. This fact indicates that Japanese companies give priority to broadly defined investment, including M&A and R&D, as well as plant and equipment investment when making business decisions.

Second, according to term by term estimation results, the first period (FY 2002-2007) is comparatively similar to the third period (FY 2010-2014) in structure, while the second period (FY 2008-2009) is different from the other periods. We see that the magnitude of coefficients for rate of capital return, as measured by liquidity in hand and cash flow, are far larger during the second period than during first and third periods. Additionally, we point out that an anxiety factor partially explains why both the plant and equipment investment and the broadly defined investment plunged during second period. This anxiety was due to uncertainty about the future associated with the World Financial Crisis, and the sentiment prevailed in companies alongside a decrease in cash flow.

Third, we discerned companies with financial surpluses from companies with financial

deficits in all samples and estimated an investment function to determine how the availability of funds to make an investment and the cost of capital affects investment. The estimation results indicate that the coefficients of rate of capital return and cost of capital in companies with financial deficits are higher than those in companies with financial surpluses. We can interpret this result as meaning that companies with financial deficits are relatively willing to make an investment based on real fundamental factors, which are determinants of investment. Additionally, the estimation results also indicate that the coefficients of cash flow in companies with financial surpluses are roughly similar to those in companies with financial deficits. We can interpret these results as meaning that companies give priority to the level of current expected cash flow when making investment decisions; the coefficient of cash flow in the investment function equates to the degree of internal financing constraints.

Given these results and interpretations, we finally make an assessment on two proposed hypotheses. The fact that the performance of the broadly defined investment function is completely better than that of the plant and equipment investment function supports to an extent the validity of the hypothesis that companies have shifted from plant and equipment investment to broadly defined investment. However, the long-term investment level of Japanese companies has been not vigorous, even if we measure the long-term investment level by broadly defined investment. Additionally, Japanese companies, including companies which are willing to make an investment, are profoundly affected by liquid factors, such cash flow and two kinds of liquidity in hand, as well as by Tobin's q when making investment decisions. These facts ultimately support the validity of the hypothesis that Japanese companies are too safety-oriented to promote investment.

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