The Role of the Market Price of Risk in the Investment Decision

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1. Introduction and summary

The purpose of this paper is to reexamine the market price of risk representing expectations relevant to the investment decision of a firm, and to have a preliminary discussion to estimate it.

It is widely known that the business fluctuations are due to the changes in the rate of capital formation to a significant extent, and which gives a strong incentive to investigate the investment behavior. The real investment of the corporation, which has the most important portion of the gross national investment, is decided depending upon a number of factors categorized into either certain or predicted information. Amongst, predictions such as forecasting future demands have particular importance, whatever kind the investment decision might be.

In both theoretical and empirical studies on the investment behavior, much efforts have been paid to handle expectations in order to explain the investment decision. Unfortunately so far, it can be said that we have not yet found overwhelmingly successful concept concerning with expectations in both theoretical and empirical grounds.

Expectations, relevant to the investment decision, should appear either explicitly or implicitly in various markets like capital markets, capital goods markets and some commodities markets as well. For example, Tobin's q ratio is successful when it notes the gap of expectations in between capital market and the capital goods market, as well as the delivery lag of capital goods. Whilist it is noteworthy as a concept for expectations, it leaves a significant limit for applications to an empirical study.

It is our fundamental objective to develop a simple and measurable concept which will work well as a signal of expectations in some economic decision models. In this paper we focus our attention on the function of the capital market where expectations play a central role, and which enables us to fully utilize the contribution of finance literatures.

It is the market price of risk, which we call MPR hereafter, that expresses expectations. First we show the relationship between the MPR and the investment decision. The MPR represents an incremental expected return required to compensate the marginal increase in risk bearing through the security transactions, as is shown in the equilibrium condition of capital markets. It will increase as an uncertainty about future states grows. Therefore, it is obvious that an increase of MPR will suppress, other things being equal, the investment which inevitably accompanies risk in its prospective yields. Because, as an anticipated own risk of the investment be unchanged, an increase of MPR will make the present value of the investment declined.

Second, we investigate the problem associated with the estimation of the MPR, and

show a tentative results of it by using the data of Tokyo Stock Exhange.

Finally, we compare the empirical examlpe with the estimated average q-ratio and the rate of investment. According to the tentative result based on our idea of estimation for the long term MPR, it is worth promoting to improve the estimation of the MPR, as well as to develop a more sophisticated investment function.

2. Market Valuation and Investment

1) Tobin's q-ratio

In the neoclassical theory of corporate investment, the management is assumed to make investment decisions so as to maximize the net present value of the firm or equivalently the market value of the outstanding stocks. An investment project should be undertaken if and only if it increases the market value of the firm. The market value of the firm is determined in the capital market by capitalizing its expected future earnings. In other words, in this neoclassical framework the investment decision of the firm wholly depends upon the market valuation.

Some leading theories of investment decision, like Keynes' marginal efficiency of capital, the net present value method in capital budgeting and also Tobin's marginal q theory, are essentially based on almost the same logic as shown above.

As far as q is concerned, its relevance is totally clear, however, there exists a difficulty in applying marginal q to an empirical study, except when the assumptions derived by Hayashi [6] are plausible.[1] With regard to the definition of the denominator, no systematic explanation of its elements has been given. For an investment decision making, not only physical assets but liquid assets, intangible assets and others that do not appear on the balance sheet should be taken into account. As for the numerator, it is almost impossible to acquire the market value of an individual investment project, because the diversification, which is characteristic to modern big business, made the valuation of a firm much complexed and inseparable into the individual activities. Namely in spite of its relevance to the investment decision, marginal q can not be properly measured. What we are able to observe is nothing but the average q ratio.

Even taking these difficulties into consideration, a strong continuity of the real economy may encourage us to observe average q ratio. But it is absolutely necessary to interpret the observation with enough care.

2) The market price of risk (MPR)

For the investment decision, one of the most important factor is the capitalization rate to have the present value of the future returns generated by the investment. Generally, this rate consists of two parts, one is the risk free rate, the other is the risk premium which is required to compensate the risk bearing associated with the investment. Then the differences of capitalizaion rates among risky projects completely depend upon the anticipated risk related to their future yields. Namely, if any two firms or investment projects are supposed to identical with respect to their risk, they would have exactly the same value per unit return.

This capitalizing mechanism works in every market where trades are based on expectations of future income or benefit almost in the same manner as in the security

1) In Japan, since the first oil crisis, the linear production function has brought an insignificant result in the empirical studies.

market. Therefore there should exist various elements representing expectations in such markets as that of the consumers durable goods or the international currency.

But we dare to focus on the capital market in order to have a clear explanation of expectations. Because we consider that in a highly developed economy the prevailing factors to form expectations are closely related, and that they operate in a systematic way. Furthermore, our approach may be supported by the substantial amount of empirical studies about the efficiency of capital market.[2)]

It is the market price of risk that appears to be the central point of issue. Once noticing it, we are inclined to utilize some contributions of finance literature. But before we begin explaining the relationship between the MPR and the investment decision in the framework of finance theory, we have to make it clear what are assumed in that theory. In the two parameter world of portfolio selection, it owes much to some critical assumptions to develop a model of resource allocation in the capital market. These are the competitve market where neither transaction cost nor tax exists, complete agreement about the future and an existence of a risk free interest rate.[3)] Although they are not indispensable for every version of the theory, we assume them in this article, and therefore should take them into consideration in the interpretation of the result. Since we do not examine these assumptions theoretically into detail, we should recognize the following argument as just an approximation.

We are concerned with the two period model, (period 1 and period 2) where economic units make their decisions only at the beginning of period 1. We denote $V_{j_0}(\equiv S_{j_0}+B_{j_0})$ as the market value of firm j at the beginning of period 1 before the decision making of firms and investors, where S_{j_0} and B_{j_0} are the market value of the equity and of the debt respectively. V_{j_0} is determined in equilibrium based on expectations of the values at the end of period 1 (the beginning of period 2), where firm j's value will be $\tilde{V}_{j_1}(\equiv\tilde{S}_{j_1}+B_{j_1})$.[4)] We assume an existence of risk free rate of interest r (or $r'=1+r$), namely $B_{j_1}=r'B_{j_0}$ with the assumption of no bankruptcy for firm j.

Firm j is supposed to possess productive assets whose physical capital stock is K_{j_0} measured by a capacity unit. At the beginning of period 1, being faced with an investment opportunity set to be defined as a function below, the management of firm j must decide on an investment plan that is consistent to the best interest of current shareholders. More concretely, the management must select a desired risk class and scale of activity that characterize the expected distribution of its end of period value.

Using the notations, we express this decision making process as follows. If firm j selects an activity with particular expected risk and return, supported by the productive capacity of $K_{j_0}+\Delta K_j$ it is known that its value at the end of period 1 will be $\tilde{V}_{j_1}'(\equiv\tilde{S}_{j_1}'+B_{j_1}')$, and that its present value would be $V_{j_0}'(\equiv S_{j_0}'+B_{j_0}')$ in equilibrium of the capital market. For this decision, an investment expenditure of I_j for an additional capital stock is required at the beginning of period 1.

Similarly every investor, endowed with initial resources, must decide the allocation of what are left in the total of initial wealth and the current income after the consumption

2) Among many works concerning with this subject, Fama [3] should be refered first of all.

3) For more complete discussion of these, see [4].

4) Throughout this paper, tildes are given to the random variables.

plan for period 1.

Here, we define some other relations as follows, for firm j,

$$\tilde{R}_j \equiv \frac{\tilde{S}_{j_1}' - S_{j_0}'}{S_{j_0}'}, \quad \tilde{R}_{j'} \equiv \frac{\tilde{V}_{j_1}' - V_{j_0}'}{V_{j_0}'} \tag{1}$$

and for the market as a whole,

$$\begin{aligned} &\sum_j V_{j_0}' = V_{m_0}', \quad \sum_j \tilde{V}_{j_1}' = \tilde{V}_{m_1}' \\ &\sum_j S_{j_0}' = S_{m_0}', \quad \sum_j \tilde{S}_{j_1}' = \tilde{S}_{m_1}' \\ &\tilde{R}_m \equiv \frac{\tilde{S}_{m_1}' - S_{m_0}'}{S_{m_0}'}, \quad \tilde{R}_{m'} \equiv \frac{\tilde{V}_{m_1}' - V_{m_0}'}{V_{m_0}'} \end{aligned} \tag{2}$$

According to the security valuation theorem, in the equilibrium at the beginning of period 1, the equity value of firm j is, for any given set of investment decision by firms,[5]

$$S_{j_0}' = \frac{E(\tilde{S}_{j_1}') - \lambda b_j}{r'} = \frac{E(\tilde{S}_{j_1}')}{r' + \lambda b_{j'}} \tag{3}$$

where, $\lambda = \dfrac{E(\tilde{R}_m) - r}{\sigma(\tilde{R}_m)}$, $b_j = \dfrac{\mathrm{Cov}(\tilde{S}_{j_1}', \tilde{S}_{m_1}')}{\sigma(\tilde{S}_{m_1}')}$, $b_{j'} = \dfrac{\mathrm{Cov}(\tilde{R}_j, \tilde{R}_m)}{\sigma(\tilde{R}_m)}$, and $b_{j'} \cdot S_{j_0}' = b_j$. By substituting $E(\tilde{V}_{j_1}') = E(\tilde{S}_{j_1}') + B_{j_1}'$ and $V_{j_0}' = S_{j_0}' + B_{j_0}'$ into (3), we get

$$V_{j_0}' = \frac{E(\tilde{V}_{j_1}') - \lambda b_j}{r'} \tag{4}$$

Further, through dividing both sides by V_{j_0}' we have

$$\frac{E(\tilde{V}_{j_1}')}{V_{j_0}'} = r' + \lambda \frac{b_j}{V_{j_0}'} = r' + \lambda \frac{\mathrm{Cov}(\tilde{R}_{j'}, \tilde{R}_{m'})}{\sigma(\tilde{R}_{m'})} \tag{5}$$

Here we define the right hand side as ρ_j, that represents the required rate of return on the gross value of firm j during the period 1, and call it the cost of capital of firm j. Namely the cost of capital of firm j is expressed as

$$\rho_j = r' + \theta_j \lambda \tag{6}$$

where $\theta_j \equiv \dfrac{\mathrm{Cov}(\tilde{R}_{j'}, \tilde{R}_{m'})}{\sigma(\tilde{R}_{m'})}$ which is called the desired risk class of firm j.[6]

Since no real decisions are executed until the equilibrium relation (6) has been determined, it is strictly restricted in equilibrium to observe a capital formation through the real investment. It is not in equilibrium but in the process of tatonnement with recontracting that expectations relevant to investment decision fully function. There, expectations are different from a stage to another of recontraction, and different combinations of desired risk and return may be selected at each stages. Therefore it seems impossible to observe a signal of expectations that prevails as an influencing factor to investment decision. However, expectations at the stage very close to equilibrium could be almost the same as that at equilibrium. Especially where the sizes of each firm are not large enough to affect the return of the market as a whole, it could be reasonable to regard expectations relevant to investment as the one appearing at equilibrium. It is λ that express expectations on the market as a whole in equilibrium. It means the shadow price of a

5) There exist some forms of expression for this valuation, and each has its own particularities. For a compact summary see [6] and [7].

6) The desired risk class means the expected risk characteristics of the operation, which is selected by firm j, based on the market valuation.

constraint to the asset selection problem of individual investor. Then we call it the market price of risk and regard it as the signal of expectations on the market.[7]

Now we explain the investment decision of firm j which was briefly introduced already into more detail. Under the assumption of constant λ, firm j selects its desired class of risk, θ_j, and after that it decides the optimum rate of growth of its capacity, $g_j(\equiv \Delta K_j/K_{j_0})$. These decision process are carried out just before the market is cleared, and the decisions are assumed to be consistent to the equilibrium condition. In the equilibrium, the optimal decisions by both firms and investors should be established simultaneously.

Firm j makes its investment decision under the condition of technology that is characterized by a transformation function such as

$$T_j(E(\tilde{V}_{j_1}'), I_j, K_{j_0}, \theta_j) = 0 \tag{7}$$

Once a desired class of risk is chosen, this function shows the maximum amount of the expected market value at the end of period 1 that can be obtained with different level of investment expenditure. As for I_j, we assume that it is a linear increasing function of g_j, so that a selection of I_j corresponds one by one to that of g_j. The convexity of this relation can be understood by considering the adjustment cost for investment, as well as so called Penrose effect. It should be made clear that this function is not only unique to firm j but also is specified by both of the physical capital stock K_{j_0}, and the desired class of risk θ_j.

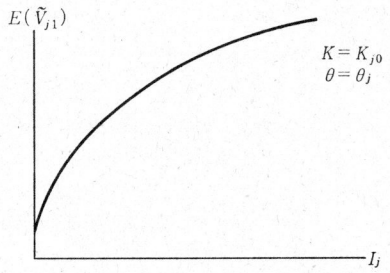

Fig. 1

Consequently, the investment problem of firm j is expressed as follows.[8]

$$\text{Max. } \Pi_j = V_{j_0}' - V_{j_0} - I_j$$

$$\text{s. t. } T_j(E(\tilde{V}_{j_1}'),\ I_j | K_{j_0}, \theta_j) = 0$$

$$V_{j_0}' \equiv \frac{E(\tilde{V}_{j_1}')}{\rho_j} \tag{8}$$

$$\rho_j = r' + \lambda \cdot \theta_j$$

To solve the problem,

$$\frac{d\Pi_j}{dg_j} = \frac{dV_{j_0}'}{dg_j} - \frac{dI_j}{dg_j} = 0 \tag{9}$$

this can be rewritten as

$$\frac{dV_{j_0}'}{dI_j} \cdot \frac{dI_j}{dg_j} = \frac{dI_j}{dg_j}$$

then Eq. (9) is

$$\frac{dV_{j_0}'}{dI_j} = 1 \tag{10}$$

This is equivalent to,

7) As for the MPR, see [8].

8) The objective function of this formulation is consistent with the best interest of the existing stockholders. It is applicable to every financing methods for I_j. In the case of retained earnings, we regard it to be acquired by the firm j additionally to s_{j_0}.

$$d\left(\frac{E(\tilde{V}_{j1}')}{\rho_j}\right)/dI_j=1 \qquad (10)'$$

Since θ_j is constant to the change of I_j,

$$\frac{dE(\tilde{V}_{j1}')}{dI_j}=\rho_j \qquad (11)$$

Now we can show the optimum investment decision graphically. In Fig. 2 where the vertical axis shows the ρ and $E[\tilde{V}_{j1}']$, OT is the transformation function, the slopes of RR and L express the MPR and the cost of capital respectively. R is the risk free rate. It is obvious that the optimum investment decision is determined, given the desired class of risk, at where the slope of L coincides with the tangency of the transformation function. Firm j should take the optimum growth policy that requires the investment expenditure of I_j^*.

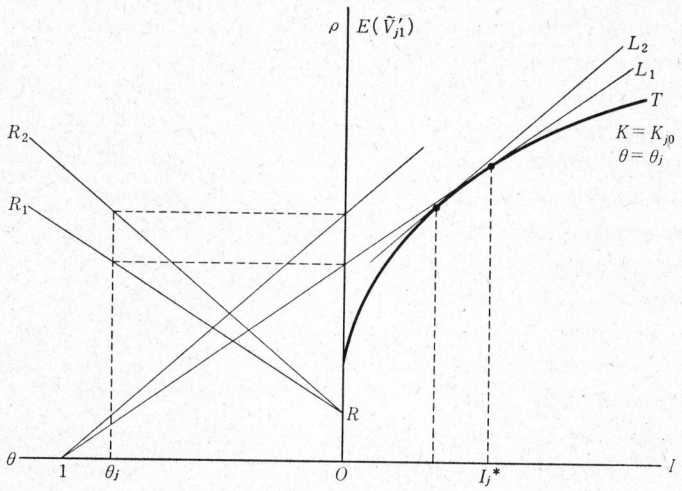

Fig. 2 Optimum decision

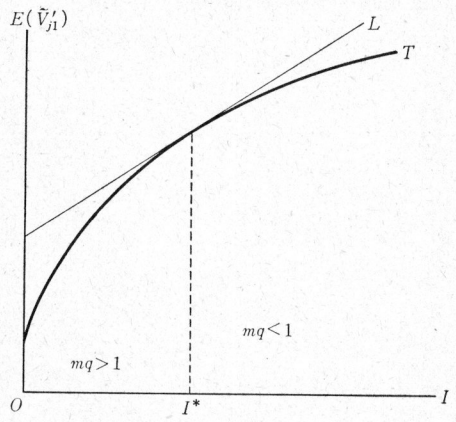

Fig. 3 Marginal *q*

If the transformation function is stable with respect to θ_j, a rise in θ_j or the MPR will suppress I_j^*. Furthermore, with any convex transformation function and θ, an increase in the MPR will definitely decrease the rate of optimum rate of growth. Therefore, it is clear that a change of the MPR is directly related to a fluctuation of the investment rate. If it becomes possible for us to measure the MPR, we can acquire the expectations in the capital market explicitly, and it will be of great help to develop an empirical study concerning with expectations.

Before proceeding to the empirical study on the MPR, we examine Tobin's marginal q ratio in the framework of this model. There would be no objection against defining marginal q to be

$$mq=\frac{d(V_{j_0}'-V_{j_0})}{dI_j} \tag{12}$$

According to Tobin and Brainard[11], the fluctuation of marginal q around the unity has a considerable importance for investment behavior. If marginal q is equal to 1, this marginal condition coincides with Eq.(10). Then it has become clear that the optimal decision derived from the maximization of the present market value of the firm is exactly equivalent to the condition of marginal q which is 1.

In Fig. 3, marginal q is greater than 1 when $I^*>I$, and it is less than 1 when $I>I^*$. Suppose by some shocks, anticipations have changed, when there is no gap of adjustment in expectations between the capital market and the capital goods market, marginal q should remain automatically to be 1 which supposed to have prevailed before. If the adjustment in the capital market is more rapid, marginal q would change depending on the valuation in the short run. It seems evident that the fluctuation of marginal q will influence the investment decision. These possible differences or gaps in the valuation between the two markets are interesting phenomena to examine, however, it is important whether they are large enough or not to influence the real investment of a firm.

As mentioned above, the criterion of optimal investment based on marginal q is perfectly substitute to the optimal decision in this model, we suggest a tentative investment function as follows.

$$I_j=f_j(K_{j_0}, \theta_j, T_j|\mathrm{MPR}, r) \tag{13}$$

where T_j is a set of parameters representing the characteristics of the transformation function.

3. Observation of the MPR

In this section, we briefly comment on the estimation of the MPR, and show a tentative result of the measurement of it.

We try neither to build an estimation model of the MPR nor to investigate the relationship between the MPR and the rate of investment empirically. Since the estimation of the expected return to the market is a big theme which is known to have difficult problem in the empirical research in finance, it requires much preparatory studies. Similarly, without taking into account other important factors we cannot analyze the empirical relationship between the MPR and the investment decision such as suggested by Eq.(13). Therefore this section should be viewed as a preliminary note for further studies.

In the equilibrium of capital markets, the MPR is expressed as $(E(R_m)-r)/\sigma(R_m)$, R_m is the predicted rate of return on market portfolio. Since R_m is a predicted value, there is no way to measure it directly by using publicized data. We must estimate both the mean and the standard deviation of the expected return on the market.

It is widely known that there has been little academic research on estimating the expected return on either individual stock or the market, in spite of the high development in the theory of finance. Exceptionally, one of the recent major contribution is Merton[8]. He mentions as the possible explanations for the lack of research on expected returns such facts as followings.

First, in many application studies in finance, they used only relative pricing relationship, so then they do not require the estimates of the expected returns.

Second, the theme of estimating the expected returns from the series of realized return data is known to be so difficult that they refrained from trying it.

And third, by the efficient market hypothesis upon which the recent development in finance theory rely, "the unanticipated part of the market return should not be forecasted by any predetermined variables.[9)]

Among these, the third is the most important. If anyone can estimate the expected return on just the market, he could realize an excess return on his portfolio consistently. If the time series of systematic risk of each securities are stable, the typical equilibrium model shows that the correct prediction of the expected return on the market makes it possible to know the exact value of expected returns on any securities in advance. But, this possibility contradicts to the principal notion of the efficient market hypothesis, and also has been rejected by some leading empirical studies. In addition, unless it is verified that a significant part of the realized return is determined by the change of expectations, it is difficult to estimate the expected return by the time series of past realized returns. For the present, a good estimation model has to predict the expost returns no matter what happens during the estimaion period. This drawback suggests us the superiority of the average q-ratio which expresses expectations by only the state variables of a given time, however, we come across the same problem as stated above when we are to estimate the marginal q.

Even taking these facts into consideration, however, we can not deny that an estimation of the expected return on the market is an exciting theme which will contribute to various financial decision to a considerable extent. Although supposing a little possibility of a rapid progress in the estimation procedure, we think it worthwhile to observe some properties of the actual MPR.

Whenever we begin observing the expected return, the first problem is the length of the period in which the return should be measured. In the model of portfolio selection, the period in which expectations of investors and firms are defined is an abstract one, and has no concrete restriction in itself. Since it is only required that all the horizons of expectations are the same among the participants in the capital market, it is unfruitful to discuss about the length of the horizon. But from a practical point of view of estimation, it might be constructive to distinguish the expected return in the short run from that in the long run. We will discuss on this matter later.

In the following of this section, categorizing the expected return into those of the short term and of the long term, we will briefly comment on the measurement of each returns.

1) Short term expected return

As was pointed by Fama[4], the observed distribution of expost short term return is sensitive to the period of measurement, it seems difficult to have a priori hypothetical model in which the short term return is determined by other economic variables. There have been a number of researches on the feature of the return distribution which follow some stochastic processes belonging to Markov Chain, therefore it could be advantageous to estimate the distribution of the short term return, which can be assumed to be identical for a short period, by actual returns.

It is necessary to get a hypothetical period in which not only the structure of expectations is stable but also statistically sufficient data are available. This condition

9) in Merton [8], p. 5.

suggests that the estimation in a short period, for example a few weeks or a month, is less difficult than for a longer period, like a year or more. Merton[8] is an excellent example, where assuming a diffusion process in expected return, he made a good performance in estimation by developing three kinds of models for short term return.

2) Long term expected return

Since the anticipation of the long term return should be closely related to the consumption and investment decision, it seems possible to make an estimation model of it with other economic variables. Besides the estimation of the long term return shares some problems with that of short term return in common, the most distinct difference is the fact that, even if we see only the actual returns, we can be free from the trouble of having such returns as negative or less than risk free rate by extending the horizon. Nevertheless, as is stated above, we have to admit a great possibility that the longer term expost return dose not reflect the true expectations. This dilemma, that it is the long term expected return that is relevant to the consumption and investment decision making, but the longer the actual return we take, the greater the possibility of having wrong data becomes, is one of the major problems. We expect that the longer the period of measurement is, the less the volatility of expost return would be. In the very long run, the actual excess return could be nearly constant. It is an interesting question that in what length of period for the return measurement, the variance of return can be viewed stable, where the movement of the MPR is substituted by the expost excess return. Hence, the period of return measurement is so important that we will try a number of length to measure the expected return.

The fundamental concept to distinguish the short term return from the long term return depends on the notion about the valuation mechanism of the market. That is, the market valuation may possibly exposed by various kinds of disturbances in the short run, but it works well to respond to the earnings of firms in the long run, and which suggests a close relationship between the expected return and other economic variables in the long run.

3) Tentative measurement of the MPR

At the moment, the available data of actual rate of return are quarterly rate of return on the value weighted market portfolio of Tokyo Stock Exchange from 1955 to 1983.[10] For the measurement of the MPR, we assume that the rate of return on the market during time t to $t+T$ follows a fair game process. In other words, when we observe a long term return by taking many sample returns within a long period, on average, the expected difference between the actual rate of return, $R^p_{t,t+T}$, and the anticipated rate of return, $R^a_{t,t+T}$, is zero. We define

$$e_{t,t+T} \equiv R^p_{t,t+T} - R^a_{t,t+T}$$

where $e_{t,t+T}$ is a random error term which has

$$E(e_{t,t+T}) = 0$$

$$\mathrm{Cov}(e_{t,t+T}, e_{t,t+T-1}) = 0$$

We can write the assumption as follows.[11]

$$E(e_{t,t+T}) = E(R^p_{t,t+T} - R^a_{t,t+T})$$

10) The raw data of rates of return on the market portfolio of Tokyo Stock Exchange are those published by Japan Securities Research Institute. The number of the corporations listed in TSE is about 850.

11) Throughout the empirical part, every return is annualized no matter what period it is based on.

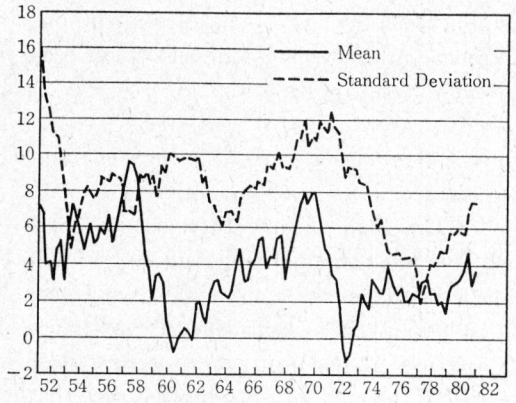

Fig. 4 Mean and standard deviation of the market return (12 quarters)

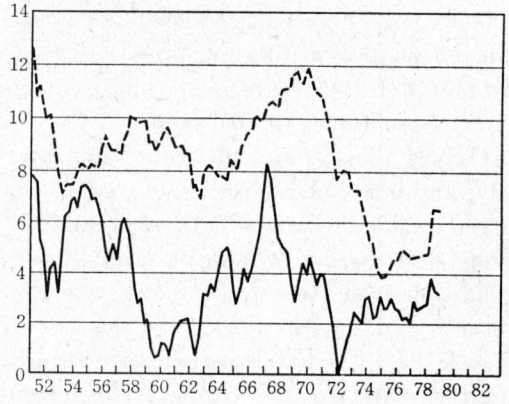

Fig. 5 Mean and standard deviation of the market return (20 quarters)

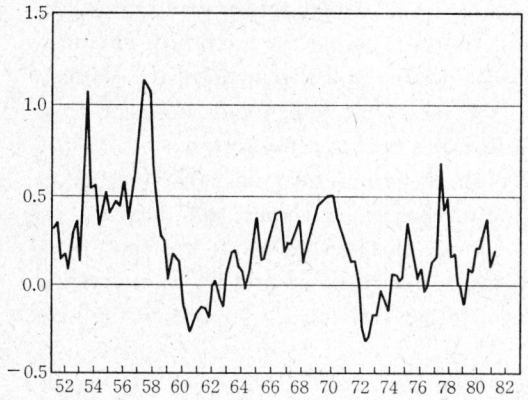

Fig. 7 Estimated MPR (12 quarters)

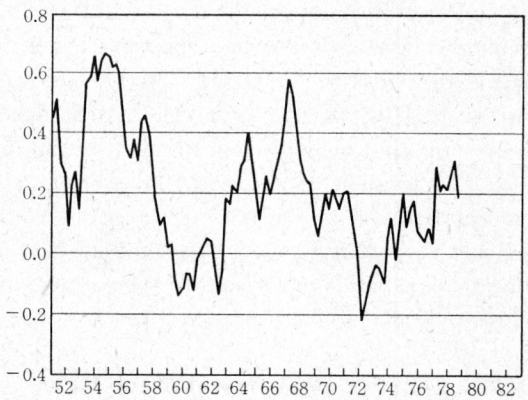

Fig. 8 Estimated MPR (20 quarters)

$$= R^{p}_{t,t+T} - E(R^{a}_{t,t+T}) = 0 \tag{14}$$

The reason why we assume a fair game is that it has no restriction on the underlying stochastic process except the strong premise on the expected return, and that in contrast with the short term return it seems inappropriate to consider the long term return to be distributed identically throughout the long period. The basic interval of the measurement is T which corresponds to the expectations period. If we take T sufficiently long, it may be reasonable to observe the realized returns as a substitute for the expected returns. $R^{a}_{t,t+T}$ is measured as the mean of sample returns during T. As for the variance, we assume that the anticipated variance of the return from time t to $t+T$ is shown as the variability of returns which realized in the interval from t to $t+T$. That is, the anticipated variance of the return from t to $t+T$ is the sample variance of the actual return around $(R^{p}_{t,t+T})$, where $R^{p*}_{t,t+T}$ is adjusted to be a quarterly return.

$$\text{Var}\ (R^{a}_{t,t+T}) = \frac{1}{T} \sum_{\tau=1}^{T} (R^{p}_{t+\tau-1,t+\tau} - R^{p*}_{t,t+T})^{2} \tag{15}$$

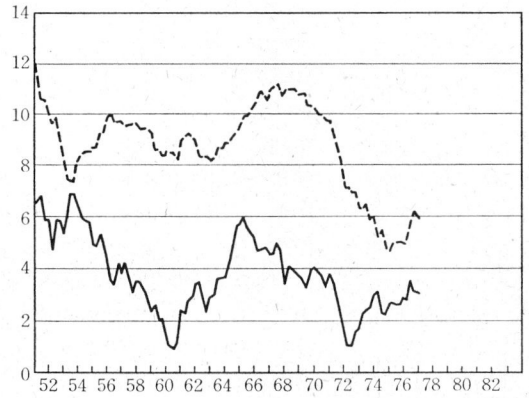

Fig. 6 Mean and standard deviation of the market return (28 quarters)

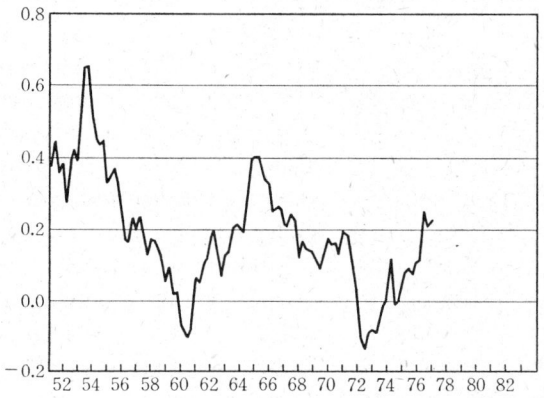

Fig. 9 Estimated MPR (28 quarters)

As for the risk free interest rate, thinking over the condition of Japanese bond market which had been controlled by the government to a considerable extent, we use as the risk free rate the yields on the bond of Japan Telephone and Telegraph Public Corporation guaranteed by the government.

We tried three cases for the interval T, they are $T=12$, 20, 28 quarters; i. e. the measurement of long term expected rate of return is based on the time horizon of 3, 5 and 7 years. We can find no rational reason for selecting these periods, except for 7 years that is the average life of tangible fixed assets in Japanese manufacturing corporations.[12]

The observed expected rate of returns and standard deviations are shown in Fig. 4 to Fig. 6, and the estimated MPRs are in Fig. 7 to Fig. 9.

We can find two interesting results in this observation. First, as we expected, the longer T is, the more stable the estimated expected returns and standard deviations are. Because the measurement based on the shorter periods reflects more straightly the actual volatility of returns, and it leaves us a larger possibility of taking abnormal figures. With respect to the sensitivity of the estimates to the length of the period, there are similar trends or cycles in the estimated expected return among the three cases, despite of their seemingly different figures. The estimated standard deviations fluctuate in the short run, but are stable in the longer interval case.

According to this tentative result, it can be suggested that in the long run there definitely exists a trend or a cycle in the expected return, which is closely ralated to the business fluctuation, while the anticipated standard deviation might be stable. Second, contrary to the result that the estimated expectation and variance of the return depend upon the time interval T, the measured MPR do not differ so conspicuously among the cases. It may be pointed out that the peaks and bottoms in the measurements coincide each other. It is due to the effect of a kind of standardization built in the definition of the MPR that

12) National Wealth Statistics, 1970 Economic Planning Agency of Japan.

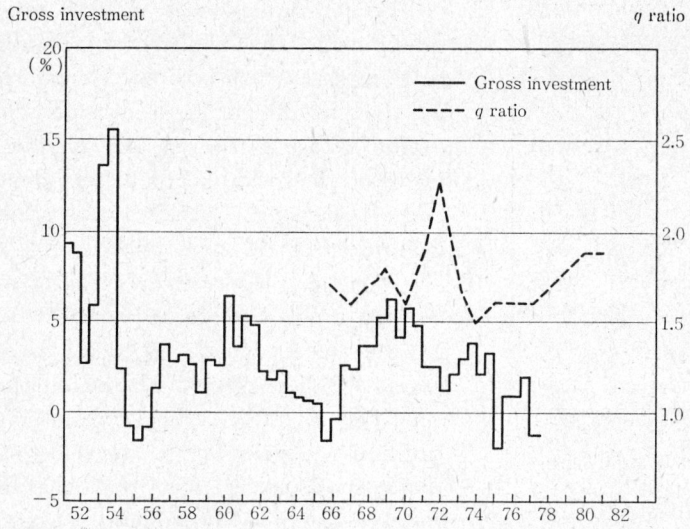

Fig. 10 Gross investment to capital stock and average *q*

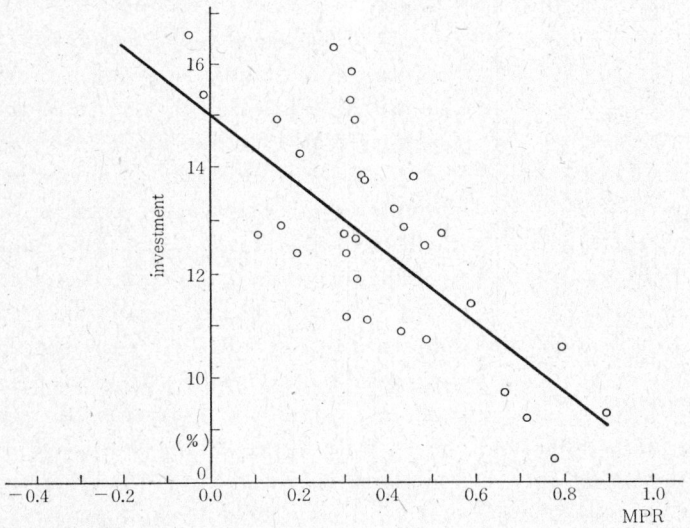

Fig. 11 The MPR (28 quarters) and the investment 〈1955–1971〉

Table 1 Correlations between the MPR and investment

	The rate of gross investment to capital stock	
	1955–1977	1955–1971
MPR lags		
0	−.466	−.691
1	−.462	−.718
2	−.499	−.747
3	−.494	−.735

the reemblance in these figures has been brought about. We are not sure that this tentative result suggests a small sensitivity for the measurement of the long term MPR to the length of time horizon. If this phenomenon is frequent in various methods of measurement, the estimation of the long term MPR will be strongly encouraged.

Finally, we compare the observed MPR with the average q and the rate of investment (gross investment to capital stock), Fig. 10. We see that throughout the obsevation period, the q was stable except in 1972, while the measured MPR decreased. Even taking into consideration the massive computation required for the estimation of average q and possible mistakes caused by it, it is hard for us to expect an interesting relationship between them. There is a clear relation between the MPR and the rate of investment, that exactly what we predicted. A rise in the MPR, which implies an increase in uncertainty, depresses the investment, and vice versa. We find a substantially negative correlation between them.

We must pay attention to the assumptions made in the model to derive the MPR, when we interpret the empirical results. Such factors as taxes, transaction costs and competitiveness of the capital markets would have unnegligible

effects on the MPR. Especially in this decade Japanese economy experienced some critical impacts both institutionally and structurally. In addition, we must also consider a possible periodical gap between the formation of the MPR and the records of actual economic decisions, that could be caused by a number of systematic differences between them. As for this phenomenon, we see a significant lag structure in their relation.

In Fig. 11 and Table 1, we look at the correlation between the MPR and the investment as well as their lag structures.[13] Their relation is the closest in the case of two quarters lag, and for the period before the first oil crisis it appears more significant.

We do not deny a possibility of the reverse causation between them by these correlation arguments only, however, we are convinced of a good reason to proceed further researches on them.

4. Conclusion

We have investigated the role of the MPR in the investment decision within the context of a competitive capital market. It is suggested that the MPR will draw an attention as a signal of expectations, and will contribute to improve the investment function.

In the empirical study, we have reexamined some problems associated with the estimation of the MPR, and have introduced a few ideas to estimate it. It is stressed that the exact time on which expectations are based is important. The tentative observation for the long term return shows the dependence of the measurement on the sample period, however, the common feature among some cases encourages further studies. In addition, the relationship between the MPR and the rate of investment, though it still remains superficial, has appeared to be consistent with what we expected.

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13) We excluded the early 1950s from the investigation of the relation between the MPR and the investment, because it is widely known that there existed a serious disturbance in Japan economy caused by Korean War.

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