Chapter 6
Financial Constraints on Intangible Investments: Evidence from Japanese Firms

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Abstract This paper uses Japanese firm-level data to analyze financial constraints on intangible investments. In contrast to past studies that focused almost exclusively on R&D investments, the intangible investments analyzed in this paper cover the acquisition of intangible assets as a whole. We estimate investment functions in which cash flow is used as a key explanatory variable to observe differences in the sensitivity of investments to cash flow by industry, firm size, and firm age. According to the estimation results, investments in intangible assets are more sensitive to internal capital compared with investments in tangible assets, suggesting the existence of market failure in financial markets. Financial constraint is more serious for young and small firms.

Keywords Intangible investments • Credit constraint • Cash flow • Investment function

6.1 Introduction

This paper uses Japanese firm-level panel data to analyze financial constraints on intangible investments. Studies on the role of intangible assets in economic growth have progressed rapidly. These studies have indicated that intangible assets play an

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important role in economic performance but that current levels of investment in intangible assets may be lower than the optimal level. The motivation of this study is to investigate why firms underinvest in intangible assets when these assets are effective in enhancing firm performance and to discuss policy measures for promoting intangible investments. In other words, the basic question of this paper is whether there is market failure in intangible investments.

Among intangible investments, studies on research and development (R&D) investments have indicated that the private rate of return to R&D investments is generally lower than the social rate of return and that capital market imperfection is serious for R&D investments. However, empirical studies have been extremely limited related to intangible investments other than R&D investments. Recent studies measuring aggregate-level intangible investments classify (1) software and other computerized information, (2) innovative property (scientific R&D and non-scientific R&D), and (3) economic competencies as "intangible assets." In advanced countries, the estimated share of scientific R&D in the total intangible investments is between 10 and 25 % (Table 6.1). This figure suggests that we should focus more heavily on other intangible investments, such as investments in computer software, advertising expenditures, and training expenses.

Regarding policy measures by the types of investments in practice, tax incentives for investments are concentrated in equipment and R&D investments (Table 6.2).[1] There are tax incentives for software and human capital investments in Japan, but the size of these measures is very small. Furthermore, while there are a variety of financial support programs in Japan, such as loans by the Japan Finance Corporation (JFC), financial support has focused mainly on tangible (equipment and buildings) investments. If the levels of intangible investments are lower than the socially optimal level, it is desirable to introduce or expand policy measures to stimulate such investments. However, it is difficult to plan appropriate policy tools without information on the nature and magnitude of market failure.

Within these contexts, this paper uses firm-level panel data from the Basic Survey of Japanese Business Structure and Activities (Ministry of Economy, Trade and Industry) to empirically analyze the financial constraints on intangible investments. Specifically, we estimate investment functions in which cash flow is used as a key explanatory variable to determine the sensitivity of the intangible investments to internal cash. A novel aspect of this study is that the intangible investments analyzed in this paper cover the acquisition of intangible assets as a whole, which are not limited to R&D investments.

We consider differences in the sensitivity of investments to cash flow by industry, firm size, and firm age. If there is a market failure in intangible investments caused by information asymmetry or agency problems, the sensitivity of the intangible investments to cash flow is expected to be stronger than that of the tangible (physical) investments. In addition, we expect the sensitivity to cash flow

[1] In addition to the special tax treatment, there are various R&D subsidy programs.

Table 6.1 Composition of intangible investments in the U.S., Japan, and U.K.

	(1) U.S.	(2) Japan	(3) U.K.
	2000–03	2000–05	2004
1. Computerized information	14.1 %	20.3 %	16.5 %
2. Innovative property			
(a) Scientific R&D	18.8 %	25.7 %	9.5 %
(b) Non-scientific R&D	19.3 %	28.1 %	20.7 %
3. Economic competencies			
(a) Brand equity	13.1 %	10.4 %	14.1 %
(b) Firm-specific resources	34.7 %	15.5 %	39.1 %

Note: Calculated from Corrado et al. (2009), Fukao et al. (2009), and Marrano et al. (2009)

Table 6.2 Major special corporate tax measures

Tax measures	Billion yen
Special Depreciation for Innovative Equipment	55
Tax Deduction for ICT Investments	70
Tax Credit for Energy-Efficient Equipment	122
Investment Tax Credit for SMEs	250
Tax Credit for R&D Expenditure	254

Note: The figures are the annual values of tax reduction (billion yen) of the special measures for the 2010 fiscal year
Source: Ministry of Finance

to be greater among SMEs and young firms whose financial constraints are generally more severe than are those of large and mature firms.

We should note that the intangible investments in this paper are confined to those covered by the Basic Survey of Japanese Business Structure and Activities, which involves the acquisition of intangible assets defined by the current accounting standard. According to the Japanese Corporate Accounting Principles, fixed intangible assets include goodwill, patents, superficies, trademarks, and software. Except software, only purchased fixed intangible assets can be appropriated in the balance sheet. In other words, the analysis in this paper does not completely cover the intangible assets defined by Corrado et al. (2009). However, several recent studies have used accounting measures of intangible assets in firm-level empirical analysis. For example, Marrocu et al. (2012) used accounting measures of intangible assets to investigate their influence on productivity among European firms. Studies by Dischinger and Riedel (2011) and Becker and Riedel (2012) use accounting measures of intangible assets to analyze the investment behavior of multinational firms.

According to the estimation results of this paper, investments in intangible assets are more sensitive to internal cash flows compared with investments in tangible assets. In analyzing the type of firm, it can be observed that the sensitivity of intangible investments to cash flow is stronger in SMEs and young firms, which face severe constraints in external financial markets, than in large and mature firms. These results suggest the existence of a market failure in intangible investments caused by information asymmetry or a lack of well-functioning resale markets for intangible assets. One policy implication of these results is that the policies

designed to remove market failure, such as improvements in financial intermediaries' ability to evaluate intangibles and the expansion of transaction markets for intellectual property rights, are socially desirable. Another implication is that investment tax credits and financial support for SMEs or young firms should focus more heavily on intangible investments.

The rest of this paper is structured as follows. Section 6.2 briefly surveys past empirical studies of liquidity constraints on investments. Section 6.3 describes the data used and the method of analysis. Section 6.4 presents and interprets the results, and Sect. 6.5 concludes with policy implications.

6.2 Literature Review

Studies on the role of intangible assets in economic growth are progressing rapidly. Recent studies, based on a framework proposed by Corrado et al. (2009), classify (1) software and other computerized information, (2) innovative property (scientific R&D and non-scientific R&D), and (3) economic competencies (brand equity and firm-specific resources) as "intangible assets." The coverage of this definition is wider than the accounting measure of fixed intangible assets.

In many advanced countries, studies have been conducted based on this framework, such as Marrano et al. (2009) in the UK, Belhocine (2009) in Canada, and Edquist (2011) in Sweden. These studies have identified the quantitative contribution of intangible assets to macroeconomic growth and productivity. In Japan, Fukao et al. (2009) conducted the representative study of this line of literature. These authors estimated that the ratio of intangible assets to GDP in Japan was 11.1 % (2000–2005 average), of which computerized information, innovative property, and economic competencies represented 2.2 %, 6.0 %, and 2.9 %, respectively. The ratio of intangible assets was lower than that of the U.S., and the recent growth rate of intangible assets in Japan was stagnant. Furthermore, Chun et al. (2012) estimated intangible investments by industry for Japan and Korea and found that the intangible investments in the service industry were far lower than were those in the manufacturing industry in Japan.

Some studies using aggregated data have demonstrated a positive relationship between intangible capital and productivity growth. Roth and Thum (2013), using cross-country data for EU countries, indicated that intangible capital explains a significant portion of the international variance in labor productivity growth. Miyagawa and Hisa (2013) estimated intangible investment in Japan at the industry level and analyzed the impacts of intangible investment on the total factor productivity (TFP) growth. Their result indicates a positive and significant effect of intangible investment on TFP growth.

Empirical studies using micro data to investigate the effects of intangible assets on firm performance are also developing rapidly. The analysis by Bloom and Van Reenen (2007), a pioneering study in this area, collected information on firm-level management practices and found that managerial practices are strongly associated

with firm-level productivity.[2] In Japan, Miyagawa et al. (2010) conducted a similar survey and provided suggestive evidence on the positive relation between management practices and productivity at the firm level.[3] Although these studies do not cover all intangible investments and their focus is on organizational innovation and human resources management, they indicate that some types of intangible investment make positive contributions to firm-level productivity performance.

To summarize, these studies have shown that intangible assets play an important role in economic performance but that the current levels of investments in intangible assets may be lower than the optimal level. The purpose of this paper is to investigate why firms underinvest in intangible assets when these assets are effective in enhancing firm performance and to discuss policy measures that are desirable for promoting intangible investments.

Among intangible investments, numerous studies have been conducted on R&D investments. These studies have indicated that the private rate of return to R&D investments is generally lower than the social rate of return that includes benefits from knowledge spillovers. Underinvestment in R&D emerges as a result of the profit-maximizing behavior of firms (see, for example, Griliches 1998 for a survey). In addition, capital market imperfection stemming from information asymmetry has been shown to be serious for R&D investments (see Hall 2002 and Hall and Lerner 2010). However, for intangible investments other than R&D investments, the existence or nonexistence of market failure has not been empirically identified.

Since the release of the influential paper by Fazzari et al. (1988), numerous studies have analyzed the effect of capital market imperfections on firm investment by estimating investment functions using internal cash flow as a key explanatory variable. Hubbard (1998) and Bond and Van Reenen (2007) present excellent surveys of the literature. In these studies, investment-cash flow sensitivity has been interpreted as evidence of a credit market imperfection caused by information asymmetry.[4] A large number of empirical studies have confirmed the significance of capital market imperfections, at least for firms such as SMEs or young firms. However, most of this literature has focused only on investment in tangible (physical) assets.

A relatively small number of studies have investigated financial market imperfection in R&D investment. The studies by Hao and Jaffe (1993), Himmelberg and Petersen (1994), Bhagat and Welch (1995), Brown et al. (2009), Brown and Petersen (2009), Czarnitzki and Hottenrott (2011), Aghion et al. (2012), Brown et al. (2012), Driver and Guedes (2012), and Borisova and Brown (2013) are examples. In general, as Hall's (2002) survey summarizes, these studies find that

[2] Bloom et al. (2013) conducted a field experiment in India that indicated that adopting good management practices raises productivity.

[3] See also Miyagawa et al. (2014), which compare the management quality between Korea and Japan based on the 2008 and 2012 surveys.

[4] However, several studies cast doubt on the interpretation of investment-cash flow sensitivity as evidence of capital market imperfection (Kaplan and Zingales 1997, 2000; Gilchrist and Himmelberg 1998; Erickson and Whited 2000; Cummins et al. 2006; Chen and Chen 2012).

SMEs and start-up firms face a higher cost of capital for financing R&D investment. These studies suggest that investments in intangible assets other than R&D may also be constrained by financial market imperfections. However, empirical studies to identify the presence of financing constraints on intangible investments other than R&D investments have been scarce.[5]

6.3 Data and Methodology

The analysis in this paper uses panel data from the Basic Survey of Japanese Business Structure and Activities conducted by the Ministry of Economy, Trade and Industry (METI). This annual survey, which began in 1991, accumulates representative statistics on Japanese firms with 50 or more regular employees, including firms engaged in the mining, manufacturing, electricity and gas, wholesale, retail, and service industries. Approximately 30,000 firms are surveyed every year. The purpose of this survey is to produce a comprehensive picture of Japanese firms, including their basic financial information, composition of businesses, R&D activities, IT usage, and foreign direct investments. Because the sample firms are coded using unique perpetual numbers, we can easily construct a firm-level longitudinal data set.

The survey began collecting information on "intangible fixed assets" (stock value) in the 2003 fiscal year and added a survey item on "intangible fixed asset investments" (flow value) in the 2006 fiscal year. As mentioned earlier, this survey item indicates the acquisition of intangible fixed assets defined by the current accounting standard. In the accounting standard of Japan, intangible fixed assets include goodwill, patent, trademark, and software, among others, and intangible investments are the acquisition of fixed intangible assets. An advantage of using these data is that intangible investments cover the acquisition of various intangible assets, which are not limited to R&D-related assets. Conversely, patents produced from internal R&D and expenditures for employee training are generally not included in intangible investments because only purchased fixed intangible assets, with the exception of software, can be appropriated on the balance sheet.

According to the survey, the ratio of intangible investments to total fixed asset investments (sum of the tangible asset and intangible asset investments) is 14.8 % at the sample mean (average for 2006–2010).[6] By industry, the ratio is higher for

[5] Studies on intangible investments other than R&D have been extremely limited, but Fee et al. (2009) studied the role of cash flows in advertisement spending and found evidence supporting the advertising-cash flow relationship. Recently, Falato et al. (2013) presented evidence from a panel of U.S. corporations suggesting that intangible capital, defined as the sum of the IT capital, R&D capital, and organizational capital, is an important determinant of corporate cash holdings, suggesting financial friction in intangible investment.

[6] In the Basic Survey of Japanese Business Structure and Activities, tangible fixed assets include land.

Table 6.3 Ratio of intangible investment to total fixed asset investment by industry

Industry	Intangible investments (%)
Manufacturing	8.1
Wholesale	20.1
Retail	10.6
Information & communication	44.5
Service	18.1
All industries	14.8

Notes: Total fixed asset investments are the sum of the tangible and intangible investments. The figures are the mean value of the firms in each industry calculated from the pooled years between 2006 and 2010

information and communication (I&C) firms and service firms: the ratios are 8.1 % (manufacturing), 20.1 % (wholesale), 10.6 % (retail), 44.5 % (I&C), and 18.1 % (service) (Table 6.3). The major reason for the very high figure for the I&C industry is that software investments are large for this industry, and internally produced software is included in the fixed intangible investments. Although the composition of fixed intangible investments (flow value) is not identified in the Basic Survey of Japanese Business Structure and Activities, the value of software assets (stock value) is surveyed as part of intangible assets. According to these data, 76 % of the fixed intangible assets are made up of software in the I&C industry. In contrast, the low ratio for manufacturing firms is due to the relatively high physical investment in this industry. These figures by industry indicate that intangible assets are important factors in production for firms operating in the non-manufacturing sector.

In this paper, we estimated a standard investment function in which cash flow was used as a main explanatory variable to observe the sensitivity of investments to internal cash flow.[7] A large number of previous studies have used Q-type investment functions where Tobin's Q is interpreted as a variable of firms' investment opportunities (see Hubbard 1998; Bond and Van Reenen 2007). However, because most of the sample firms in this paper are not publicly listed firms, the market value of firms to calculate Q is not available. For this reason, we employed an accelerator-type investment model where the growth of firm sales was included as an independent variable. Among representative past studies, Fazzari et al. (1988) showed the estimation results of both the Q model and the accelerator-type investment model, and the size of the coefficients for cash flow is quite similar in both specifications. Himmelberg and Petersen (1994) and Borisova and Brown (2013) analyzed financing constraints on R&D investment and reported results replacing Tobin's Q with sales growth. The estimated coefficients for cash flow are similar in size irrespective of the proxy measures for investment opportunities.

The equations to be estimated are expressed below. Equation (6.1) shows a pooled OLS estimation, and Eq. (6.2) shows a fixed-effect (FE) estimation. The reasons for using OLS and FE are that the time-series observation period is

[7] Another possible approach to detecting financial constraints is to compare the rates of return to tangible/intangible assets.

relatively short and the cross-sectional variation contains useful information.[8] All standard errors were adjusted for clustering at the firm level, which accommodates the non-independence of errors within firms over time.

$$I_{it}/K_{it\text{-}1} = a + \beta_1 CF_{it}/K_{it\text{-}1} + \beta_2 \Delta S_{it} + \varphi_{it} + \lambda_t + \varepsilon_{it} \quad (6.1)$$

$$I_{it}/K_{it\text{-}1} = a + \beta_1 CF_{it}/K_{it\text{-}1} + \beta_2 \Delta S_{it} + \varphi_{it} + \lambda_t + \eta_i + \varepsilon_{it} \quad (6.2)$$

In these equations, I_{it}, CF_{it}, and ΔS_{it} denote fixed tangible/intangible investments, internal cash flows (net profit after tax plus depreciation), and sales growth (average of past 2 years), respectively. Investments and cash flows were normalized by the beginning-of-period total capital stock ($K_{it\text{-}1}$: tangible fixed assets plus intangible fixed assets). In addition, three-digit industry dummies (φ_{it}) were used to control for industry effects. λ_t denotes year dummies, η_i denotes firm fixed effects, and ε_{it} is an i.i.d. error term. Because the data for intangible investments were available only from the year 2006, the period of analysis is 5 years, from 2006 to 2010.[9] To avoid any bias caused by outliers, we eliminated firms for which the absolute value of cash flow or tangible/intangible investments exceeded ten times the value of total fixed assets. We restricted our sample to firms that report the values of tangible investment, intangible investment, tangible fixed asset, intangible fixed asset, net profit after tax, and depreciation.

Our interest relates to the different sensitivities to internal cash flow of tangible investments and intangible investments. We expect the sensitivity to be larger for intangible investments than it is for equipment investments. However, we should not simply compare the size of the coefficients (β_1) because the value of tangible investments is approximately four times larger than the value of intangible investments (Table 6.4).[10] Thus, we calculated the implied elasticity of investments with respect to cash flow on each type of investment and compared the estimated elasticity of tangible/intangible investments (see Himmelberg and Petersen 1994).

Then, we divided the sample by firm size and firm age to identify the different effects of internal cash flow on intangible investments. The threshold to determine SMEs is paid-up capital of 100 million yen. In corporate tax policy, "SMEs" are firms with paid-up capital equal to or less than 100 million yen, irrespective of the industry.[11] The number of observations for SMEs make up about half of the total sample. We define "young firms" as those whose age after establishment is the

[8] In estimating investment functions, recent studies have often employed dynamic panel models to control for the endogeneity of regressors. However, when using a dynamic panel estimator, reasonably long panel data are necessary. Because we have only 5 years of observations, we used pooled OLS and FE estimators.

[9] Data on lagged total fixed assets from 2005 and data on annual sales from 2004 were used for the estimations.

[10] Brown and Petersen (2009) noted that the increase in the R&D share to total investment must be considered when evaluating the size of the cash flow coefficients over time.

[11] In the Small and Medium-sized Enterprise Basic Act, "SMEs" are defined by both the number of employees and the value of the paid-up capital, and the thresholds differ by industry.

Table 6.4 Summary statistics

		Full sample		SMEs		Large firms		Young firms		Mature firms	
Variables		Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Tangible investments/Total assets	*tinv_k*	0.172	0.374	0.165	0.390	0.180	0.356	0.228	0.483	0.126	0.241
Intangible investments/Total assets	*iinv_k*	0.045	0.230	0.036	0.206	0.055	0.253	0.081	0.327	0.015	0.077
Cash Flow/Total assets	*cflow_k*	0.373	1.058	0.373	1.056	0.374	1.060	0.570	1.413	0.210	0.576
Number of employees	*emp*	638	2,265	273	1,237	1,032	2,953	554	2,096	707	2,394
Sales growth (2 years' average)	*avgsale*	1.019	0.884	1.007	0.218	1.032	1.248	1.043	1.314	1.000	0.207
Number of observations		67,448		35,021		32,427		30,592		36,856	

Notes: Variables are for the years between 2006 and 2010

sample median (39 years) or less.[12] We expected the sensitivity to cash flow to be larger among SMEs and young firms because these firms are generally more likely to be financially constrained than large and mature firms are.

The list of the major variables and their summary statistics are shown in Table 6.4. In addition to the statistics for the full sample, the table reports separate statistics for the SME and large firm subsample and for the young and mature subsamples. We can observe a number of interesting facts from Table 6.4. On average, young firms invest more in intangible assets than mature firms do. The dispersion of the ratio of cash flow to total assets is far larger for young firms than for mature firms.

6.4 Results

Table 6.5 shows the estimation results of investment functions (1) and (2) for the full sample. We evaluated the statistical significance using cluster-robust standard errors adjusted for the non-independence of errors within firms. The coefficients of cash flow (β_1) are positive and highly significant in both OLS and FE estimations, and the sizes of the coefficients are similar in magnitude for both specifications. According to the FE estimation results, the coefficients are 0.0511 and 0.0225 for tangible and intangible investments, respectively (columns (3) and (4)). However, as mentioned, the value of the tangible investments is approximately four times greater than the value of the intangible investments (Table 6.4). The effect of cash flow on the percentage change in investments is greater for intangible investments than it is for tangible investments. The last row of Table 6.5 indicates the implied elasticities (evaluated at the sample mean) of tangible/intangible investments with respect to cash flow. According to the FE estimation results, the implied elasticity of intangible investments (0.187) is larger than that of tangible investments (0.111).[13] It is clear that intangible investments depend on internal cash flow more than tangible investments do. The following are possible reasons for the higher sensitivity of intangible investments to internal finance: (1) Information asymmetry between the borrowing firms and financial intermediaries is severe for intangible investments because of the limited ability of financial intermediaries to evaluate the profitability of investment.[14] (2) The collateral value of intangible

[12] We calculated firm age as the difference between the foundation year of the firm and the year of the survey. Listing status is another possible criterion with which to divide the sample firms, but the Basic Survey of Japanese Business Structure and Activities does not survey the listing status of respondent firms.

[13] The implied elasticity is calculated as the estimated coefficient for CF × (mean CF/mean investment).

[14] The higher risk inherent to intangible investments relative to tangible investments may exacerbate the influence of the information asymmetry.

Table 6.5 Estimation results of investment functions

	(1)	(2)	(3)	(4)
	tinv_k	iinv_k	tinv_k	iinv_k
	OLS	OLS	FE	FE
cflow_k	0.0542***	0.0259***	0.0511***	0.0225***
	(0.0039)	(0.0026)	(0.0071)	(0.0048)
avgsale	0.0176	0.0055	0.0639***	−0.0021
	(0.0149)	(0.0056)	(0.0194)	(0.0052)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	62,035	62,035	62,035	62,035
R-squared	0.0451	0.0951	0.0130	0.0483
Implied elasticities	0.118	0.215	0.111	0.187

Notes: Cluster-robust standard errors in parentheses, $***p < 0.01$. Adjusted R-squared for OLS estimates, R-squared for FE estimates. tinv_k, iinv_k, cflow_k, and avgsale denote tangible investments divided by total fixed assets, intangible investments divided by total fixed assets, cash flows divided by total fixed assets, and sales growth (past 2 years' average). The last row shows the implied elasticities evaluated at the sample means. The sample period is 2006–2010

assets is relatively low because of the lack of resale markets for intangible assets compared with real estate or equipment and machinery.

Table 6.6 shows the regression results achieved by splitting the sample firms into manufacturing and non-manufacturing firms. The sensitivity to cash flow is higher in the non-manufacturing subsample for both tangible and intangible investments. In particular, in the FE estimation result, the sensitivity of intangible investments to internal cash flow has a large positive value for non-manufacturing firms, but the sign of the coefficient is negative and insignificant for manufacturing firms. This result suggests that the financial market imperfection hinders productive investments among firms operating in the service industry, which may be related to the poor productivity performance of the service sector.

Table 6.7 shows the results for the separate estimations for the subsamples of SMEs and large firms. As explained in Sect. 6.2, "SMEs" are defined as firms with paid-up capital of 100 million yen or less. According to the FE estimation results, the sensitivity to cash flow is higher among SMEs than it is among large firms in both tangible and intangible investments. Among large firms, the implied elasticities of tangible and intangible investments are 0.089 and 0.169, respectively, but the figures are 0.137 and 0.216 among SMEs (see the last row of columns (7) and (8)). The result suggests that the degree of capital market imperfection is more severe for SMEs.

Next, we divided the sample into younger firms and mature firms to estimate investment functions. The median age of sample firms (39 years) was used as the threshold value to divide the sample. The results are presented in Table 6.8. It is clear that intangible investments among young firms are more sensitive to cash flow than are those among mature firms. According to the FE estimation results, the

Table 6.6 Estimation results by industry

	(1)	(2)	(3)	(4)
	Manufacturing	Non-manufacturing	Manufacturing	Non-manufacturing
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0788***	0.0471***	0.0089***	0.0297***
	(0.0121)	(0.0038)	(0.0030)	(0.0031)
avgsale	0.0032	0.0685***	–0.0001	0.0289***
	(0.0039)	(0.0157)	(0.0001)	(0.0074)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,198	30,837	31,198	30,837
AdjR-squared	0.0425	0.0546	0.0249	0.0840
Implied elasticities	0.117	0.131	0.172	0.194
	(5)	(6)	(7)	(8)
	Manufacturing	Non-manufacturing	Manufacturing	Non-manufacturing
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0412**	0.0542***	–0.0006	0.0289***
	(0.0188)	(0.0075)	(0.0048)	(0.0059)
avgsale	0.0667***	0.0586**	–0.0043	0.0049
	(0.0232)	(0.0266)	(0.0068)	(0.0071)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,198	30,837	31,198	30,837
R-squared	0.0014	0.0223	0.0000	0.0454
Implied elasticities	0.061	0.150	–	0.189

Notes: Cluster-robust standard errors in parentheses, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

sensitivity of intangible investments to internal cash flow is positive and significant for young firms, but the coefficient is insignificant for mature firms (Table 6.8, columns (7) and (8)). By the type of investment, the implied elasticities among young firms are about 0.136 and 0.187 for tangible and intangible investments, respectively. This result indicates that young firms face severe constraints in the external capital market to finance intangible investments.

Finally, Table 6.9 presents the results for young SMEs and mature large firms. Young SMEs are supposed to be the most financially restrained firms. According to the FE estimation results, the coefficients for cash flows are insignificant for mature large firms, but the coefficients are positive and highly significant for young SMEs (see columns (7) and (8)).

Table 6.7 Estimation results by firm size

	(1)	(2)	(3)	(4)
	SMEs	Large firms	SMEs	Large firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0598***	0.0459***	0.0243***	0.0272***
	(0.0048)	(0.0062)	(0.0030)	(0.0041)
avgsale	0.0063	0.0130	0.0083	0.0053
	(0.0278)	(0.0134)	(0.0063)	(0.0056)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,910	30,125	31,910	30,125
AdjR-squared	0.0563	0.0401	0.1035	0.0950
Implied elasticities	0.135	0.096	0.253	0.186
	(5)	(6)	(7)	(8)
	SMEs	Large firms	SMEs	Large firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0606***	0.0428***	0.0207***	0.0247***
	(0.0088)	(0.0113)	(0.0056)	(0.0078)
avgsale	0.0629	0.0634***	0.0025	–0.0058
	(0.0385)	(0.0180)	(0.0078)	(0.0070)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,910	30,125	31,910	30,125
R-squared	0.0201	0.0044	0.0525	0.0276
Implied elasticities	0.137	0.089	0.216	0.169

Notes: Cluster-robust standard errors in parentheses, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

6.5 Conclusion

Recent studies have shown that intangible assets play an important role in explaining economic performance and that the level of investments in intangible assets might be lower than the socially optimal level. This paper uses panel data from the Basic Survey of Japanese Business Structure and Activities to empirically analyze the financial constraints on intangible investments.

The results of the analysis can be summarized as follows:

1. Investments in intangible assets are more sensitive to internal cash flow compared with investments in tangible assets, suggesting the existence of market failure in financial markets caused by information asymmetry between lenders and borrowers or by the lack of a resale market for intangible assets.
2. The sensitivity of intangible investments to cash flow is stronger for small and young firms than it is for large and mature firms, indicating severe constraints of financing from external markets among SMEs and young firms.

Table 6.8 Estimation results by firm age

	(1)	(2)	(3)	(4)
	Young firms	Matured firms	Young firms	Matured firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0491***	0.0550***	0.0243***	0.0193***
	(0.0046)	(0.0063)	(0.0030)	(0.0037)
avgsale	0.0135	0.0831**	0.0053	0.0031
	(0.0136)	(0.0366)	(0.0057)	(0.0038)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	27,155	34,880	27,155	34,880
Adj R-squared	0.0351	0.0476	0.0836	0.0682
Implied elasticities	0.123	0.092	0.171	0.275
	(5)	(6)	(7)	(8)
	Young firms	Matured firms	Young firms	Matured firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0545***	0.0358***	0.0267***	0.0033
	(0.0083)	(0.0129)	(0.0057)	(0.0053)
avgsale	0.0398*	0.1258***	–0.0051	0.0107**
	(0.0215)	(0.0281)	(0.0069)	(0.0045)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	27,155	34,880	27,155	34,880
R-squared	0.0107	0.0083	0.0356	0.0012
Implied elasticities	0.136	0.060	0.187	–

Notes: Cluster-robust standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

The analysis in this paper suggests that the government should consider investment tax credits and financial support for intangible investments to prevent underinvestment. In particular, such policies are necessary for young and small firms that are likely to be financially constrained. However, actual policies to promote investments have been concentrated on tangible assets, with the exception of R&D.[15] Among potential policy measures, investment tax credits are effective only for firms with positive profits, but more than 70 % of Japanese firms have deficits: according to the statistics from the National Tax Agency, 72.3 % of Japanese corporations had deficits in the 2011 fiscal year. Financial support programs and direct subsidies may be more effective policy tools for firms in deficit.

[15] The effectiveness of investment tax credits or special depreciation on tangible investment itself is a controversial issue because Hall and Jorgenson (1967), Goulder and Summers (1989), for example, present positive results, whereas Pereira (1994) and Goolsbee (1998) are not supportive of the effectiveness of tax measures.

Table 6.9 Estimation results by firm size and age

	(1)	(2)	(3)	(4)
	Young SMEs	Mature large firms	Young SMEs	Mature large firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0522***	0.0345***	0.0234***	0.0197***
	(0.0054)	(0.0069)	(0.0033)	(0.0051)
avgsale	0.0847***	0.0444**	0.0055	–0.0004
	(0.0279)	(0.0215)	(0.0079)	(0.0015)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	13,895	16,865	13,895	16,865
AdjR-squared	0.0428	0.0428	0.0904	0.0662
Implied elasticities	0.137	0.057	0.206	0.229
	(5)	(6)	(7)	(8)
	Young SMEs	Mature large firms	Young SMEs	Mature large firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0564***	0.0042	0.0244***	0.0047
	(0.0096)	(0.0148)	(0.0065)	(0.0061)
avgsale	0.0146*	0.0994***	–0.0005	0.0101
	(0.0411)	(0.0219)	(0.0116)	(0.0064)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	13,895	16,865	13,895	16,865
R-squared	0.0173	0.0025	0.0417	0.0004
Implied elasticities	0.148	–	0.215	–

Notes: Cluster-robust standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

In practice, intangibility itself may be an obstacle to establishing concrete policy measures. Therefore, one possible policy option is to reduce the corporate tax rate on the one hand and to downsize the existing tax expenditures for tangible investments on the other. In addition, direct policy measures to correct market failure are desirable. The improvement of financial intermediaries' capability to evaluate intangibles and the expansion of transaction markets for intellectual property rights are examples of these policies.

This study is subject to some limitations. The data on intangible investments in this paper were confined to the acquisition of intangible assets defined by the current accounting standard. As a result, the analysis in this paper does not cover some intangible investments, such as intellectual property developed inside a firm, and organizational innovations. We used simple OLS and FE to estimate investment functions because the sample period was limited to the 5 years between 2006 and 2010. Employing dynamic panel models to control for the possible endogeneity could be a subject of future research.

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