

AGENCY COSTS, FINANCING AND CORPORATE INVESTMENT

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Abstract

As shown in the seminal Modigliani and Miller's paper (1958), under the assumption of a perfectly frictionless capital market, the capital structure of firms is irrelevant to financial sources. However, in the actual capital market, there is an asymmetry of information between management and external investors, and if a firm uses external funds, agency cost due to asymmetry of information will be incurred. So we can deduce there is a hierarchy of financial sources with respect to financial cost.

In this paper we constructed a theoretical model which showed the existence of a hierarchy of financing, assuming an asymmetry of information. Furthermore, we tested our model empirically based on data of Japanese manufacturing firms.

Introduction

Since 1991, the Japanese economy has experienced unexpected dramatic and rapid stock price declines due to a collapse of its economic "bubble." Before this event, the prices of Japanese stocks in terms of Nikkei indices continued to rise, resulting in lower cost of capital of external financing. In fact, stock financing of production industries increased rapidly, with the cost of capital only around one percent. Therefore, capital expenditures also increased eventually affecting almost all the industries. Not only real investment, but financial investment (*Zaitoku* in Japanese) reached a high level as well.

However, following the collapse, at present the formation of stock market prices must be examined as to whether they were fairly priced or not. In most cases, however, it is a commonly known fact that they were manipulated. It is said that the four largest securities companies tacitly covered losses. Such deplorable events disrupt fair formation of stock prices. We think that such events would not happen if monitoring had been made appropriately as by the SEC in the US. Also, the Japanese firms do not pay high dividends to stock holders, even in the case of high earnings. This is due to the network of mutual stock ownerships among many industrial companies and main banks. In fact, this financial system contributed to the agency cost of external financing in Japan.

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We would like to survey in the first section the periodical reviews dealing with financial constraints and investment, and in the second section examine extended model of corporate financing for investments, then test such a model using the listed companies' data, while stressing our conclusion in the fourth section.

I. *Existence of Financial Hierarchy*

In an interview-based study by G. Donaldson, most American firms prefer internal financing to external, and debt to equity financing. Recently, according to a number of different sources, agency cost or the asymmetric information approach are cited, such as the "Pecking Order Theory of Finance" by S. Myers and Majluf N., and "Financial Hierarchies" by Fazzari S., Hubbard G., and Peterson, B., (hereafter referred to as FHP). These approaches are the same in the fact that there exist some hierarchies of financing. Here the term "financial hierarchy" will be used.

(A) *Pecking Order Hypothesis*

Empirical work by the neoclassical theory or model has largely neglected the importance of financial variables. Cash flow or other financial variables play no direct role in this model, because it assumes that any desired investment project can be financed, and complete information is available to all participants in the capital market.

However, in reality the market for investment finance often suffers from asymmetric information. Firms may be reluctant to reveal proprietary information, and have an incentive to present lenders or banks with an optimistic assessment of their financial condition. Myers and Majluf (1984) show that asymmetric information about real investment projects causes conflicts of interest between existing shareholders and providers of new investment financing. When investment must be financed externally, the firm may forego desirable investment projects. But conflict of interest is removed if the firm has access to internal funds. Then, the firm undertakes all projects with positive net present value.

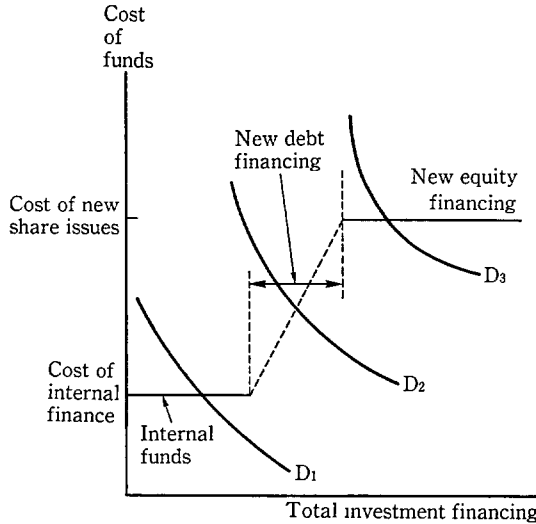
When firms issue safe debt, they need not forego desirable projects. On the other hand, issuing risky debt prevents firms from undertaking all desired investments. The notion that there is a financing hierarchy generates a rich model of financial policy. If external finance is required, firms start with safest debt first, then hybrid securities such as convertible bonds, and finally equity as a last resort.

(B) *Hierarchy Model of FHP*

FHP agree that the effective tax rate on capital gains is much lower than the tax rate on dividends. This differential gives a cost advantage to internal finance within Tobin's q framework, with the threshold marginal q value a project must attain to be undertaken depending on how it is financed. Shareholders benefit from externally financed projects only if their marginal q exceeds unity. Projects financed with retentions, however, need only attain $q < 1$.

Asymmetric information about prospects between firms and potential investors can

FIGURE 1. INVESTMENT AND FINANCING DECISIONS



create substantial cost differentials between internal and external funds. This point is best explained in the case of new equity finance. Suppose managers have better information than potential new shareholders about the true value of the firm. The true value will be revealed eventually, but new shares must be issued before that date.

A modified version of the market for “lemons” argument shows that firms may turn down some investment projects with positive net present value rather than issue new shares. They argue that the break-even q value for a new investment project is $1 + \Omega > 1$, where Ω is the “premium” necessary to compensate new investors for the losses they incur from inadvertently funding lemons.

Figure 1 shows a financing hierarchy based on the effect of asymmetric information. Firms exhaust internal finance first and issue new shares only if the marginal project has a q of at least $1 + \Omega$. A firm with internal finance and an investment demand schedule of projects ranked by Tobin’s q of D_1 , would finance investment internally and pay some dividends. With investment demand D_2 , it would exhaust internal finance, but not issue new shares. Only if a firm’s investment demand schedule intersects the upper segment of the supply of finance schedule, as with D_3 , will it issue new shares despite the cost disadvantage of external finance.

Next, FHP examine the model using the general form of the reduced form investment equation:

$$(I/K)_{it} = f(X/K)_{it} + g(CF/K)_{it} + u_{it}, \tag{1}$$

where I_{it} represents investment in plant and equipment for firm i during period t ; X represents a vector of variables as determinants of investment, and u represents an error term. The function g depends on the firm’s internal cash flow (CF); it represents the potential sensitivities of investment to fluctuations in available internal finance. All variables are

TABLE 1. SUMMARY STATISTICS AND RESULT OF REGRESSION SAMPLE OF MANUFACTURING FIRMS (1970-1984)

Statistics/independent variables	Class 1	Class 2	Class 3
Number of firms	49	39	334
Average retention ratio	0.94	0.83	0.53
Average real sales growth (percent per year)	13.7	8.7	4.6
Average years having new share issues	4	5	10
Average annual q values	3.8	2.4	1.6
Average ratio of debt to capital stock	0.57	0.52	0.33
Q_{it}	0.0008(0.0004)	0.0046(0.0009)	0.0020(0.0003)
$(CF/K)_{it}$	0.461 (0.027)	0.363 (0.039)	0.230 (0.010)
R^2	0.46	0.28	0.19

(Figures in brackets denote standard deviations. R^2 =coefficient of determination.)

divided by the beginnings-of-period capital stock K . In order to examine the empirical test, they use Value Line data for manufacturing firms, and classify firms by dividing them into three groups. Class 1 firms have a dividend-to-income ratio of less than 0.1 for at least 10 years. Class 2 firms have a dividend-to-income ratio of less than 0.2, but more than 0.1 for at least 10 years. Class 3 includes all other firms. Several summary statistics and results of the tests for the firms in each class are presented in Table 1.

In short, FHP's efforts to explain the effects of cash flow on investment deserve attention, and empirically the use of Tobin's q data as a representative variable is also noteworthy. However, we would like to further examine two points in particular in FHP's paper. The first, on a priori grounds, is that they classify manufacturing firms by the standard of individual payout ratio. We think a better criterion, however, would be to classify the firms according to size. The second is that they show that there is some hierarchy of financing, and that a firm's opportunity cost of internal funds can be substantially lower than its cost of external finance. We agree with this view, but the problem is whether the first source of financing is necessarily always retained earnings. For example, debt finance may be cheaper than retained earnings in some cases. If this is true, some of arguments within the hierarchy hypothesis may require change through further examination.

II. Formulation of the Model

We assume the management maximizes wealth or equity value of shareholders, the capital market is frictionless perfect market except for information, owners of a firm hold most shares of the firm, and there is a parity of interests between the management and the owners. However, in reality, there can be asymmetry of information and divergence of interests between owner manager and external investors, especially in this case, such as creditors including financial institutions. We regard asymmetry of information as an agency relationship between the management and creditors. We will consider the relation between agency cost and financing hierarchy generated by conflicts of their respective interests.

Suppose the management finances all investments by borrowing alone. Creditors will not hesitate to make such loans if the firm can reliably repay both the principal and interest. Consider a case in which there are two investment projects such that while each

investment opportunity has same expectations regarding return, it has a different risk or variance. Though the creditors require the lower risk project to be executed if the expectation is the same, adopting the riskier investment plan can possibly enhance the share value in light of the shareholders.¹ If the riskier project is carried out, the wealth moves from the debtholders to the shareholders. Thus investments which decrease the value of debt or bonds but increase the equity value consequently diminish the value of the firm. In short, the owners bear such cost that decreases the firm value in order to shift the wealth from the debtholders to the shareholders. This is the part consisting of the agency cost of debt. The other part is the cost taken when default or bankruptcy occurs. Of course, since bankruptcy generates great losses of debtholders, they need to monitor the management of the borrowing firm in some way to insure that it not occur. The cost necessary for this purpose is called monitoring cost. If creditors can perfectly predict the management, monitoring cost does not rise.

In the following model of analysis, we assume the agency cost of debt is given exogenously, the periods of a considered economy are two, and the management is risk-neutral for the simplicity of the analysis and to focus on the problem, although we need not assume that debtholders are risk-neutral. Furthermore, we assume that management maximizes the equity value of shareholders.

Then the management faces the following maximization problem.

$$\max_{\{B, I, D_0\}} V = D_0 + (1+r)^{-1}\bar{D}_1 \quad (2)$$

$$\text{s.t.} \quad K_0 + B = I + D_0, \quad (3)$$

$$\bar{D}_1 = \bar{f}(I) - B[1 + (r + \Omega)], \quad (4)$$

$$D_0 \geq \underline{D}, \quad (5)$$

$$B \geq 0, \quad (6)$$

where:

K_0 = initial capital (given),

B = amount of debt,

I = amount of investments,

D_0 = amount of dividend at the end of the 1st period,

\bar{D}_1 = expected value of the liquidated dividend,

\bar{f} = expected value of the profit function (differentiable with respect to I),

r = riskless interest rate,

Ω = agency cost arising from the asymmetry of information,

\underline{D} = minimum dividend amount required by the shareholders.

Here we make some comments on the above constraint equations. (3) is a budget constraint; the investment and initial dividends are financed by the initial capital and debt. (4) asserts that the residual earnings of the investment after subtracting the principal and interest of debt are all paid out as dividend. The amount of dividend must not be less than

¹ This proposition can be derived from the option pricing model (see Black and Scholes (1973)).

the minimum required by the shareholders, as represented in (5). (6) shows that the firm does not participate in lending.

We make the following Lagrangean function from (2), . . . , (6).

$$\begin{aligned}
 L &= L(B, I, D_0) \\
 &= D_0 + (1+r)^{-1} \{ \bar{f}(I) - B[1+(r+\Omega)] \} \\
 &\quad + \lambda_1(K_0 + B - I - D_0) \\
 &\quad + \lambda_2(D_0 - D) \\
 &\quad + \lambda_3 B,
 \end{aligned} \tag{7}$$

where $\lambda_1, \dots, \lambda_3$ are Lagrangean multipliers.

The F.O.C. (first order condition) for the maximization of (7) is thus given by following equations.

$$\frac{\partial L}{\partial B} = -\frac{1+(r+\Omega)}{1+r} + \lambda_1 + \lambda_3 = 0, \tag{8}$$

$$\frac{\partial L}{\partial I} = \frac{\partial \bar{f}}{\partial I} \times \frac{1}{1+r} - \lambda_1 = 0, \tag{9}$$

$$\frac{\partial L}{\partial D_0} = 1 - \lambda_1 + \lambda_2 = 0, \tag{10}$$

$$\lambda_2(D_0 - D) = 0, \quad \lambda_2 \geq 0, \tag{11}$$

$$\lambda_3 B = 0, \quad \lambda_3 \geq 0. \tag{12}$$

Further, (11) and (12) denote the complementary slackness conditions of Kuhn-Tucker corresponding to inequality constraints (5) and (6).

Now we derive optimal policies with respect to B, I, D_0 satisfying the above F.O.C. *The case that $D_0 > D$*

$$\lambda_2 = 0 \quad \text{by (11),}$$

$$\lambda_1 = 1 \quad \text{by (10),}$$

$$\frac{\partial \bar{f}}{\partial I} = 1+r \quad \text{or}$$

$$\frac{\partial \bar{f}}{\partial I} - 1 = r \quad \text{by (9).}$$

Hence we can derive the cost of capital retained earnings as r . Furthermore, by (8) and since $\lambda_1 = 1$,

$$\lambda_3 = \Omega / (1+r) > 0.$$

Thus, by (12),

$$B=0.$$

That is, the firm does not take debt financing.

We shall consider the implication that $\lambda_1=1$ from (7). In this case, λ_1 is shadow price of the value of the firm as we increase K_0 by one unit money account. That is, the increment of the firm value from each additional one dollar investment is exactly equivalent to one dollar. Thus, as we show just below, it is coincident with the marginal Tobin's q ratio (which is denoted as q^M hereafter). The marginal Tobin's q ratio is defined as a ratio of marginal increments of rate of return of capital with respect to marginal increments of investment, i.e.,

$$q^M = dV/dI.$$

Therefore, this marginal q ratio is equivalent to λ_1 . From the above arguments, if $q^M > 1$, the firm should make the investment until converging to 1.

The case that $B > 0$ (the case that firms finance investment by borrowing)

$$\lambda_3 = 0 \quad \text{by (12),}$$

$$\lambda_1 = 1 + \frac{\Omega}{1+r} \quad \text{by (8),}$$

$$\frac{\partial \bar{f}}{\partial I} = 1 + (r + \Omega) \quad \text{or}$$

$$\frac{\partial \bar{f}}{\partial I} - 1 = r + \Omega \quad \text{by (9).}$$

Thus, in this case, the cost of capital is interest rate (r) plus the cost of asymmetry information Ω . Hence, as compared to retained earnings, asymmetry information cost is the more expensive. Therefore, as far as the rate of return on investment is greater than interest rate plus the agency cost of debt, the firm should keep investing. Furthermore, by (10),

$$\lambda_2 = \frac{\Omega}{1+r} > 0,$$

$$D_0 = D.$$

That is, if financing the investments by borrowing, the optimal dividend policy is that the firm pay out the minimum dividend amount.

We now summarize results of the above analysis. If the marginal rate of return on investments is lower than the cost of capital (r), then the firm does not make investments

TABLE 2. RESULTS OF ANALYSIS

Conditions	Optimal investment	Dividend policy
$\partial \bar{f} / \partial I - 1 < r$	$I = 0$	$D_0 = K_0$
$r \leq \partial \bar{f} / \partial I - 1 < r + \Omega$	$I = K_0 - D$	$D_0 = D$
$\partial \bar{f} / \partial I - 1 \geq r + \Omega$	$I = K_0 + B - D$	$D_0 = D$

and the initial capital stock K_0 paid out as dividends. To the contrary, if the marginal rate of return is higher than r and lower than $r + \Omega$, the firm invests the residual funds after paying the minimum dividend. Furthermore, if it is higher than $r + \Omega$, the firm borrows the funds and make the investments after paying the minimum dividend amount.

III. Empirical Analysis

In the above section we argued over whether retained earnings or borrowing is the first financial source for investment, assuming there are asymmetries of information between creditors and debtors. In the process we showed the cost of capital of retained earnings to be lower than that of debt. Furthermore, this could be paraphrased by Tobin's q term. That is, though the marginal q of retained earnings is 1, that of debt is higher than 1.

In recent empirical studies of investment, Tobin's q has played an important role in investment theory. According to this theory, if the value of a firm evaluated in a stock market divided by reacquisition price of the capital is higher than 1, the firm should adopt an investment plan. It is said that there is divergence between market value and reacquisition price due to the adjusting cost which accompanies investments. On the other hand, investment decision of a firm depends on shadow price of capital (λ_1), i.e., marginal q which is the marginal firm value or marginal discounted value of cash flow with respect to one unit money account of capital.

Here we will empirically test the existence of hierarchy of financial sources of investments by investigating the cost of capital for each firm. However, it is quite difficult to estimate the actual cost of capital. But there is a one-to-one correspondence between cost of capital and marginal q in our model as derived in the above section. So we examined Tobin's q in place of cost of capital. Furthermore, we will empirically test below using not marginal q but average q as average q is equivalent to marginal q under some conditions (see Hayashi (1982)).

FIGURE 2. COST OF CAPITAL AND INVESTMENT AMOUNT

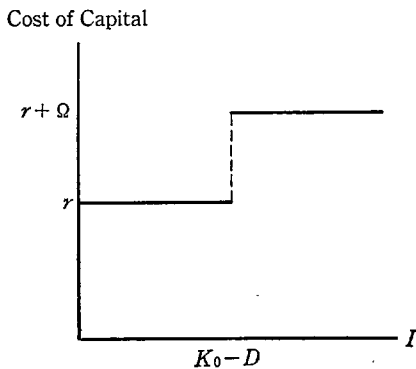
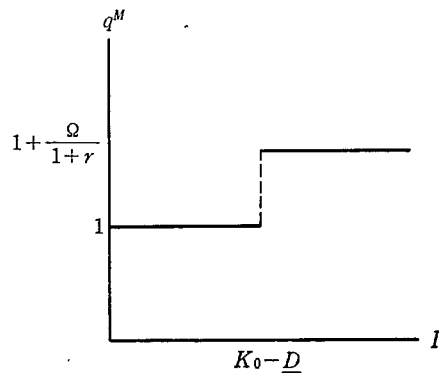


FIGURE 3. TOBIN'S q AND INVESTMENT AMOUNT



We took 36 sample firms in 3 industrial classes; electronics (17 firms), automobiles (7 firms) and precision machines (12 firms) during the ten-year period from 1977 to 1986. In addition, we used the value of average q as calculated by the Japan Development Bank. With regard to the data of financial statements, we used that of the Data Bank Bureau of Nihon Keizai Shinbun Inc., and the Japan Development Bank as recorded at the computer center of Hitotsubashi University.

III-1. Model Equations and Statistics

Financial sources of investments are not perfectly substitutional if there is an asymmetry of information. Thus we derive model equations for empirical tests which represent a non-perfect substitutional relationship between internal and external funds. We tested the following models:

model 1:

$$Q_{it} = \alpha_0 + \alpha_1(RE)_{it} + \alpha_2(D/K)_{it} + u_{it}, \quad (13)$$

model 2:

$$Q_{it} = \alpha_0 + \alpha_1(RE)_{it} + \alpha_2(D/K)_{it} + \alpha_3(RA)_{it} + u_{it} \quad (14)$$

where:

$(RE)_{it}$ = ratio of retained earnings of i th firm at period t ,

$(D/K)_{it}$ = ratio of liabilities to capital stock of i th firm at period t ,

$(RA)_{it}$ = return on total assets of i th firm at period t ,

Q_{it} = average $q - 1$ of i th firm at period t .

TABLE 3. BASIC STATISTICS
1977-1986

	Total	Electronics	Automobiles	Precision machines
Q_{it}	0.900 (1.007)	0.981 (1.017)	0.655 (0.828)	1.065 (1.175)
$(RE)_{it}$	51.736 (50.517)	36.800 (105.667)	58.845 (23.172)	59.562 (22.711)
$(D/K)_{it}$	321.726 (299.355)	432.860 (638.894)	357.275 (166.407)	175.042 (92.765)
$(RA)_{it}$	7.586 (3.447)	7.052 (4.862)	6.995 (2.065)	8.710 (3.413)
1977-1981				
	Total	Electronics	Automobiles	Precision machines
Q_{it}	0.881 (0.804)	0.997 (0.960)	0.738 (0.700)	0.907 (0.750)
$(RE)_{it}$	62.429 (23.618)	58.607 (30.277)	59.939 (22.259)	68.740 (18.319)
$(D/K)_{it}$	389.386 (376.264)	508.634 (841.373)	402.865 (161.671)	226.661 (125.748)
$(RA)_{it}$	8.969 (3.668)	8.706 (4.960)	7.616 (2.049)	10.590 (3.993)
1982-1986				
	Total	Electronics	Automobiles	Precision machines
Q_{it}	0.920 (1.210)	0.964 (1.074)	0.573 (0.956)	1.223 (1.599)
$(RE)_{it}$	41.042 (77.415)	14.993 (181.058)	57.752 (24.085)	50.383 (27.103)
$(D/K)_{it}$	264.065 (222.447)	357.087 (436.416)	311.685 (171.144)	123.423 (59.782)
$(RA)_{it}$	6.203 (3.226)	5.404 (4.764)	6.374 (2.080)	6.830 (2.833)

(Figures denote average values and figures in brackets denote standard deviations)

From the results of discussion in the above section, we can consider that the more retained earnings or the less liabilities a firm has, the lower the cost of capital is. This is the reason we tested model 1. Besides, regardless of the test of existence of hierarchy of financial sources with respect to cost of capital, we can consider that there is a positive correlation between marginal q and return on total assets by definition. So, we further tested the model including return on total assets as an explanatory variable in addition to the variables in model 1; i.e., model 2. We summarize the values of variables to estimate the results in Table 3.

III-2. Results of Empirical Tests

From the above arguments, expected signs of regression coefficients of the models are as follows:

$\alpha_1 < 0$; the higher the ratio of retained earnings, the lower the cost of capital is,

$\alpha_2 > 0$; the higher the ratio of liabilities to capital stock, the higher the cost of capital is,

$\alpha_3 > 0$; the higher the corporate profit ratio, the higher the q is.

We summarize the result of regression analysis in Table 4.

TABLE 4. RESULT OF REGRESSION

Model 1 (1977-1986)				
	Total	Electronics	Automobiles	Precision machines
α_0	0.844 (0.486)	0.835 (1.126)	1.814 (1.775)	0.910 (1.466)
α_1	0.004 (0.006)	0.007 (0.014)	0.002 (0.021)	-0.002 (0.020)
α_2	-0.001 (0.001)	-0.001 (0.001)	-0.004 (0.002)	0.001 (0.006)
R^2	0.083	0.174	0.505	0.175
Model 1 (1977-1981)				
	Total	Electronics	Automobiles	Precision machines
α_0	0.711 (0.619)	0.817 (1.809)	0.618 (1.631)	-0.249 (1.112)
α_1	0.006 (0.007)	0.009 (0.022)	0.018 (0.020)	0.008 (0.015)
α_2	-0.001 (0.051)	-0.001 (0.002)	-0.003 (0.002)	0.003 (0.002)
R^2	0.111	0.240	0.534	0.280
Model 1 (1982-1986)				
	Total	Electronics	Automobiles	Precision machines
α_0	1.011 (0.316)	0.853 (0.443)	3.009 (1.920)	2.068 (1.820)
α_1	0.001 (0.003)	0.005 (0.006)	-0.013 (0.021)	-0.012 (0.012)
α_2	-0.001 (0.001)	-0.000 (0.001)	-0.005 (0.003)	-0.002 (0.010)
R^2	0.050	0.109	0.475	0.069
Model 2 (1977-1986)				
	Total	Electronics	Automobiles	Precision machines
α_0	0.155 (0.614)	0.448 (1.046)	1.279 (2.572)	0.911 (1.748)
α_1	0.001 (0.006)	-0.010 (0.013)	-0.004 (0.032)	-0.001 (0.030)
α_2	-0.000 (0.001)	-0.000 (0.001)	-0.004 (0.703)	0.001 (0.007)
α_3	0.077 (0.055)	0.157 (0.066)	0.093 (0.340)	-0.015 (0.198)
R^2	0.177	0.399	0.649	0.230

Model 2 (1977-1981)				
	Total	Electronics	Automobiles	Precision machines
α_0	-0.354 (0.702)	0.924 (1.495)	-1.586 (2.755)	-0.504 (1.236)
α_1	0.002 (0.007)	-0.020 (0.020)	-0.001 (0.029)	0.005 (0.021)
α_2	0.000 (0.001)	-0.001 (0.001)	-0.000 (0.003)	0.004 (0.003)
α_3	0.112 (0.046)	0.169 (0.057)	0.352 (0.321)	0.040 (0.099)
R^2	0.269	0.495	0.638	0.363
Model 2 (1982-1986)				
	Total	Electronics	Automobiles	Precision machines
α_0	0.538 (0.497)	-0.029 (0.598)	4.145 (2.388)	2.325 (2.261)
α_1	-0.000 (0.004)	-0.000 (0.006)	-0.007 (0.036)	-0.007 (0.039)
α_2	-0.000 (0.001)	0.000 (0.001)	-0.007 (0.003)	-0.002 (0.011)
α_3	0.054 (0.061)	0.144 (0.075)	-0.166 (0.359)	-0.071 (0.296)
R^2	0.120	0.302	0.661	0.096

Figures in the table denote average values of sample firms while figures in brackets denote standard deviations. All estimated values of the coefficients of regression are significant at the 5 percent level in all cases assuming the disturbance terms obey normal distributions. Regarding the sign of estimated coefficients, α_1 is plus α_2 minus in general. Unfortunately, the signs appear in the opposite way as expected by our theoretical model, although those of precision machines coincide with expectation in total periods (1977~1986) in each regression model. The coefficients of determination are about 10 percent on total firms averages in all period terms in model 1 and are slightly improved in model 2. Therefore the independent variables in the models do not explain well variations in the variable Q_{it} . Though the coefficients of determination with respect to automobiles are about 50 percent in model 1 and about 60 percent in model 2, it should be considered that the number of samples in this group was only 7.

Concluding Remarks

Though we do not intend to examine the acceleration principle or Tobin's q in themselves, which have both been considered elements of investment determination, we determined that there are some differences among the costs of capital with respect to the sources of funds of investments. We thereby made analysis in connection with such theories to focus on the asymmetry of information, while theoretically showing the existence of hierarchy of financial sources. However, in the empirical tests, we were not able to obtain the results needed to fully support our theoretical model. We assert that this is not due to poor formulation of the regression model but rather in the difficulty in estimating the true value of q .

Poor performance of previous empirical tests with respect to q may have been unavoidable. To rectify this, we need to improve methods of measuring q or develop a way to estimate capital cost itself. We think these to be main themes addressed in future studies.

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