Real Investment, Debt, and Monetary Policy: Evidence from the Panel Data of Japanese Manufacturing Firms*

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1. Introduction

There are several ways in which the effects of monetary policy shocks are propagated to the real economy.[1] Among them, we focus on the efficacy of monetary policy shocks on a firm's real fixed investment, which is a crucial component of aggregate output. According to Bernanke and Gertler (1995), this route is the so-called "*balance sheet channel.*"

The underlying concept of the balance sheet channel is based on the theoretical prediction that a wedge between the cost of funds raised externally (for example, through the issuance of imperfectly collateralized debt) and the opportunity cost of internal funds occurs because of asymmetric information. This wedge is called the external finance premium. When effects such as imperfect information or costly enforcement of contracts interfere with the smooth functioning of financial markets, the size of the external finance premium should depend on the borrowers' net worth (financial position).[2] In other words, there is a negative relation between the external finance premium and net worth.

We consider that it is important to investigate the existence of the balance sheet channel, because according to credit view, the firms' real investment activities play a significant role

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1) See, for example, Bernanke and Gertler (1995), Mishkin (1995), and Hoshi (1997).

2) The theoretical studies of financial propagation mechanisms that emphasize the role of borrowers' balance sheets include Bernanke and Gertler (1989), Calomiris and Hubbard (1990), Gertler (1992), and Kiyotaki and Moore (1997).

in the transmission of monetary and financial shocks in the real economy.

The purpose of this paper is to investigate the existence of the balance sheet channel. We empirically analyze the effect of monetary policy shocks on fixed investments based on a large panel dataset of Japanese manufacturing firms from 1971 to 2006.[3] In particular, we attempt to present evidence on the differential response to contractionary monetary policy shocks according to firm size.

This paper is different from previous studies in several respects detailed in the following. Gertler and Gilchrist (1994) attempted to gain empirical evidence on the same type of financial propagation mechanism for the US economy. While they deal with the impact of net worth conditions on inventory demand, this paper shows that the balance sheet channel can explain swings in a more important aggregated demand component, which is the real fixed investment.

Ogawa (2000) investigated the existence of the balance sheet channel in the Japanese economy using the quarterly time series data disaggregated by firm size for manufacturing and non-manufacturing industries. Especially, he focused on the role of land as collateral in the monetary transmission mechanism. However, his estimation results showed that the monetary policy shock decreased the investments of large firms but kept those of small firms in manufacturing industries at a high level for several quarters. This is not consistent with the balance sheet channel theory.

Then, Ogawa (2002) applied Gertler and Gilchrist (1994), *ibid*. to inventory investment of Japanese firms, but he obtained contradictory results. This may have been caused by a non-financial factor such as the Japanese subcontracting system between large and small firms being different from that in the US, or may have been contaminated by the observational equivalence problem in the reduced-form VAR system. To improve these deficiencies, we choose the real fixed investment as a dependent variable, which seems to be relatively independent of the differences in the subcontracting systems. Moreover, we do not employ the VAR system but use structural equations to avoid both small sample and observational equivalence problems.

Hosono and Watanabe (2002) also analyzed the importance of the balance sheet channel in Japan. Unfortunately, however, their *net worth* variable did not contain any debt item; hence, they reached a very misleading conclusion that the heavy debt burden in the 1990s had nothing to do with the inactive investment behavior of Japanese firms.

Nagahata and Sekine (2005) investigated how the monetary easing policy influenced the firm's investment after the collapse of the asset price in the early 1990s in Japan. Their analysis, in particular, considered the effect of the bank balance sheet on a firm's investment. They found that the monetary easing policy worked through the interest rate

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3) The panel studies for examining firms' liquidity constraints begin with Fazzari, Hubbard and Peterson (1998).

channel but the efficacy of the balance sheet channel was interrupted because of the deterioration in balance sheet conditions. Incidentally, they use accelerator investment functions, and not Tobin's q investment functions. Therefore, it is difficult for their evidence to support the interest rate channel without considering asset price.

Moreover, Angelopoulou and Gibson (2009) investigated the sensitivity of investments to cash flow using a panel data of UK's manufacturing firms to examine the effect of the balance sheet channel. Additionally, they constructed a dummy of tight monetary policy for the UK based on the narrative indicator of Romer and Romer (1989). They found that the investments of financially constrained firms relative to unconstrained firms became more sensitive to cash flow during the periods of the contractionary monetary policy.

Here let us briefly summarize the main results of this paper. We clearly succeed in extracting the effects of the monetary and financial shocks even after controlling for the omitted variable problem. Specifically, the firms' investments are sensitive to their debt burden during the period of tight monetary policy. Additionally, the smaller the firm size, the greater is the efficacy of the contractionary monetary policy.

This paper is organized as follows. In Section 2, we construct a panel data set and define the firm-size classes. Section 3 presents the construction of dummy variables for monetary policy by size of firm. Section 4 shows our regression models and Section 5 reports the estimation results. Conclusions are given in Section 6.

2. Data Description

2.1. Construction of Panel Data

The panel data set is constructed from the firm's financial database of Nikkei NEEDS Financial Quest and the sample periods range from 1970 to 2006. The dataset we use for the estimation is unbalanced because of two reasons. First, there are some firms in our panel data set that were delisted during the sample periods. Second, two firms combined together to form a new company via a merger and/or acquisition during the estimation periods.[4]

2.2. Classification of Firm Sizes

Each firm falls into one of four classes according to their level of capital *and* real interest-bearing debt amount since the external finance premium depends on debt amounts as well as capital sizes (net worth position). The largest firms in the first category have over 10 billion yen in capital and less than 20 billion yen in real interest-bearing debt amount (sample size is 147). The second largest firms with over 10 billion yen in capital and more than 20 billion yen in real interest-bearing debt amount are classified in the second category (sample size is 220). Medium-sized firms in the third category have less than 10

4) We consider a single case of such a merger.

billion yen in capital and up to 20 billion yen in real interest-bearing debt amount (sample size is 867). The fourth category represents relatively small firms with a capital of less than 10 billion yen and debt of more than 20 billion yen (sample size is 31).

3. Construction of Dummy Variables for Monetary Policy Shocks by Firm Size

First, we concentrate on only one type of shock, which is the monetary policy shock, to exclude the influences by endogenous factors as far as possible. Kuroki (1999) analyzes in detail the historical record to isolate the monetary policy shock. During our sample period, the paper identifies three episodes in which the Bank of Japan formed a tight monetary policy to cool down the economic overheating and stabilize inflation; therefore, we adopt 1973–1974, 1979–1980, and 1989–1990 as the contractionary monetary policy periods.

To precisely extract the significance of the balance sheet channel, we introduce interaction variables composed of a monetary shock dummy, debt, and a firm-size dummy. That is, we append the cross term of contractionary monetary policy dummy ("one" for the periods of contractionary policy and "zero" for other periods) to the negative net worth variable (DEBT). This device is quite useful to prove the existence of the balance sheet channel, but we need an additional improvement to reach a full specification model.

Therefore, we should introduce a firm-size dummy because the more severely the channel works, the smaller the firm size, and/or lesser the firm's net worth position. Based on the category defined in the previous section, we can have the new variables, LFDUMMY1, LFDUMMY2, SMFDUMMY1, and SMFDUMMY2, which, respectively, can take the following values:

$$\text{LFDUMMY1} = \begin{cases} 1 \text{ for the largest firms} \\ 0 \text{ otherwise} \end{cases},$$

$$\text{LFDUMMY2} = \begin{cases} 1 \text{ for the second largest firms} \\ 0 \text{ otherwise} \end{cases},$$

$$\text{SMFDUMMY1} = \begin{cases} 1 \text{ for the medium-sized firms} \\ 0 \text{ otherwise} \end{cases},$$

and

$$\text{SMFDUMMY2} = \begin{cases} 1 \text{ for the relatively small firms} \\ 0 \text{ otherwise} \end{cases}.$$

Then, we introduce these cross terms, CMP DUMMY × DEBT × FIRMSIZE DUMMY into Tobin's q investment function to identify the balance sheet channel from other factors.

4. Estimation Based on the Fully Specified Models

4.1. Models of Investments with Contractionary Monetary Policy Shocks

To see whether the efficacy of the balance sheet channel is significant and whether it is different with respect to firm size, we add the cross terms to Tobin's q investment functions.[5] Then, we estimate the following fully specified real investment functions with contractionary monetary policy shocks.[6] If the balance sheet channel exists, the coefficients of DEBT and the cross terms are expected to be significantly negative.

$$\frac{I_{it}}{K_{it}} = \delta_{1t} + \tau_{1t} q_{it} + \beta_{1t} LIQ_{it} + \gamma_{1t} DEBT1_{it} + \theta_{1t}(CMP \times DEBT1_{it} \times LFDUMMY1) + \xi_{1t}(CMP \times DEBT1_{it} \times LFDUMMY2) + \varpi_{1t}(CMP \times DEBT1_{it} \times SMFDUMMY1) + \phi_{1t}(CMP \times DEBT1_{it} \times SMFDUMMY2) + \varepsilon_{1t} \quad (1)$$

$$\frac{I_{it}}{K_{it}} = \delta_{2t} + \tau_{2t} q_{it} + \beta_{2t} LIQ_{it} + \gamma_{2t} DEBT2_{it} + \theta_{2t}(CMP \times DEBT2_{it} \times LFDUMMY1) + \xi_{2t}(CMP \times DEBT2_{it} \times LFDUMMY2) + \varpi_{2t}(CMP \times DEBT2_{it} \times SMFDUMMY1) + \phi_{2t}(CMP \times DEBT2_{it} \times SMFDUMMY2) + \varepsilon_{2t} \quad (2)$$

where

I_{it}: real fixed investment of firm i in year t, K_{it}: real capital stock of firm i in year t, and q_{it}: Tobin's q of firm i in year t,

LIQ_{it}: ratio of liquid assets to total assets that firm i has in year t (proxy variable for measurement of liquidity constraints),

$DEBT1_{it}$: ratio of interest-bearing debt amount to net income of firm i in year t (proxy variable for debt burden or negative net worth),

$DEBT2_{it}$: real interest-bearing debt amount that firm i has in year t (proxy variable for debt burden or negative net worth)

CMP: contractionary monetary policy dummy.

δ_{1t} and δ_{2t} are constant terms, and ε_{1t} and ε_{2t} are disturbances, respectively.

The interpretation of DEBT1 and DEBT2 as negative net worth in the regression models (1) and (2) is important. Masuda (2013) found that for large, small-, and medium-sized firms, there was a negative relation between the real fixed investments and debt burden in a cross section regression in each year, and it tended to be much stronger during the periods

5) See the appendix to Masuda (2012) for more details on the construction of each variable.

6) Based on the results of the Hausman test, we adopt the fixed effects model.

of contractionary monetary policy.

Therefore, negative net worth, which is evaluated as a measure of a firm's health, is large when a bad economic situation such as debt deflation or financial crisis occurs. Thus, as the situation is the same for the external financial premium with a net worth value, the premium is assumed to be an increasing function of negative net worth. Namely, this premium is higher in bad economic conditions, or for firms with more debt burden, than in good conditions, or for large firms with less debt burden.

4.2. Estimation Period

We construct and estimate not only full sample periods but also subsample periods. Concretely, we create two types of panel data sets: type 1 ranges from 1971 to 1996 (before the break out of the Asian financial crisis in 1997), type 2 from 1971 to 1998 (before the introduction of the zero-interest-rate policy in 1999) to remove the peculiar impact of the Asian financial crisis and the zero-interest-rate policy.[7)]

5. Estimation Results: Firms' Investments and the Balance Sheet Channel

The estimated results of the regression models (1) and (2) during the periods from 1971 to 1996 are shown in Table 1 and Table 2, respectively. Panel A of Table 1 shows the estimation results of the simple investment functions (1), excluding all the four identification dummy variables. While the coefficient of LIQ is not significantly positive, the coefficients of Tobin's q and DEBT1 are of the correct signs and are statistically significant at the 1% level.

Panel B of Table 1 shows the estimation results of the fully specified version model (1) introducing four cross terms. The results are quite similar to those in Panel A. Although the coefficient of LIQ is not significant, the coefficient of Tobin's q is significantly positive and DEBT1 is significantly negative. In addition, the coefficient of the cross term for the largest firms is statistically significant except for the other three. These results suggest that net income relative to debt burden has played an important role in the rate of the real investments of the largest firms.

Table 2 reports the estimation results both from the simply specified and fully specified models on the effects of DEBT2 on firms' investments. Let us focus on the estimation results based on the fully specified model (Panel D), since the simpler model, presented in Panel C, may be contaminated by the endogeneity problem. Comments on Panel D are warranted. In contrast to the results presented in Panel B of Table 1, most of the interaction dummy variables as well as DEBT2 are statistically significantly negative. This implies that the

7) We devise this type of panel data to exclude the exogenous factors as far as possible.

Table 1 Coefficients estimated by model (1) during the period of the contractionary monetary policy from 1971 to 1996

Panel A Estimates of model (1)

Variable	q		LIQ	DEBT1	
Coefficient	0.0041	***	−0.0214	−0.0000093	***
t-Statistic	4.2629		−2.7954	−3.5911	

Adjusted R-squared	0.1393
Observations	22098

Panel **B** Effect of the contractionary monetary policy on the firms' investments

Variable	q		LIQ	DEBT1		CMP×DEBT1 ×LFDUMMY1		CMP×DEBT1 ×LFDUMMY2	CMP×DEBT1 ×SMFDUMMY1	CMP×DEBT1 ×SMFDUMMY2
Coefficient	0.0043	***	−0.0221	−0.0000077	***	−0.0002130	***	−0.0000144	−0.0000028	0.0000744
t-Statistic	4.1359		−2.7536	−2.7356		−2.8058		−0.8421	−0.2180	0.2170

Adjusted R-squared	0.1407
Observations	22073

Note: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. 2. Estimation results by OLS. 3. We adopt the fixed effect model. 4. White's heteroskedasticity-consistent standard errors are used to compute t-statistics.

firms' investments are decidedly sensitive to debt burden, particularly during the period of the contractionary monetary policy.

Additionally, the smaller the firm sizes, the larger the estimated coefficients of the cross terms. Furthermore, the significance levels of those coefficients are also larger for the smaller firm-size classes. For instance, while the estimated coefficient for the firm category with the least amount of net worth is −0.0001190 at the 1% significance level, that for the second largest firms is -0.31×10^{-5} at the 5% level but the effect of DEBT2 on the richest firms' investments is statistically insignificant. These results are highly consistent with the theory of the balance sheet channel, and therefore, we can conclude that the balance sheet channel of monetary policy transmission operates through the debt burden.

Including the financial crises period does not modify our conclusion. Table 3 and Table 4 show the estimation results of the regression models (1) and (2) during the periods from 1971 to 1998, respectively.

Panel E and Panel F of Table 3 report the results of the regression model (1) with and without the cross terms. As shown in these Panels, the magnitude of the estimated coefficients of Tobin's q, LIQ, and DEBT1 are nearly identical with those in Panel A and Panel B of Table 1. However, as shown in Panel F, the coefficient of the cross term for the second largest firms is significantly negative except for the other three.

The results revealed in Table 4 are quite similar to those in Table 2 in terms of magnitude and statistical significance of estimated coefficients of DEBT2 and the cross terms for

Table 2 Coefficients estimated by model (2) during the period of the contractionary monetary policy from 1971 to 1996

Panel C Estimates of model (2)

Variable	q		LIQ	DEBT2	
Coefficient	0.0041	***	−0.0251	−0.0000036	***
t-Statistic	4.2644		−3.1762	−9.3199	

Adjusted R-squared	0.1398
Observations	22107

Panel D Effect of the contractionary monetary policy on the firms' investments

Variable	q		LIQ	DEBT2		CMP×DEBT2 ×LFDUMMY1	CMP×DEBT2 ×LFDUMMY2		CMP×DEBT2 ×SMFDUMMY1		CMP×DEBT2 ×SMFDUMMY2	
Coefficient	0.0041	***	−0.0247	−0.0000028	***	0.0000029	−0.0000031	**	−0.000110	***	−0.0001190	***
t-Statistic	4.2503		−3.0988	−6.1352		0.1588	−2.3655		−3.0501		−3.6611	

Adjusted R-squared	0.1410
Observations	22082

Note: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. 2. Estimation results by OLS. 3. We adopt the fixed effect model. 4. White's heteroskedasticity-consistent standard errors are used to compute t-statistics.

Table 3 Coefficients estimated by model (1) during the period of the contractionary monetary policy from 1971 to 1998

Panel E Estimates of model (1)

Variable	q		LIQ	DEBT1	
Coefficient	0.0042	***	−0.0216	−0.0000085	***
t-Statistic	5.5892		−2.5800	−3.1611	

Adjusted R-squared	0.1410
Observations	24374

Panel F Effect of the contractionary monetary policy on the firms' investments

Variable	q		LIQ	DEBT1		CMP×DEBT1 ×LFDUMMY1	CMP×DEBT1 ×LFDUMMY2		CMP×DEBT1 ×SMFDUMMY1	CMP×DEBT1 ×SMFDUMMY2
Coefficient	0.0043	***	−0.0224	−0.0000071	***	0.0000112	−0.0002240	***	−0.0000004	−0.0000537
t-Statistic	5.5092		−2.7345	−2.7610		−0.8661	−4.0154		−0.0292	0.1609

Adjusted R-squared	0.1423
Observations	24349

Note: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. 2. Estimation results by OLS. 3. We adopt the fixed effect model. 4. White's heteroskedasticity-consistent standard errors are used to compute t-statistics.

Table 4 Coefficients estimated by model (2) during the period of the contractionary monetary policy from 1971 to 1998

Panel G Estimates of model (2)

Variable	q		LIQ	DEBT2	
Coefficient	0.0042	***	−0.0252	−0.0000033	***
t-Statistic	5.5857		−3.0271	−7.4065	

Adjusted R-squared	0.1415
Observations	24384

Panel H Effect of the contractionary monetary policy on the firms' investments

Variable	q		LIQ	DEBT2		CMP × DEBT2 × LFDUMMY1		CMP × DEBT2 × LFDUMMY2	CMP × DEBT2 × SMFDUMMY1		CMP × DEBT2 × SMFDUMMY2	
Coefficient	0.0042	***	−0.0248	−0.0000027	***	0.0000028	**	0.0000082	−0.0001140	***	−0.0001240	***
t-Statistic	5.5818		−3.0268	−5.1684		−2.1881		0.4439	−2.8577		−3.7053	

Adjusted R-squared	0.1426
Observations	24359

Note: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. 2. Estimation results by OLS. 3. We adopt the fixed effect model. 4. White's heteroskedasticity-consistent standard errors are used to compute t-statistics.

medium-sized firms and relatively small firms. Especially, the coefficients of the cross terms are negative at a high significance level for relatively small firms. As presented in Panel B and F, the only point we should note is that the estimation result of the cross term for the largest firms are opposite to that for the second largest firms. This may simply suggest a possibility that the financial crisis exerts some influence on the financial condition of the largest and the second largest firms. This will be a subject for further research.

In summary, we have confirmed that the effects of monetary policy shocks have been transmitted to the firms' investments through their debt. The verified evidence shows the importance of the debt burden in the monetary transmission, and as the theoretical consensus suggests, it also argues that the smaller the firm size, the larger the efficacy of monetary policy shocks via debt burden. Consequently, we can conclude that the balance sheet channel of monetary policy operates more effectively for medium-sized firms and relatively small firms.

6. Conclusion

The purpose of this paper was to identify the balance sheet channel of monetary policy from other factors. We reported that the firms' investments are sensitive to their debt burden during the period of tight monetary policy. As expected, the smaller the firm size, the greater the efficacy of contractionary monetary policy shocks. Therefore, our analysis can show evidence on the existence of the balance sheet channel through the debt burden of firms.

References

Angelopoulou, E., H. D. Gibson 2009. "The balance sheet channel of monetary policy transmission: evidence from the United Kingdom." *Economica* 76, 304, 675–703.

Bernanke, B. S., M. Gertler 1989. "Agency costs, net worth, and business fluctuations." *American Economic Review* 79 (1), 14–31.

Bernanke, B. S., M. Gertler 1995. "Inside the black box: the credit channel of monetary policy transmission." *Journal of Economic Perspectives* 9 (4), 27–48.

Calomiris, C. W., R. G. Hubbard 1990. "Firm heterogeneity, internal finance, and credit rationing." *Economic Journal* 100 (399), 90–104.

Fazzari, S., R. G. Hubbard, B. C. Petersen 1988. "Financing constraints and corporate investment." *Brookings Papers on Economic Activity* 19 (1), 141–206.

Fukuda, S. 2003. *Nihon no choki kin-yu*, Tokyo: Yuhikaku.

Gertler, M., 1992. "Financial capacity and output fluctuations in an economy with multiperiod financial relationships." *Review of Economic Studies* 59 (3), 455–472.

Gertler, M., S. Gilchrist 1994. "Monetary policy, business cycles, and the behavior of small manufacturing firms." *Quarterly Journal of Economics* 109 (2), 309–340.

Hayashi, F., T. Inoue 1991. "The relation between firm growth and Q with multiple capital goods: theory and evidence from panel data on Japanese firms." *Econometrica* 59 (3), 731–753.

Hoshi, T. 1997. "Shihon Shijo no Fukanzensei to Kin-yu Seisaku no Hakyu Keiro-Saikin no Kenkyu Seika no Tenbo -." *Kin-yu Kenkyu* 16 (1), 105–136 (in Japanese).

Hosono, K., T. Watanabe 2002. "Kigyo Balance-Sheet to Kin-yu Seisaku. [The Transmission of Monetary Policy through Borrower's Balance Sheets]." *Keizai Kenkyu*, (*The Economic Review*) 53 (2), 117–133 (in Japanese).

Kiyotaki, N., J. Moore 1997. "Credit Cycle." *Journal of Political Economy* 105 (2), 211–248.

Kuroki, Y. 1999. *Kin-yu Seisaku no Yukousei* [The Effectiveness of Monetary Policy]. Tokyo: Toyo Keizai Shinposha (in Japanese).

Masuda, K. 2012 "The Balance Sheet Channel of Monetary Policy: Evidence from the Panel Data of Japanese Manufacturing Firms," The Institute of Economic Research, Chuo University, Discussion Paper Series No. 187.

Masuda, K. 2013 "Monetary and Financial Shocks & the Real Fixed Investments of Japanese Manufacturing Firms," *Keizaigaku Ronsan* (*The Journal of Economics*) 53 (2), 69–88.

Mishkin, F. 1995. "The Channels of Monetary Transmission: Lessons for Monetary Policy," NBER Working Paper, No. 5464.

Nagahata, T., T. Sekine 2005. "Firm investment, monetary transmission and balance-sheet problems in Japan: an investigation using micro data." *Japan and the World Economy* 17 (3), 345–369.

Ogawa, K. 2000. "Monetary policy, credit, and real activity: evidence from the balance sheet of Japanese firms." *Journal of the Japanese and International Economies* 14 (4), 385–407.

Ogawa, K. 2002. "Monetary transmission and inventory: evidence from firm balance-sheet data by firm size." *Japanese Economic Review* 53 (4), 425–443.

Romer, C. D., Romer, D. H., 1989. Does monetary policy matter? A new test in the spirit of Freidman and Schwartz. In: Blanchard, O. J., Fischer, S., (Eds.). NBER Macroeconomics Annual. Cambridge, MA: MIT Press. 121–183.

Suzuki, K. 2001. Setsubi toshi to kin-yu shijo: joho no taisho-sei to fukaku zitsu-sei. Tokyo: University of Tokyo Press (in Japanese).

Appendix. Descriptive Statistics

Table. Summary Statistics

	INV	Q	LIQ	DEBT1	DEBT2
Mean	0.1496	1.5928	0.4336	35.0606	303.2433
Median	0.0990	1.0457	0.4331	7.9060	51.8678
Std. Dev.	0.2439	5.0629	0.1297	241.1685	1019.8660
Observations	36329	34182	36331	36314	36340

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