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Return on Equity, the Cost of Capital and Income Taxation: Evidence from the Japanese Industries

by

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Abstract

We estimate required rates of return on equity for all firms listed in the first section of the Tokyo Stock Exchange using both CAPM and Fama and French three-factor model with monthly data from January 1980 through December 1999. We report the summary statistics at the industry level to compare the equity cost of capital among industries. We also compare the cost of equity for Japan with the US result by Fama and French (1998) at the industry level. Then, we estimate the weighted-average cost of capital, excluding financial firms, by computing the effective interest rates and the average tax rates for each firm using the actual data. At a next step, we compute the marginal cost of capital for typical Japanese firms in each industry. To do so, we use both original Miller and Modigliani tax correction model and the after-tax value relationship formulation by Miller (1977) before the Miller equilibrium gets reached. By using reasonable parameter values based on the prevalent and the hypothetical corporate and individual income tax rates for Japan, we demonstrate how tax change policies can affect the cost of capital for Japan, and, hence, the capital allocations in the economy. Finally, we investigate the association between the long run trends of return on equity, the equity premium, and the productivity growth rates, and show how aggregate cost of capital changes along with business cycle changes.

I. Introduction

After Modigliani and Miller formulated the concept of the cost of capital in 1958, the theory of the cost of capital and the optimal financing choice have been elaborated to incorporate tax considerations (Modigliani and Miller (1963) and Miller (1977)), bankruptcy cost, agency cost, and information asymmetry. We will focus on the issue of corporate and personal income taxation in this paper. The effect of taxation on the cost of capital and the resulting capital allocation decisions are important issues not only to corporate finance research, but also to public finance research. This issue is taken up from the viewpoint of the policy neutrality and the capital reallocation decisions inside country and across countries (Sinn (1991) and Jorgenson and Yun (2001)). Recently, Easley and O'Hara (2001)) introduced the informational asymmetry for both firms and investors in the capital markets and show how this assumption affect the equilibrium cost of capital among firms in one country and among different countries.

Aside from the cost issue, how we measure the corporate income for taxing purposes is another important issue, because the international accounting standards for income measurement are directed towards the use of comprehensive income concept. From the viewpoint of valuing the firm, Lehmann (1993), for example, points out that it is important to measure capital gains and losses to correctly evaluate the value of the firm under Miller and Modigliani (1961) dividend irrelevance propositions. Hence, the propositions by Lehmann are in a way in support of comprehensive income measurement view.

From a viewpoint of individual household, on the other hand, Poterba (2001) analyzes the significance of the tax policy on the household investment decisions. Also, from a viewpoint of maximizing firms Auerbach (1979, 2001) formulated the dynamic objective function for value-maximizing firm, and shows how tax rates affect firms' new share issue and dividend payment decisions.

However, even though the original Modigliani and Miller's (1958) paper presented some empirical evidence on the cost of capital using the data from US utility industry, relatively little work has been done to estimate the cost of capital within the framework of the formal cost of capital theory. Fama and French (1998), exceptionally, thoroughly estimated the cost of equity within the framework of their three-factor model. As well known, a market-wide factor, the size-related "so-called" SML factor, and the book-to-price ratio-related "so-called" HML factor are used in Fama and French's three-factor model.

In another line of research the cost of equity concept has been extensively used to estimate the so-called Edwards-Bell-Ohlson model (Ohlson (1995)). In this model the cost of equity is an important parameter along with accounting numbers to estimate the fundamental value of firms (Frankel and Lee (1998). The traditional dividend discount model and Miller and Modigliani dividend irrelevance proposition are assumed (Lehmann (1993)) in this type of research. With the same framework, however, one can also infer implied cost of equity given the future earnings and the current market value of the firm (Fama and French (1998) and Gebhardt, Lee and Swaminathan (2001))[1).

As for previous empirical studies that estimated the cost of capital for Japan, McCauley and Zimmer (1989) show empirical comparisons of the cost of capital among several countries, including Japan. However, they did not explicitly incorporate the cross-sectional difference of risk of firms and hence the difference of the cost of capital in Modigliani and Miller's "risk class" sense. The similar criticism also applies to other studies that estimated the cost of capital for Japan by Ando and Auerbach (1988) and Suzuki (1992).

In this paper we incorporate the cross-sectional risk difference of firms as Fama and French (1998) did for US firms. We use both CAPM and Fama and French three-factor model to estimate the required rate of return on equity for individual firms. We report estimation result using both models, even though there is ample evidence that the multivariate asset pricing theory is a better return generating model for Tokyo Stock Exchange firms both in the cross-section (Jagannathan, Kubota, and Takehara (1998)) and in the time-series (Kubota and Takehara (1997)). It is because the CAPM is still widely used among practitioners.

Then, with Modigliani and Miller theory and the formulation by Miller (1997) before Miller equilibrium gets reached we analyze the effect of corporate and individual taxation for firms at the industry level, given their debt equity ratios and effective interest rates. We also conduct some experiments of tax rate changes and investigate the effects on the marginal cost of financing. Finally, we look at the business cycle considerations.

Our paper outline is the following. In Section II we formulate and synthesize the cost of capital concept under taxation. In Section III we describe our data. In Section IV we explain the estimation method for return on equity. In Section V we report our main estimation result of the cost of equity. In Section VI we compute the hypothetical cost of capital under some alternative tax regimes and explore the implications of the tax rate change policies. In Section V we analyze the empirical dynamic behavior of the cost of equity along with the business cycle changes. Section VI concludes.

II. The Cost of Capital and Income Taxation: Different Views

Miller and Modigliani (1963), in their classical tax correction paper, defined the following variable ρ_τ as the after-tax adjusted cost of capital, assuming there exists only corporate income tax in the economy. In the equation (1) $\widetilde{X}$ is the future net operating income of the firm, which is an i.i.d. random variable, t_c is the corporate income tax rate, V is the value of the firm, and the subscript U denotes a firm without debt.

$$\rho_\tau \equiv \frac{E(\widetilde{X}) \times (1-t_c)}{V_u} \qquad (1)$$

The value of the firm without debt, which is called an unlevered firm, is given in (2) at the equilibrium (Modigliani and Miller (1958, 1963)), given the "risk class" of the firm. Then, the value for the firm with debt called "levered firm" is given as in equation (3). The subscript *L* means firm with outstanding debt *D*.

$$V_U = \frac{E(\widetilde{X}) \times (1 - t_c)}{\rho_\tau} \tag{2}$$

$$V_L = V_U + t_c \times D_L \tag{3}$$

Furthermore, under the regime of both the corporate income tax and the personal tax, the following price relationship between the levered firm and the unlevered firm holds as in equation (4) (Miller (1977)) before the so-called Miller equilibrium gets attained. Miller equilibrium gets attained when the aggregate demand and supply of debt capital coincide. In this relationship (4) we denote the coefficient term on D_L as *g* for simplicity. In this equation, each *t* is the tax rate, in which subscript *c* denotes corporate tax, *gd* average tax rate from capital gain and dividend income, and *i* the tax rate on individual interest income received. Miller (1977), furthermore, argues that this preferential benefit of taxation for debt disappears as equilibrium is attained and thus *g* below becomes zero in this equilibrium. On the other hand, Grinblatt and Titman (1998, p. 502) argue that corporations cannot utilize the full benefit of this tax shield. It is not clear whether Miller equilibrium at the aggregate level really holds (Sinn (1991)). We use, hence, the relationship like the equation (4) when *g* is not equal to zero as our benchmark equation for the following empirical studies.

$$V_L = V_U + (1 - \frac{1}{(1 - t_i)} \times (1 - t_c) \times (1 - t_{gd})) \times D_L$$

$$\equiv V_U + g \times D_L \tag{4}$$

In a classical corporate finance literature and in the practice the concept of weighted average cost of capital (hitherto we denote *WACC*) is oftentimes used. We will show in the following how this concept is related to the "adjusted cost of capital" defined by Modigliani and Miller (1963).

One can expand the weighted cost of capital as follows, in which we define the weighted-cost of capital, *WACC*, as the after tax net operating income before interest payments. *S* denotes market value of equity and *r* the interest rate. *ROE* is the return on equity.

$$\begin{aligned}
WACC &= \frac{E(\tilde{X}) \times (1 - t_c)}{V_L} \\
&= \frac{(E(\tilde{X}) - rD_L) \times (1 - t_c) + rD_L \times (1 - t_c)}{V_L} \\
&= \frac{S_L}{V_L} \times \frac{(E(\tilde{X}) - rD_L) \times (1 - t_c)}{S_L} + \frac{D_L}{V_L} \times r(1 - t_c) \\
&= \frac{S_L}{V_L} \times \frac{E(\tilde{X}) - (E(\tilde{X}) - rD_L)t_c - rD_L}{S_L} + \frac{D_L}{V_L} \times r(1 - t_c) \\
&= \frac{S_L}{V_L} \times ROE + \frac{D_L}{V_L} \times r(1 - t_c) \qquad (5)
\end{aligned}$$

Thus, we find that the weighted average cost of capital can be represented as the weighted average of the equity return after tax and interest payments and the debt return after taking into considerations the tax shield effect, in which weights are equity-asset ratio and debt-asset ratio. On the other hand, Modigliani and Miller adjusted after tax cost of capital of equation (1) above was defined with respect to the value of the unlevered firm. Hence, using equation (2) the following inequality holds when the firm has positive amount of outstanding debt.

$$\rho_\tau \equiv \frac{E(\widetilde{X})\times(1-t_c)}{V_U} > WACC \equiv \frac{E(\widetilde{X})\times(1-t_c)}{V_L} \qquad (6)$$

In the following we will show the relationship between this Modigliani and Miller tax adjusted cost of capital and the return on equity after tax, assuming the relationship (3) under the corporate tax. Let us define $\overline{\pi}^\tau$ as the expected net income after tax. That is,

$$\begin{aligned}\overline{\pi}^\tau &= E(\widetilde{X}) - (E(\widetilde{X}) - rD_L)t_c - rD_L \\ &= E(\widetilde{X})\times(1-t_c) + rD_Lt_c - rD_L \ . \end{aligned} \qquad (7)$$

From equations (4) and (7), then, the following holds.

$$\begin{aligned} V_L &= \frac{E(\widetilde{X})\times(1-t_c)}{\rho_\tau} + gD_L \\ &= \frac{E(\widetilde{X})\times(1-t_c) - rD_L + rD_Lt_c}{\rho_\tau} + \frac{rD_L}{\rho_\tau} - \frac{rD_Lt_c}{\rho_\tau} + gD_L \\ &= \frac{\overline{\pi}^\tau}{\rho_\tau} + \frac{rD_L}{\rho_\tau} + \frac{g\rho_\tau - rDt_c}{\rho_\tau} \end{aligned} \qquad (8)$$

By subtracting D_L from both side of this equation, we get

$$S_L = \frac{\overline{\pi}^\tau}{\rho_\tau} - \frac{\rho_\tau - r}{\rho_\tau}\times D_L + \frac{g\rho_\tau - rDt_c}{\rho_\tau} \quad . \qquad (9)$$

After arranging for return on equity term on the RHS of the equation, we get

$$\frac{\overline{\pi}^\tau}{S_L} = \rho_\tau + \left[(\rho_\tau - r) - (g\rho_\tau - t_c r)\right]\times\frac{D_L}{S_L} \ . \qquad (10)$$

Or, equivalently, if we arrange the term with respect to after-tax adjusted Modigliani and Miller cost of capital ρ_τ defined in equation (1), we get

$$\rho_\tau = \frac{\bar{\pi}^\tau / S_L + (1-t_c)\times r \times \dfrac{D_L}{S_L}}{1+(1-g)\times \dfrac{D_L}{S_L}} \quad . \tag{11}$$

We can compute *WACC* from (5) when there is only corporate tax. On the other hand, we can compute cost of capital from our equation (4) (Miller (1997)) *a la* Modigliani and Miller adjusted cost of capital from (11) when there are both personal income tax and corporate tax. In order to do so, we use the estimated expected return on equity, *ROE*, obtained from the stock market, the debt-to-equity ratio using total equity market value of the equity, and the available tax rates.

The *WACC* has been used in the traditional finance literature to discount the investment project for the firm and to decide whether to accept project or not. More recently it is used to compute the so called EVA^{TM} to measure the value created by the firms.

On the other hand, in Modigliani and Miller (1958, 1963) adjusted cost of capital concept, the marginal cost of equity financing is the tax adjusted cost of capital, while the cost for debt financing is adjusted for the corporate tax shield. When the firm uses the target debt-to-asset ratio for financing the new project, the marginal weighted-cost of capital can be derived as the weighted-average of these costs as shown in the following equation (12) (Modigliani and Miller (1958)).

How can we get implication about firm's investment decisions and financing decisions from these two different thoughts? In this paper, we derive the cost of capital from the viewpoints of investors who are concerned with the after -tax yield. The spirit is in par with Poterba (2001) and it is our equation (4) which is the relationship before Miller equilibrium is attained.

We present the formal derivations of the marginal cost of capital in our Appendix, because they are standard results except that we replace g in Miller (1977) for t_c in Modigliani and Miller (1963).

The cost for equity in which new financing is 100 per cent conducted by equity is $\frac{1}{1-t_c}\rho_\tau$, and the cost for debt is $\frac{1-t_{gd}}{1-t_i}\times\rho_\tau$. Then, if we denote L^* as the target debt ratio for the firm, we get the following marginal weighted cost of equity based on Modigliani and Miller theory.

$$WACC_{MM} = (1-L^*)\times\frac{1}{1-t_c}\times\rho_\tau + L^*\times\frac{1-t_{gd}}{1-t_i}\times\rho_\tau \qquad (12)$$

So far our results are for outside financing. What would be the cost of internal financing via retained earnings under the corporate taxation? Sinn (1991) discusses this issue thoroughly. In the US there is only one corporate tax rate no matter how much firms pay out dividends, while in some European countries and in Japan until 1990 (see Table 4) the reduced corporate tax rate applies up to the amount firms pay as dividends. The effects of these tax differentials are summarized in Table 1 of Sinn (1991). He, moreover, argues that there are both old views and new views on how taxation affects the cost of equity. However, Sinn (1991) assumes risk-free economy. On the other hand, Miller's (1997) does not distinguish between the capital gain tax rate and the personal tax rate for dividend income, while Sinn (1991) does. Besides, these marginal tax rates changed as the government policy changed (Scholes *et al* (2002, p.11)) in the U.S.A. as well in other countries. These differences complicate the reconciliation between the view of Miller (1997) and Sinn (1991), because corporate and personal taxation is widely different among countries.

We, in this paper, use the model by Miller (1997) to analyze the effect of taxation on Japanese cost of capital. Besides, since the preferential tax rates for paid dividend do not exist anymore for Japan, we assume there exits only one corporate tax rate as Miller analyzed. Moreover, in view of the recent changes in personal taxation on stock holding in Japan applicable for coming several years toward the uniform tax rate for both capital gain and dividend income, the simplification by Miller seems acceptable for our research purposes.

III. The Data

We use monthly returns of manufacturing and non-manufacturing firms listed in the First Section of the Tokyo Stock Exchange from September 1980 to December 1999. The number of the sample firms is 1,351, and, after excluding financial firms and missing data, it is 1,084. The maximum data months to compute returns were hence 232 months, while the minimum months were 37 months. The average months were 201 months.

All the data used in our study is available at the Institute of Policy and Planning Sciences, University of Tsukuba. The primary source for the return data for the period up to December 1989 is the Japan Securities Research Institute monthly stock return tape. For the observation after 1990 the primary source for the return data is Nikkei NEEDS Data Service. For overlapping period we confirmed that they are completely identical.

The primary source for accounting variables in computing the book-to-price ratio to form the HML factor for Fama and French (1993) model is the Nikkei NEEDS data base supplied by the Nihon Keizai Shinbun Inc (Economic Information Department, Data Bank Bureau). We form HML factor and SMB factor as of September 1st every year. We sort stocks to form factor portfolios according to the procedure used by Fama and French (1993). Firms are firstly sorted into two categories based on their market value of their equity, and within each size class firms are further sorted into three categories based on their book-value-to-market-price ratios. The book-to-price ratios are computed from the book values at the end of the fiscal year that ends on or prior to March 31 and from the market price at the end of August of the current year. Thus, for each portfolio formation year firms are assigned to each one of these portfolios by the information publicly available at the end of August. In this portfolio formation process all sample firms that appear in our return file each month is always included in computing our portfolio returns. This means that the survivorship bias is minimal, because the Nikkei Tape includes all firms that are listed in each month. The value-weighted index is computed from this same data set. For risk free rate we use call rates without collateral reported by the Bank of Japan, again available on Nikkei NEEDS data.

IV. Estimation of Required Rates of Return on Equity

It is well known that a multivariate asset-pricing model is a better theory to describe the return generating structure of Tokyo Stock Exchange firms. For example, Jagannathan, Kubota, and Takehara (1998) show that Fama and French model works almost as good as their labor income risk model for Japanese sample, while the CAPM cannot explain stock return variations well. However, in our paper we estimate the cost of equity with both the standard CAPM and Fama and French three-factor model for comparison purposes. This is also because one factor model is still used in capital-budgeting decisions in the U.S.A. (Graham and Harvey (2001)) or because CAPM can be used with additional real option premium interpretations (Jagannathan and Meier (2002)). Also, in Japan the pension fund performance evaluations are widely conducted by one factor model instead of multifactor model.

The standard CAPM is written as follows. In the following equation (13) $E(R_i)$ denotes the expected return for each stock, $E(R_m)$ the expected return for the market portfolio, R_f the risk free rate, and β_i the market beta.

$$E(R_i) = R_f \times (1 - \beta_i) + \beta_i \times E(R_m) \quad (13)$$

Fama and French three factor model is composed of following three factors; the value-weight excess market returns, the size factor spread portfolio (SML), and the book-to-price ratio factor spread portfolio (HML). The Fama and French's three factor model is denoted as equation (14) where $E(R_{SMB})$ is the expected return of the "small minus big" factor portfolio and $E(R_{HML})$ is the "high book-to-price ratio minus low book-to-price ratio" factor portfolio. Each beta coefficient is the corresponding factor loading for each stock or portfolio.

$$E(R_i) = R_f + \beta_{i1}(E(R_m) - R_f) + \beta_{i2}E(R_{SMB}) + \beta_{i3}E(R_{HML}) \qquad (14)$$

We assume the model is unconditional in this paper. Return on equity is also defined as the rate before tax

Thus, we use both the CAPM and Fama and French three-factor model, and estimate those using individual firm data. Fama and French (1998) pointed out that there exist substantial estimation errors for individual firms' estimates, especially with Fama and French model. Frankel and Lee (1998), for example, estimate the industry level cost of equity for every industry-portfolio and then apply this same number to all firms in the same industry to compute the fundamental value for each firm. We do not use this method, because we believe that identifying the dispersion of the cost of equity in the same industry is important. However, we only report the aggregate statistics at the industry level obtained from individual firms' estimates[2)]. To justify this simplification, we have to assume that the error terms are not intra-firm correlated within each industry. We run once-for-all time-series OLS regressions. In the next version of the paper, however, we will also estimate the conditional asset-pricing model with reasonable instruments, and analyze the changes in the conditional required rates of returns at different business cycle facets[3)].

V. Empirical Result

a. The Industry Cost of Equity and Factor Loadings

In Table 1 we report overall summary statistics of the estimates of the required rate of return on equity for our 1,351 sample firms. In the first two columns we present monthly excess returns using both CAPM and the Fama and French three-factor model. We notice that the average monthly required returns are higher for Fama and French model than CAPM: 0.62 *vs*. 0.32. The standard deviations are also higher for Fama and French model. We also notice that the median is lower than the average in case of Fama and French three-factor model and the distributions are skewed to the right.

In the third and fourth columns of the Table 1 are the annualized costs of equity where we impose the risk free rate to be 1.5 percent. The 8.92 per cent return for Fama and French model is 3.4 per cent higher than 5.30 per cent for CAPM. It gives us strong warning against using CAPM, if the multivariate model is a true representation of the asset returns.

In the next Table 2 we report the summary statistics of the estimated annualized equity rate of return for all firms in each industry. The industry classifications are based on the two-digit classifications by the Tokyo Stock Exchange. In the column furthest to the left, we report the number of firms included in each industry. We caution that there are several industries with a very small number of sample firms: *e.g*., Air industry and Communication. For most of the cases, the cost of equity is higher for Fama and French model than for CAPM, although there are some exceptions. The numbers in the lowest row show the simple averages of industry figures.

Let us focus on the result from Fama and French model in this table, because it is a better empirical model than CAPM for Japan. The highest ranked four industries using mean values are in its descending orders, Security Brokerage industry, Construction, Real estate, and Metal. In view of the boom and the following collapse of the asset and mortgage price around 1990 the high risk of these three industries is not surprising. For the Metal industry it may be the case that the price of gold or coppers is highly correlated with financial asset price.

On the other hand, the lowest ranked six are, in ascending order, Communication industry, Pharmaceutical, Services, Nonferrous Metals, Banks, and Land Transportation. It is interesting that Communication, Banks and Land Transportation industries have been regulated to some extent and also Pharmaceutical products are subject to governmental approval. The quick interpretation for this phenomenon might be the hope for government intervention in case of firm's distress, which helps reduce the required rate of return. As for Pharmaceutical, this is the least levered industry, of which point we come back later in the paper and this can lower the return on equity through reduced financial risk. As for Service industry, since it is a highly labor intensive industry and relies heavily on part-time workers, we judge that the adjustment cost of this industry during the recession is smaller.

In Table 3 we report medians of factor loadings for each industry, because there is no *a priori* reason to believe that the distributions are symmetric. As for the CAPM case, Securities industry, Communication, and Real Estate show high factor loading betas, while Banks, Electric Power and Gas and Pharmaceutical show low market betas. However, we also note that the alpha estimates are very large for most industries. Even after extracting risk free rates, we expect that the intercept term will be significantly from zero and thus we reconfirm that CAPM will not be a correct pricing model (Grinblatt and Titman (1987)).

When we look at the result from Fama and French model, overall there are not substantial differences in loadings on market factor between these two models, while the alpha coefficients become substantially closer to zero. This supports the use of Fama and French model in pricing stock return series.

As for the SMB factor loadings only the Utility and Gas industry has negative loadings. In this case, the smaller is the firm, the smaller the return, which would be an exceptional case. As for HML factor loadings there are more industries with negative loadings. These are Communication industry, Glass and Ceramics Products and Precision Instruments. The growth firms in these industries may be related to the "IT bubble" that were prevalent around the world during our sampling period.

Next, we compare the result between the US and Japan. The Table 4 reports our result *versus* the one from Fama and French (1998). We show the annual expected equity premium values for both. We tried to match industries by similar industry classifications in Fama and French (1998) as much as possible, because the classification codes in the US are different from the ones in Japan. We could not find the match for some industries, while there are several duplications. If we compare the numbers in the lower bottom of the row that show the simple averages of all column numbers with some overlapping, we note that the difference between CAPM result and Fama and French model result for the US was 2.8 per cent. That is: for the US as well Fama and French model gives us higher cost of equity than CAPM! Although there are several industry-wise differences, the US cost and Japanese one are similar in case of Fama and French model, while in case of CAPM the one for Japan is about 1.4 per cent lower than for the US. It is also noteworthy that the premium is lower for Japan for Banks and higher for Construction than the US. Since the US study covers the period between 1963 and 94, while our study covers the period between 1980 and 1999, the simple comparison may not be meaningful. But, the comparison shows the robustness of the cost difference between CAPM and Fama and French model among two countries, and also the overall similar characteristics among industries between the US and Japan.

b. Computation of Effective Tax rates and Interest Rates

In order to compute the after tax adjusted cost of capital which we derived in Section II of the paper we give necessary parameter values applicable for Japan. Table 5 shows the history of Japanese corporate government tax rates. In addition to this governmental tax, firms have to pay local prefecture tax of 12 per cent. Until April 1990 there was preferential corporate tax rate applied for the paid dividends. As for the capital gain tax for individuals, it was not taxable until 1987. For the dividend received, one can utilize the 20 per cent withheld rate, if the dividend amount received is within some range. The capital gain tax rate, however, was changed in 1988. With this new code one can choose between the joint filing marginal income tax rate or the simple rate of the sales price multiplied by 5.25 per cent and further 20 per cent. In 2002 these tax codes on stock holdings were abolished and currently the taxation change is under scrutiny towards the flat 10 per cent for both the dividend income and capital gains at least for coming several years. We, hence, use 50 per cent corporate tax for our initial calculations. Also, in view of the extremely low dividend yield in Japan during our sampling period and the absence of capital gain tax until 1988, we assume away the tax on holding the stock also at our initial calculations. Both of these assumptions will be relaxed in the next section.

Table 6 shows the pre-calculations of debt-to-total asset ratios and marginal tax rates. Total value of equity is the market price times the number of shares. The debt items include short-term and long-term bank borrowing, commercial paper, and bond and convertible bond measured by the historical issuing cost. We use five-year average from 1966 through 2000 to compute these numbers in hope for avoiding the year-to-year variations in debt equity ratios (Welch (2002)). The total assets are defined as the sum of these two numbers. The computed debt-to-total asset ratios are shown in the columns from two to five. By looking at medians, we find that Pharmaceutical industry is very low geared at 7.72 per cent. This point was already raised in conjunction with the low required return on equity on this industry. On the other hand, Real Estate and Other Financing Business are highly debted at 66.65 per cent and 75.54 per cent, respectively. The averages of medians and means for all industries are 47.06 per cent and 45.84 per cent, which implies the debt-to-equity ratio of less than one, measured in market value of the equity. Note that we do not include Banks, Insurance, and Securities industries in this calculation, because it will not be appropriate to include deposits, money accounts owned by investors, and the insurance premium in the calculation of the debt cost of capital. If we include these, it may make comparisons even difficult.

The last four columns to the right in the table show the results for average tax rates for each firm. The effective tax rates are computed as the total tax payment, both the government and the local, divided by the pre-tax income for tax purposes. In Japan, except for the tax deferral debit account or credit account, the measured income for financial purposes has to be basically in line with the income for taxing purposes with respect to the depreciation and inventory costing, unlike in the US. The differences in these computed average tax rates among industries, hence, reflect the differences in the tax savings and the tax credits allowances across industries as well as differences in accounting treatments across industries. Research and development related expense is one example with this regard. Hence, theses effective rates are not the same with the aforementioned marginal tax rates. We find that the average rate is 38.07 per cent from the average of means in the lowest bottom of the table.

In the following Table 7 we compute the effective interest rates as follows. We divide the total interest paid during the fiscal year by the debt outstanding computed as the average of the beginning of the period value and the end of the period value. Then, we take the five-year average of 1996 through 2000. Reflecting the recent low interest rate during this period, the average of medians in the table was 2.61 per cent.

c. Computation of Weighted Average Cost of Capital and Modigliani-Miller Tax Adjust Cost of Capital

From the computations in the previous subsection of the paper we can compute the *WACC* defined in equation (5) of the Section II in this sub-section. The results are shown in Table 8. By reflecting the low interest rate and the tax-deductible effect for interest payments, the weighted cost of capital is 3.55 per cent with CAPM and 4.33 per cent for Fama and French using averages of medians. With CAPM the cost of capital for Construction industry is surprisingly low, while Fama and French model can detect the true risk of Construction industry, in which many companies went bankrupt afterwards.

Table 9 compares this *WACC* with Modigliani and Miller tax adjusted cost of capital defined in equation (1) to see whether the inequality (6) holds. In Both for CAPM and Fama and French case, we find the latter is higher than the *WACC* as suggested in the Section II. With CAPM it is 4.44 percent versus 3.98 per cent and with Fama and French model it is 6.68 per cent versus 5.51 per cent. In Figure 1 these industry-wise Modigliani and Miller tax adjusted cost are plotted against the debt to total asset ratios. The plots are almost flat and the intercept term of from a standard OLS regression is insignificantly different from zero. This is in line with the empirical study on Utility companies presented in the original Modigliani and Miller (1958) paper. These results justify the use of Modigliani and Miller tax adjusted cost concept when there is not personal income tax.

VI. The Marginal Cost of Capital and Policy Implications from Income Taxation

Based on equation (A-3) and (A-4) in the Appendix and (12) in Section II we compute the cost of new financing under both the corporate tax and the individual income tax in this section. Modigliani and Miller tax adjusted cost is modified to allow for personal income (Miller (1997)). These relationships were derived in equation (11) of Section II and our empirical results are computed from this equation (11). Also, because this is the marginal concept we want to explore, we use the marginal corporate tax rate of 50 per cent, instead of the effective average rate computed in the previous section. If the new investment were eligible for any tax credit, however, this reduction effect would have to be taken into account for the firm's optimal decision making.

Table 10 shows the result. The three columns to the right are by similar computation with Table 9 except that tax rate of 50 per cent is assumed this time. Equation (4) reduces to equation (1) because there is no personal income tax in the case of Table 9. The left columns in Table 10 are the cases for 10 per cent personal income tax rates on interest received, but without dividend and capital gain tax. The header Cost MM is the Modigliani and Miller tax adjusted cost and it is also the cost for new 100 per cent debt financing. As is expected, the cost of new financing by the equity is much higher for both cases. The averages shown in the bottom row are 12.86 per cent versus 6.43 per cent with personal income tax. It is even more than 5 per cent higher. In case of no personal income tax, these are 6.92 per cent versus 13.84 per cent. With the typical mixed financing with both equity and debt the weighted-average of cost capital *a la* Miller is 9.98 per cent versus 10.73 per cent *a la* Modigliani and Miller. In all cases the personal income taxation can reduce the cost of new financing. This is because the required yield on debt before income tax becomes higher and the advantage of debt financing enhances the value of the levered firm defined in equation (4) of Section II.

In the next Table 11 we change the parameter values of the tax rates to see the effect of different taxation on the cost of equity and hence the re-allocation of capital. In the left columns we impose 10 per cent tax rate both on capital gains and dividends received, in addition to the 10 per cent tax on interest income, as Japanese tax codes propose to do in coming years. If one compares this result with the previous result in left columns if Table 10, we notice that the additional 10 per cent tax levying on equity income raises the cost of capital only about 0.5 per cent. This does not seem to be a serious detriment against the investment decision motives for firm managers.

In the right hand columns are the case when the corporate tax rate is reduced to 35 per cent on top of the assumptions above. The effect is quite drastic. Although the cost of debt financing does not change as expected, the cost of equity financing decreases from 13.33 per cent to 9.33 per cent. Also, the mixed debt-equity financing based on the current firms' ratio decreases from 10.33 percent to 7.90 per cent. The former is a large 4 per cent reduction and the latter is also a 2.4 per cent reduction. The former effect would be important, because it implies the required return on equity before tax is drastically reduced and thus will enhance the aggregate corporate investments. It also benefits the stock holders by increasing the value of their owned stock as long as the firms accepts investment projects that can surpass this lowered cost of capital [5)].

Hall and Jorgenson (1967) years ago investigated the effect of Kennedy's 1962 investment tax credit and the corporate tax rates reduction in 1964 on firms' investment decisions and the capital formation. Although our analysis is not based on the explicit firms' optimal objective functions as theirs, we could present the evidence that the corporate tax rate reduction can reducing the cost of capital *ceteris paribus* with the actual capital market data.

VII. Economic Dynamics and the Trend of Required Rates on Equity

In a neoclassical growth model with certainty the economic growth rate, the real interest and population growth coincide in a steady state. In an uncertainty model as well, the cost of capital and the economic growth rate should coincide in a frictionless economy However, with frictions, for example, the labor immobility the cost of capital can be either pro-cyclical or counter-cyclical to business cycles (Christiano and Fisher (1995)). The use of conditional asset pricing model instead of unconditional model seems also important in this analysis. However, in this paper we only look at the aggregate behavior of the cost of equity versus the business cycle growth.

Figure 2 reports the trend of net operating income after tax divided by total assets for 20,000 firms in Japan. This aggregate net operating income after tax figure was reconstructed from Hojin Kigyou Tokei issued by the Ministry of International Trade and Industry using the definition by Miller and Modigliani (1963) tax adjusted cost of capital in equation (1) of Section II. The historical ratio started from less than 3 per cent in 1980 and decreases to one percent in 1998. It is even lower than the cost of debt financing which we reported in our Table10. One should, however, note that the sample contains all 20,000 firms, among which smaller firm is not making money at all. Even so, it is unlikely that the marginal returns on firms' new projects always surpassed the cost of capital.

The Table 12 shows historical summary of the variables, which are pertinent in determining asset prices in a dynamic equilibrium model; *i.e.*, the real consumption growth, the index real returns, and the real interest rate for Japan and the US. Because we have compared the cost of equity in Section III, we again do the same for the above variables. The first row for the US case is from Mehra and Prescott (1985), which reveals the well know equity premium puzzle. In the last three rows we show the more recent results from Jagannathan and McGrattan (1996). On the other hand, in the first row are the results for Japan between 1970 and 1997. We find that these numbers are comparable to the US case between 1981 and 1991, the last row of the table. The index real returns are both at around 11 per cent while the short-term real rate is higher for Japan than for the U.S.A. Because Japan has low interest rate period in 1990s, this difference is disappearing. So, it is fair to say these numbers are comparable. For example, Kubota, Tokunaga, and Wada (2002) show the existence of the equity premium puzzle using the data between 1986 till 1998.

In the following we analyze the direct relationship between economic growth and the rate of return on equity and investigate how the long run trend of economic growth and the one of equity returns are related each other from the business cycle perspectives. In a following equation (15) $RV\hat{W}_t$ is the trend component of value-weighted market index real return after being applied Hodrick-Prescott filter (Hodrick and Prescott (1980)) with the lambda value of 1600. Similarly the variable $GD\hat{P}_{t-l}$ is either the real return of GDP or its trend component again after being applied Hodrick-Prescott filter. In Figure 3 we plot the trend components of real GDP growth against the cyclical components and we show the definition of the economic recessions by Economic Planning Agency in the bottom of the figure. The long run trend is decreasing gradually and almost uniformly as the Japanese economic long run growth rate saturates and turns around.

$$RV\hat{W}_t = a + bGD\hat{P}_{t-l} + e_t \qquad (15)$$

The subscript l denotes an index that shows quarter lead and lags. The positive l means GDP lead of the market index, and the negative values denote the case where GDP lags behind the market index in equation (15). In a former case, the positive and significant b coefficient in this regression equation means that the stock market anticipates the future GDP growth.

Table 13 shows the OLS coefficients of these regressions where the t-values inside parentheses are Newey and West corrected for any auto-correlated structure. We find that, for GDP case, the regression coefficients of the trend of components of stock real returns are significant from the leads of 4 quarters till contemporaneous time. However, they are not significant after time zero and the trend of stock returns cannot predict the future cycle turnaround of economic growth. On the other hand, in case of the trend components of GDP, they are all significant from four quarters back to three-quarters after. Moreover, the leads are highly significant and the magnitude of significance decrease uniformly.

This is evidence that the long-term trend of productivity and the trend of equity returns co-move each other. Hence the evidence support a simple neoclassical growth model implications. Hence, the cost of capital is indeed related to the productivity of aggregate economy. It supports the concept of the cost of capital proposed by Modigliani and Miller (1958), in whose proposition the marginal efficiency of the capital and the returns of the financial assets are integrated by using the concept of financial market arbitrage[6)].

VIII. Conclusion

We estimate required rates of return on equity for all firms listed in the first section of the Tokyo Stock Exchange using both CAPM and Fama and French three-factor model with monthly data from January 1980 through December 1999. We report the summary statistics at the industry level to compare the equity cost of capital among industries. We also compare the cost of equity for Japan with the US result by Fama and French (1998) at the industry level. Then, we estimated the weighted-average cost of capital, excluding financial firms, by computing the effective interest rates and the average tax rates for each firm using the actual data. At a next step, we computed the marginal cost of capital for typical Japanese firms in each industry. To do so, we used both original Miller and Modigliani tax correction model and the after-tax value relationship formulation by Miller (1977) before the Miller equilibrium gets reached. By using reasonable parameter values based on the prevalent and the hypothetical corporate and individual income tax rates for Japan, we demonstrated how tax change policies can affect the cost of capital for Japan, and, hence, the capital allocations in the economy. Finally, we investigated the association between the long run trends of return on equity, the equity premium, and the productivity growth rates, and showed how aggregate cost of capital changes along with business cycle changes.

Footnotes:

1) Fama and French (2002) estimate the implied equity premium with a somewhat different model using only the return growth and the dividend yield.

2) The estimates for individual firms are available on request from the authors.

3) The importance of distinguishing between the conditional equity premium and the unconditional one is, for example, emphasized in Constantinides (2002) in resolving the equity premium puzzle.

4) Poterba (2001) analyzes the relationship between taxation and portfolio returns for individual investors.

5) However, we also note that Aiyagari (1995) has proven the social welfare is maximized in a competitive equilibrium when capital gain tax is non-zero.

6) Chen (1991) empirically examines the relationship between equity return, GDP growth, and the state variables related to economic productivity. Christiano and Fisher (1995) derive the relationship between the equity return and the marginal efficiency of capital in a dynamic equilibrium under uncertainty.

Appendix:

The arithmetic and the procedure to compute the cost of capital for new financing are as follows. We utilize the relationship (4) in the main text. When a new project of which investment outlay is I is taken, the value of the levered firm will increase if and only if the following inequality holds.

$$\frac{dV_L}{dI} = \frac{(1-t_c)}{\rho_\tau} \times \frac{dE(\tilde{X})}{dI} + g\frac{dD_L}{dI} \geq 1 \qquad \text{(A-1)}$$

Simplifying the above inequality we get the following.

$$\frac{dE(\tilde{X})}{dI} \geq \frac{1-g\frac{dD_L}{dI}}{1-t_c}\rho_\tau \qquad \text{(A-2)}$$

When the new financing for this project is covered by 100 per cent equity issued, dD_L / dI term is zero. Hence, the right hand side of the equation (A-2) reduces to the following (A-3). Thus, we note that the cost of capital for equity financing is higher than the after tax cost of capital defined in (1) in the main text by the order of corporate income tax $(1-t_c)$.

$$\frac{dE(\tilde{X})}{dI} \geq \frac{1}{1-t_c}\rho_\tau \qquad \text{(A-3)}$$

On the other hand, when the new financing is covered by 100 per-cent debt financing, dD_L / dI in equation (A-2) is one and we get the following.

$$\frac{dE(\tilde{X})}{dI} \geq \frac{1-g}{1-t_c} \times \rho_\tau = \frac{\frac{(1-t_c)\times(1-t_{gd})}{(1-t_i)}}{1-t_c} \times \rho_\tau = \frac{1-t_{gd}}{1-t_i} \times \rho_\tau \qquad \text{(A-4)}$$

When the capital gain and dividend tax is zero, it is a standard result for the cost of debt for new financing.

Finally, if we denote the target leverage ratio for a particular firm as L^* and assume that the firm finances the new project following this target leverage ratio, the weighted cost of capital *a la* Modigliani and Miller adjusted for tax can be computed as following. In equation (A – 5) it is the weighted average of the cost of capital for equity financing and for debt financing, where again we assume the relationship derived by Miller (1977) of equation (4) in the main text to hold.

$$WACC = (1 - L^*) \times \frac{1}{1 - t_c} \times \rho_\tau + L^* \times \frac{1 - t_{gd}}{1 - t_i} \times \rho_\tau \qquad \text{(A-5)}$$

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Table 1

Estimated Cost of Equity for Japanese Firms: Summary Statistics

	Monthly Excess Return		Annualized Cost of Equity	
	CAPM	Fama-French	CAPM	Fama-French
Min.	−0.07	−1.10	0.66	−11.74
1st Qu.	0.25	0.36	4.55	5.86
Median	0.32	0.57	5.33	8.34
Mean	0.32	0.62	5.30	8.92
3rd Qu.	0.37	0.82	5.97	11.39
Max.	1.41	2.36	18.46	29.78
S.D.	0.11	0.39	1.28	4.68
Skewness	1.34	0.69		
Kurtosis	15.55	5.17		

The samples are all listed firms in the First Section of the Tokyo Stock Exchange. The number of the estimated firms was 1,351 and the estimation period is from January 1980 through December 1999. We use both CAPM and Fama and French three-factor model to estimate the expected excess return model using monthly data. The annual expected cost of equity was then computed by multiplying these numbers by 12 and adding the assumed risk free rate of 1.5 percent. The reported numbers are the aggregate summary of each firm's cost of equity covering these 1,351 Japanese firms. All numbers are in per cent.

Table 2
Industry Average Cost of Equity

		CAPM				Fama-French 3 Factor Model			
	Firms	1st Qu.	Median	Mean	3rd Qu.	1st Qu.	Median	Mean	3rd Qu.
Fishery & Agriculture	7	4.99	5.24	5.18	5.58	7.99	9.24	8.96	10.23
Mining	8	5.25	5.46	5.57	5.96	7.81	10.61	9.84	11.66
Construction	116	4.65	5.46	5.41	6.00	10.73	12.53	12.99	15.26
Foods	60	4.15	4.79	4.64	5.25	5.41	7.04	7.19	8.64
Textiles & Apparels	49	4.58	5.44	5.33	5.91	7.48	8.91	9.83	10.53
Pulp & Paper	19	4.54	5.30	5.24	5.78	6.61	8.52	8.60	10.36
Chemicals	108	4.98	5.48	5.47	5.97	5.12	7.31	7.30	9.25
Pharmaceutical	35	4.06	4.59	4.49	5.05	3.63	4.97	5.67	7.73
Oil & Coal Products	10	4.47	5.17	5.15	5.57	6.33	8.71	8.24	10.11
Rubber Products	9	4.53	4.92	4.99	5.79	6.53	7.57	8.88	10.47
Glass & Ceramics Products	30	4.91	5.63	5.48	6.08	5.01	7.65	7.66	9.70
Iron & Steel	39	5.34	5.83	5.83	6.44	8.50	9.96	10.59	13.04
Nonferrous Metals	24	5.19	5.58	5.66	6.25	4.64	7.19	6.74	9.24
Metal Products	30	4.49	5.07	5.15	5.36	7.75	10.56	11.32	14.18
Machinery	103	5.12	5.61	5.67	6.25	7.01	8.48	9.30	11.11
Electric Appliances	137	5.02	5.63	5.61	6.01	4.36	6.22	7.17	9.06
Transportation Equipment	55	4.29	5.01	5.05	5.65	5.86	8.27	9.39	11.95
Precision Instruments	21	4.53	5.40	5.24	5.79	3.52	7.09	6.86	10.29
Other Products	36	4.43	5.01	5.14	5.79	5.79	7.89	8.84	12.33
Electric Power & Gas	14	4.15	4.23	4.45	4.79	7.05	7.76	7.65	8.40
Land Transportation	31	4.22	4.68	4.55	5.21	5.67	6.86	6.84	8.21
Marine Transportation	13	5.90	6.14	6.10	6.55	8.86	10.22	9.88	10.83
Air Transportation	4	4.59	4.96	5.18	5.54	7.45	8.78	7.65	8.98
Warehousing	12	5.17	5.42	5.49	5.74	9.60	10.44	10.62	11.33
Communication	4	6.23	7.06	7.09	7.92	−2.67	−0.10	0.14	2.71
Wholesale Trade	84	4.75	5.54	5.56	5.99	7.74	10.03	10.60	13.32
Retail Trade	75	4.05	4.84	4.77	5.38	6.45	9.39	10.28	12.43
Banks	103	3.10	3.78	4.22	5.10	4.82	6.52	6.81	8.45
Securities	20	7.00	7.64	7.71	8.45	12.61	15.64	15.17	16.46
Insurance	14	5.57	5.78	5.76	6.06	6.75	7.41	7.48	8.12
Other Financing Business	17	4.49	5.64	5.42	6.42	7.86	9.51	10.14	11.05
Real Estate	22	5.39	6.24	6.20	7.21	8.75	13.33	13.33	17.46
Services	42	4.71	5.37	5.68	6.45	3.48	7.01	6.37	10.26
Total and Averages	1351	4.81	5.39	5.41	5.98	6.50	8.53	8.74	10.70

The samples are all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,351 and the estimation period is from January 1980 through December 1999. We use both CAPM and Fama and French three-factor model to estimate the expected excess return model with monthly data. The annual expected cost of equity was computed by multiplying these numbers by 12 and by adding the assumed risk free rate of 1.5 percent. All numbers are in per cent. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications.

Table 3
Industry Median Factor Loadings

		CAPM		Fama-French 3 Factor Model			
	Firms	Alpha	Beta	Alpha	BetaM	BetaSMB	BetaHML
Fishery & Agriculture	7	−14.13	0.93	−0.55	0.92	0.82	0.17
Mining	8	−16.37	0.99	−0.62	0.95	1.20	0.18
Construction	116	−4.29	0.99	−0.61	0.94	1.06	0.74
Foods	60	17.92	0.82	0.01	0.79	0.56	0.12
Textiles & Apparels	49	6.01	0.98	−0.22	0.89	1.30	0.15
Pulp & Paper	19	12.83	0.95	−0.17	0.89	0.83	0.09
Chemicals	108	9.92	0.99	−0.01	0.94	0.91	−0.02
Pharmaceutical	35	52.79	0.77	0.50	0.72	0.44	−0.04
Oil & Coal Products	10	−14.86	0.91	−0.38	0.90	0.67	0.19
Rubber Products	9	15.38	0.85	0.04	0.94	0.61	0.20
Glass & Ceramics Products	30	15.32	1.03	−0.03	1.00	0.91	−0.21
Iron & Steel	39	−6.96	1.08	−0.40	1.02	1.16	0.41
Nonferrous Metals	24	21.08	1.02	0.09	0.95	0.87	−0.16
Metal Products	30	4.51	0.89	−0.42	0.82	1.10	0.57
Machinery	103	1.49	1.03	−0.22	0.98	0.92	0.11
Electric Appliances	137	31.15	1.03	0.26	0.98	0.50	−0.06
Transportation Equipment	55	−0.22	0.87	−0.23	0.85	0.53	0.27
Precision Instruments	21	0.67	0.97	0.00	0.87	0.87	−0.18
Other Products	36	16.65	0.88	−0.11	0.82	0.67	0.14
Electric Power & Gas	14	31.19	0.68	0.04	0.77	−0.39	0.67
Land Transportation	31	14.86	0.79	−0.04	0.80	0.13	0.24
Marine Transportation	13	−5.57	1.16	−0.39	1.17	1.54	0.13
Air Transportation	4	−2.38	0.86	−0.18	0.81	0.68	0.37
Warehousing	12	6.16	0.98	−0.33	1.00	0.87	0.38
Communication	4	47.39	1.39	0.73	1.27	0.14	−1.18
Wholesale Trade	84	−1.50	1.01	−0.30	0.95	0.84	0.46
Retail Trade	75	−15.46	0.83	−0.44	0.79	0.51	0.40
Banks	103	6.50	0.57	−0.16	0.59	0.24	0.26
Securities	20	2.75	1.53	−0.42	1.48	0.71	0.84
Insurance	14	16.83	1.07	0.10	1.08	0.14	0.22
Other Financing Business	17	17.91	1.03	−0.02	0.96	0.61	0.35
Real Estate	22	−6.38	1.18	−0.48	1.16	1.04	0.59
Services	42	40.50	0.96	0.35	0.94	0.51	0.01
Total and Averages	1351	9.14	0.97	−0.14	0.94	0.71	0.19

The samples are all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,351 and the estimation period is from January 1980 through December 1999. We use both CAPM and Fama and French three-factor model to estimate the expected excess return model using monthly data. The caption Alpha is intercept term and three factors in Fama and French three-factor model are market excess returns, the size factor (SMB), and the book-to-price factor (HML). We assumed that the risk free rate is 1.5 percent. The industry classification is based on the Tokyo Stock Exchange 33 way industry classifications

Table 4
Comparison of Equity Risk Premium: Japan versus USA

TSE Classfication 30 (Japan)	CAPM Median	CAPM Mean	US CAPM	Fama-French 3 Factor Model Median	Fama-French 3 Factor Model Mean	US FF3	SIC Codes into 48 (USA)
Fishery & Agriculture	3.74	3.68	5.11	7.74	7.46	6.51	Agiriculture
Mining	3.96	4.07	4.99	9.11	8.34	7.65	Non-metal Mining
Construction	3.96	3.91	6.52	11.03	11.49	6.42	Construction
Foods	3.29	3.14	4.44	5.54	5.69	8.43	Food
			6.35			8.46	Candy and Soda
			4.69			2.99	Alcoholic Beverages
Textiles & Apparel	3.94	3.83	5.71	7.41	8.33	9.18	Textiles
			6.33			8.85	Apparel
Pulp & Paper	3.80	3.74	6.71	7.02	7.10	9.69	Fabricated Products
Chemicals	3.98	3.97	5.57	5.81	5.80	6.58	Chemicals
Pharmaceutical	3.09	2.99	4.71	3.47	4.17	0.09	Pharmaceutical Prod
	3.09	2.99	5.99	3.47	4.17	2.64	Medical Equipment
Oil & Coal Products	3.67	3.65	4.32	7.21	6.74	4.93	Petro. & Natural Gas
			4.90			5.97	Coal
Rubber Products	3.42	3.49	6.16	6.07	7.38	7.78	Rubber &Plastic Prod
Glass & Ceramics Products	4.13	3.98		6.15	6.16		
Iron & Steel	4.33	4.33	5.94	8.46	9.09	9.61	Steel Works etc.
Nonferrous Metals	4.08	4.16	3.98	5.69	5.24	5.35	Precious Metals
Metal Products	3.57	3.65		9.06	9.82		
Machinery	4.11	4.17	5.93	6.98	7.80	6.46	Machinery
Electric Appliances	4.13	4.11	5.86	4.72	5.67	5.98	Electronic Eq (ElcEq)
			5.29			2.49	Computers
Transportation Equipment	3.51	3.55	5.13	6.77	7.89	9.39	Automobiles & Trucks
			6.07			8.63	Shipbulding, Railroad Eq
Precision Instruments	3.90	3.74	7.04	5.59	5.36	6.01	Electronic Eq (Chips)
			6.59			5.8	Measuring & Control Eq
Other Products	3.51	3.64	5.98	6.39	7.34	6.96	Books & Printing
Electric Power & Gas	2.73	2.95	3.39	6.26	6.15	5.41	Utilities
Land Transportation	3.18	3.05	6.17	5.36	5.34	7.39	Transportation
Marine Transportation	4.64	4.60		8.72	8.38		Transportation
Air Transportation	3.46	3.68		7.28	6.15		Transportation
Warehousing	3.92	3.99	5.24	8.94	9.12	5.77	Shipping Containers
Communication	5.56	5.59	3.39	-1.60	-1.36	5.17	Telecommunication
Wholesale Trade	4.04	4.06	5.90	8.53	9.10	7.52	Wholesale
Retail Trade	3.34	3.27	5.68	7.89	8.78	5.88	Retail
			6.75			6.81	Restaurants, Hotels
Banks	2.28	2.72	5.55	5.02	5.31	8.08	Banking
Securities	6.14	6.21		14.14	13.67		
Insurance	4.28	4.26	5.14	5.91	5.98	5.72	Insurance
Other Financing Business	4.14	3.92		8.01	8.64		
Real Estate	4.74	4.70	5.99	11.83	11.83	11.16	Real Estate
Services	3.87	4.18		5.51	4.87		
Average	4.24	4.33	5.56	8.40	8.38	8.32	

The sample for Japan is from listed firms in the First Section of the Tokyo Stock Exchange. The number of the estimated firms is 1,351 and the estimation period is from January 1980 through December 1999. For Japan we use both CAPM and Fama and French three-factor model to estimate the risk premium for each firm in the industry using monthly data. The industry classification is based on the Tokyo Stock Exchange 33 way industry classifications. The result for USA is from Fama and French (1997) Table 7, in which they classify firms based on SCI 4-digit codes into 48 industries. Their estimation period is from July 1963 through December 1994, again using monthly data.

Table 5
Corporate Tax Rate Changes in Japan

Date of Changes	Coporate Tax Rate	Div. Reduced Rate
May-75	40.0%	30.0%
April-81	42.0%	32.0%
April-84	43.3%	33.3%
April-87	42.0%	32.0%
April-88	40.0%	35.0%
April-90	37.5%	37.5%

Japanese government corporate tax rate changes during our sampling period. Time of changes means the date of enactment, all of which are on the first day of the month. This corporate rate applies to larger firms with the size of firms listed in the first section of Tokyo Stock Exchange. Div Reduced Rate means the reduction rate applicable to the corporate tax up to the amount of dividends paid. In Japan, in addition to this corporate tax, corporations have to pay the prefecture local corporate tax whose marginal tax rate is 12 per cent.

Table 6
Estimated Debt-to-Total Asset Ratios and Average Tax Rates
for Industries

	Debt to Total Asset					Average Tax Rate			
	Firms	1st Qu.	Median	Mean	3rd Qu.	1st Qu.	Median	Mean	3rd Qu.
Fishery & Agriculture	7	44.15	66.02	55.42	73.70	16.43	21.50	30.89	50.08
Mining	8	21.59	66.85	54.01	81.74	24.02	34.36	41.65	47.84
Construction	110	30.46	59.75	56.45	86.02	39.26	51.30	47.55	58.98
Foods	60	11.70	28.13	31.49	48.55	37.38	44.90	42.17	53.56
Textiles & Apparels	48	28.41	50.39	48.72	72.90	14.66	26.52	27.21	41.76
Pulp & Paper	16	49.61	64.81	61.29	72.64	11.36	27.26	29.24	41.64
Chemicals	104	20.10	36.95	35.76	52.21	35.09	45.64	42.13	54.61
Pharmaceutical	33	3.75	7.72	14.85	17.82	50.55	53.65	52.60	57.62
Oil & Coal Products	8	39.06	53.40	49.54	70.36	15.49	22.17	29.66	41.95
Rubber Products	9	18.11	20.85	32.68	53.49	38.51	41.44	42.79	48.36
Glass & Ceramics Products	25	19.60	45.91	42.37	62.69	25.25	38.14	34.52	44.65
Iron & Steel	37	37.35	55.87	56.15	80.86	5.70	28.55	27.74	45.38
Nonferrous Metals	22	25.08	48.61	47.55	67.72	16.58	31.49	30.70	44.49
Metal Products	29	11.48	44.20	43.53	67.91	29.14	40.29	37.96	49.54
Machinery	102	17.55	37.95	37.27	58.97	19.65	35.32	33.13	48.27
Electric Appliances	132	8.61	23.60	26.72	40.38	25.23	36.68	34.00	47.90
Transportation Equipment	54	20.01	36.76	39.60	60.26	25.55	41.27	37.88	47.12
Precision Instruments	21	8.55	23.22	33.37	47.63	27.89	43.68	37.02	50.79
Other Products	36	14.48	39.09	37.48	49.50	24.87	45.31	38.78	54.62
Electric Power & Gas	14	67.37	73.40	67.59	77.03	48.91	54.90	55.16	60.72
Land Transportation	31	42.55	57.64	53.20	64.76	46.00	52.02	52.15	56.92
Marine Transportation	11	60.49	70.18	65.57	73.29	9.87	21.62	28.78	48.76
Air Transportation	4	54.12	60.01	59.68	65.56	24.07	38.90	38.77	53.60
Warehousing	12	25.62	51.33	45.46	65.09	41.96	46.94	43.85	50.45
Communication	3	9.84	10.10	16.41	19.83	38.02	39.61	43.36	46.82
Wholesale Trade	76	23.28	55.87	51.21	76.54	30.22	47.25	41.61	53.07
Retail Trade	70	22.69	45.54	45.34	69.31	26.94	44.35	37.55	48.85
Other Financing Business	15	54.82	88.73	75.54	94.27	24.92	47.56	38.70	51.34
Real Estate	21	40.10	81.04	66.65	87.62	4.26	22.33	22.42	43.06
Services	39	2.21	7.89	24.25	43.24	39.13	45.51	42.12	49.59
Total and Averages	1157	27.76	47.06	45.84	63.40	27.23	39.02	38.07	49.74

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,157,excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. The numbers computed are the time series averages from 1996 to 2000. Debt is the book value of the debt, excluding the notes payable and accounts payable. Total asset is the sum of the debt and the total market value of equity. Average tax rate is computed as ratio of the total corporate and local tax paid during the period to the reported net income before tax.

Table 7
Effective Interest Rates for Firms

	Firms	1st Qu.	Median	Mean	3rd Qu.
Fishery & Agriculture	6	2.37	2.48	2.59	3.08
Mining	8	2.48	2.91	3.41	3.40
Construction	105	1.82	2.23	2.29	2.56
Foods	57	1.84	2.23	3.11	2.81
Textiles & Apparels	46	2.07	2.45	3.38	3.30
Pulp & Paper	16	2.21	2.65	2.68	3.15
Chemicals	99	2.04	2.65	5.49	3.38
Pharmaceutical	29	1.99	2.21	2.98	2.63
Oil & Coal Products	8	2.47	2.71	2.71	3.03
Rubber Products	9	1.96	2.30	2.67	3.16
Glass & Ceramics Products	24	1.99	2.25	2.30	2.56
Iron & Steel	36	2.28	2.64	2.65	3.00
Nonferrous Metals	22	2.30	2.57	2.50	2.84
Metal Products	26	2.23	2.55	4.70	2.73
Machinery	92	1.96	2.57	5.61	3.08
Electric Appliances	122	2.12	2.66	6.40	3.73
Transportation Equipment	52	2.17	2.80	2.89	3.16
Precision Instruments	19	2.20	2.33	25.97	3.79
Other Products	34	1.77	3.03	4.91	4.25
Electric Power & Gas	14	3.04	4.42	3.90	4.65
Land Transportation	31	2.40	3.04	4.53	3.66
Marine Transportation	11	3.05	3.73	3.48	4.18
Air Transportation	4	2.53	3.52	3.33	4.32
Warehousing	12	1.80	2.57	5.69	3.34
Communication	3	3.22	3.38	3.50	3.72
Wholesale Trade	70	1.87	2.39	2.73	2.97
Retail Trade	63	1.80	2.38	2.58	3.03
Other Financing Business	15	0.00	0.00	0.28	0.27
Real Estate	20	2.01	2.43	2.58	2.81
Services	34	1.61	2.34	2.50	3.24
Total and Averages	1087	2.12	2.61	4.14	3.19

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,087excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. The numbers computed are the time series averages from 1996 to 2000. Debt is the book value of the debt, excluding the notes payable and accounts payable. Effective interest rate is computed as ratio the interest paid during the period to the average value of the debt at the beginning of the period and the end of the period.

Table 8
Weighted Average Cost of Capital

	WACC based on CAPM					WACC based on Fama-French model			
	Firms	1st Qu.	Median	Mean	3rd Qu.	1st Qu.	Median	Mean	3rd Qu.
Fishery & Agriculture	6	2.83	3.27	3.13	3.43	3.66	3.90	4.58	4.90
Mining	8	2.16	3.22	3.12	4.21	3.25	4.45	4.47	5.57
Construction	104	1.85	2.73	2.81	3.52	3.02	4.87	5.47	7.52
Foods	57	3.15	3.44	3.48	3.81	3.99	4.77	5.26	6.14
Textiles & Apparels	45	2.91	3.58	3.72	4.23	3.88	5.09	5.81	6.60
Pulp & Paper	16	2.86	3.25	3.25	3.80	3.54	4.06	4.43	5.34
Chemicals	99	3.36	4.00	4.03	4.66	3.46	4.84	5.13	6.10
Pharmaceutical	29	3.62	3.95	3.86	4.30	3.34	4.45	4.75	5.97
Oil & Coal Products	8	3.38	3.61	3.54	3.79	4.37	5.05	5.45	5.50
Rubber Products	9	2.60	4.13	3.78	4.89	4.15	5.92	6.74	8.57
Glass & Ceramics Products	24	3.14	3.47	3.65	4.20	3.54	4.04	4.42	5.16
Iron & Steel	36	3.15	3.39	3.59	3.96	3.96	4.47	5.50	6.65
Nonferrous Metals	22	2.95	3.70	3.83	4.59	2.79	3.52	4.02	4.38
Metal Products	26	2.71	3.37	3.74	4.19	4.29	5.48	6.70	7.77
Machinery	92	3.50	4.08	4.12	4.44	4.52	5.52	6.05	6.89
Electric Appliances	122	3.95	4.52	4.57	5.08	3.35	4.80	5.41	6.35
Transportation Equipment	52	2.99	3.60	3.56	4.16	3.92	4.90	5.77	7.07
Precision Instruments	19	3.11	3.87	5.49	4.68	2.83	5.19	6.65	6.56
Other Products	34	3.24	4.05	4.11	4.56	3.86	4.84	5.88	6.54
Electric Power & Gas	14	2.29	2.55	2.68	3.03	3.16	3.51	3.68	4.00
Land Transportation	31	2.40	2.87	3.03	3.58	3.08	3.89	4.21	4.90
Marine Transportation	11	3.22	3.81	3.70	4.44	4.03	5.49	4.85	5.73
Air Transportation	4	2.67	2.98	3.19	3.50	3.38	4.41	4.39	5.42
Warehousing	12	2.63	3.87	3.86	4.06	4.03	5.82	6.71	7.26
Communication	3	6.03	7.18	6.59	7.44	−2.44	−2.00	−0.42	0.80
Wholesale Trade	69	2.44	3.08	3.44	4.02	2.80	4.10	5.41	6.74
Retail Trade	63	2.37	3.15	3.15	3.78	3.57	5.16	5.37	7.16
Other Financing Business	15	0.42	0.62	1.19	1.90	0.65	1.14	2.67	3.39
Real Estate	20	2.37	2.87	3.12	3.94	3.29	4.19	4.68	5.80
Services	34	3.18	4.19	4.79	6.08	2.69	4.01	4.31	6.33
Total and Averages	1084	2.92	3.55	3.67	4.21	3.26	4.33	4.94	5.90

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,084 excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. *WACC* is computed from equation (5) of the main text, where the return on equity is estimated from CAPM and Fama and French three factor model.

Table 9
Comparison of WACC and Modigliani Miller Adjusted Cost of Capital:
Using Industry Average as a Representative Firm

	CAPM		Fama and French	
	rho(MM)	WACC	rho(MM)	WACC
Fishery & Agriculture	3.98	3.49	6.01	5.17
Mining	4.70	3.90	7.23	5.86
Construction	4.14	3.07	8.66	6.37
Foods	4.32	3.68	6.33	5.43
Textiles & Apparels	4.53	3.97	7.19	6.28
Pulp & Paper	3.89	3.26	5.47	4.56
Chemicals	5.47	4.68	6.86	5.86
Pharmaceutical	4.38	3.94	5.47	4.94
Oil & Coal Products	4.15	3.62	5.98	5.18
Rubber Products	4.49	3.68	7.53	6.30
Glass & Ceramics Pro	4.45	3.85	5.92	5.10
Iron & Steel	4.30	3.62	6.77	5.71
Nonferrous Metals	4.44	3.81	5.10	4.38
Metal Products	5.00	4.20	9.18	7.68
Machinery	5.65	4.98	8.25	7.26
Electric Appliances	5.76	5.10	7.02	6.25
Transportation Equipn	4.43	3.71	7.51	6.33
Precision Instruments	10.21	7.29	11.44	8.37
Other Products	5.07	4.39	7.79	6.70
Electric Power & Gas	4.19	2.73	5.84	3.76
Land Transportation	4.54	3.38	6.02	4.45
Marine Transportatior	4.59	3.84	6.19	5.14
Air Transportation	4.30	3.31	5.59	4.31
Warehousing	5.55	4.63	9.05	7.43
Communication	6.73	6.12	0.47	0.32
Wholesale Trade	4.48	3.60	7.61	6.06
Retail Trade	4.02	3.34	7.65	6.35
Other Financing Busir	2.05	1.47	3.69	2.63
Real Estate	4.00	3.69	6.79	6.07
Services	5.19	4.42	5.77	4.94
AVERAGE	4.77	3.96	6.68	5.51

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,084 excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. *WACC* is computed from equation (5) of the main text, where the return on equity is estimated from CAPM and Fama and French three-factor model. Modigliani and Miller tax adjusted cost captioned rho(MM) in the table is computed from equation (11) of the main text.

Table 10
Comparison of MM Adjusted Cost of Capital for Debt, Equity and for Target Leverage Ratio with Miller Cost with Personal Income Tax:
Using Industry Average as a Representative Firm

	Miller (Interset Income Taxed)			MM Adjusted		
	Cost MM	Cost Equ	Cost Taget	Cost MM	Cost Equi	Cost Taget
Fishery & Agriculture	5.95	11.89	9.23	6.52	13.03	10.11
Mining	6.83	13.67	10.85	7.47	14.93	11.86
Construction	8.00	15.99	11.74	8.78	17.56	12.90
Foods	6.14	12.28	10.14	6.43	12.86	10.62
Textiles & Apparels	7.17	14.35	10.97	7.75	15.50	11.86
Pulp & Paper	5.39	10.78	7.67	5.98	11.97	8.51
Chemicals	6.55	13.10	10.84	6.91	13.81	11.43
Pharmaceutical	5.35	10.70	9.52	5.46	10.91	9.71
Oil & Coal Products	5.93	11.86	9.15	6.42	12.84	9.91
Rubber Products	7.31	14.62	11.36	7.67	15.33	11.92
Glass & Ceramics Products	5.82	11.65	9.39	6.22	12.43	10.02
Iron & Steel	6.82	13.65	9.80	7.49	14.98	10.75
Nonferrous Metals	5.02	10.05	7.71	5.42	10.83	8.31
Metal Products	8.86	17.72	13.93	9.48	18.96	14.90
Machinery	8.00	15.99	13.07	8.45	16.91	13.81
Electric Appliances	6.79	13.57	11.55	7.05	14.10	11.99
Transportation Equipment	7.33	14.66	11.55	7.78	15.57	12.26
Precision Instruments	10.18	20.35	15.93	10.69	21.37	16.72
Other Products	7.50	15.01	12.31	7.94	15.87	13.02
Electric Power & Gas	5.09	10.17	7.03	5.74	11.47	7.93
Land Transportation	5.50	11.00	8.32	6.00	12.00	9.07
Marine Transportation	6.02	12.04	8.37	6.75	13.51	9.39
Air Transportation	5.25	10.51	7.39	5.81	11.62	8.17
Warehousing	8.54	17.08	13.70	9.17	18.34	14.71
Communication	0.43	0.86	0.76	0.44	0.88	0.78
Wholesale Trade	7.27	14.53	11.15	7.89	15.78	12.11
Retail Trade	7.48	14.95	11.58	8.02	16.05	12.42
Other Financing Business	3.61	7.21	4.96	4.15	8.31	5.72
Real Estate	7.07	14.14	10.45	7.96	15.91	11.75
Services	5.64	11.28	8.99	5.84	11.67	9.30
AVERAGE	6.43	12.86	9.98	6.92	13.84	10.73

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,084 excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. We set the corporate marginal tax rate to be 50 per cent and the tax on interest income to be 20 per cent. We assume away the personal income tax in this calculation. Modigliani and Miller tax adjusted cost captioned Cost MM in the table, which is equivalent to the cost of debt financing, is computed from equation (11) of the main text. Cost of equity captioned as Cost Equ is computed from equation (A-3) in the Appendix. Modigliani and Miller cost with target leverage ratios denoted as Cost Target is computed from equation (12) of the main text.

Table 11
Effect of Tax Changes on Cost of Equity, Debt, and Target Leverage Ratio :
Using Industry Average as a Representative Firm

	Miller with 10% tax on equity			Corporate tax reduction to 35%		
	Cost MM	Cost eq	Cost Taget	Cost MM	Cost eq	Cost Taget
Fishery & Agriculture	6.22	12.44	9.65	5.53	8.51	7.45
Mining	7.14	14.27	11.33	6.37	9.81	8.77
Construction	8.37	16.74	12.29	7.43	11.43	9.42
Foods	6.28	12.56	10.37	5.92	9.10	7.90
Textiles & Apparels	7.45	14.90	11.40	6.75	10.38	8.72
Pulp & Paper	5.67	11.34	8.07	4.97	7.65	6.18
Chemicals	6.72	13.45	11.12	6.27	9.65	8.52
Pharmaceutical	5.40	10.80	9.62	5.26	8.09	7.30
Oil & Coal Products	6.16	12.33	9.51	5.57	8.57	7.30
Rubber Products	7.48	14.97	11.64	7.03	10.82	8.75
Glass & Ceramics Proc	6.01	12.03	9.69	5.53	8.51	7.44
Iron & Steel	7.14	14.28	10.25	6.34	9.76	7.82
Nonferrous Metals	5.21	10.43	8.00	4.73	7.28	6.12
Metal Products	9.16	18.32	14.39	8.40	12.92	11.01
Machinery	8.22	16.44	13.43	7.64	11.76	10.28
Electric Appliances	6.91	13.83	11.77	6.58	10.12	8.97
Transportation Equipm	7.55	15.10	11.90	6.98	10.75	9.06
Precision Instruments	10.43	20.85	16.31	9.78	15.05	12.30
Other Products	7.71	15.43	12.66	7.17	11.03	9.70
Electric Power & Gas	5.39	10.79	7.45	4.64	7.14	5.72
Land Transportation	5.74	11.48	8.68	5.14	7.91	6.66
Marine Transportation	6.37	12.73	8.85	5.51	8.48	6.79
Air Transportation	5.52	11.04	7.76	4.86	7.47	5.93
Warehousing	8.84	17.69	14.19	8.07	12.42	10.91
Communication	0.43	0.87	0.77	0.42	0.65	0.58
Wholesale Trade	7.57	15.13	11.61	6.81	10.47	8.91
Retail Trade	7.74	15.48	11.99	7.07	10.87	9.16
Other Financing Busin	3.86	7.72	5.31	3.24	4.99	4.10
Real Estate	7.49	14.98	11.06	6.46	9.94	8.55
Services	5.74	11.47	9.14	5.49	8.44	6.83
AVERAGE	6.66	13.33	10.34	6.07	9.33	7.90

The sample is from all listed firms in the First Section of the Tokyo Stock Exchange. The number of the firms is 1,084 excluding banks, security firms and insurance companies. The industry classification is based on Tokyo Stock Exchange 33 way industry classifications. We set the corporate marginal tax rate to be 50 per cent and the tax on interest income to be 20 per cent. Furthermore, as an experiment, we assume the corporate tax rate be reduced to 35 per cent in the right columns. In both cases we assume 10 % dividend tax and capital gain tax which is applicable from year 2003 for Japan. Modigliani and Miller tax adjusted cost captioned Cost MM in the table, which is equivalent to the cost of debt financing, is computed from equation (11) of the main text. Cost of equity captioned as Cost Equ is computed from equation (A-3) in the Appendix. Modigliani and Miller cost with target leverage ratios denoted as Cost Target is computed from equation (12) of the main text.

Table 12
Consumption Growth and Equity Returns: USA versus Japan

The author computed the statistics for Japan. The data for the U.S. A. is from Mehra and Prescott (1985) and Jagannathan and McGrattan (1996). All numbers are in real terms and consumption for Japan is seasonally adjusted by Esmooth function of RATS.

Real Consumption Growth and Returns
Japan: 1970–1997
USA1(Mehra–Prescott): 1889–1979
USA2(Jagannathan–McGrattan):1926–91
(Annual in per cent)

	Consumption	r_m	r_f
Japan 70–97	6.38	11.7	5.64
(S.D)	6.24	23.2	2.92
USA 89–79	1.8	7.0	1.0
USA 26–91		8.8	0.54
USA 76–80		5.32	−1.34
USA 81–91		11.46	3.73

Table 13
Estimated Cost of Equity for Japanese Firms: Summary Statistics

Quarterly regression result of the trend component of real value weighted market index on the leads of real GDP variable, the raw data and the trend components. The trend components for both variables are extracted from the Hodrick-Prescott filter with lambda value of 1600 applied to quarterly observations.

Lag	GDP	GDPTrend
−4	0.657	6.845
	(2.836)	(11.261)
−3	0.645	6.259
	(2.786)	(10.039)
−2	0.616	5.648
	(2.648)	(8.918)
−1	0.519	5.035
	(2.260)	(7.907)
0	0.486	4.439
	(2.141)	(7.006)
1	0.409	4.087
	(1.765)	(6.131)
2	0.320	3.690
	(1.346)	(5.275)
3	0.220	3.251
	(0.899)	(4.441)

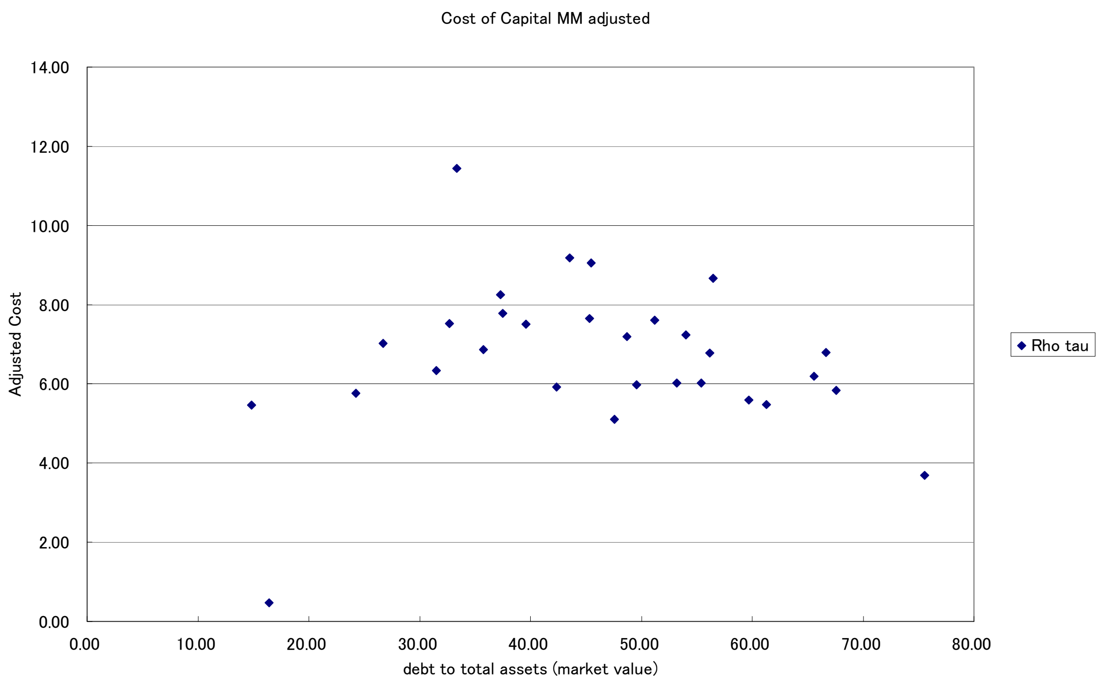

Figure 1 Cross-section of MM Adjusted Cost and Debt to Total Assets

Based on the industry representative firm constructs of 30 industries excluding financial firms. The data is the average of total sampling period of January 1980 through December 1999. Debt is measure by the book value and equity is total market value and the total assets are the sum of these. Tax adjusted cost of capital is based on Modigliani and Miller (1963).

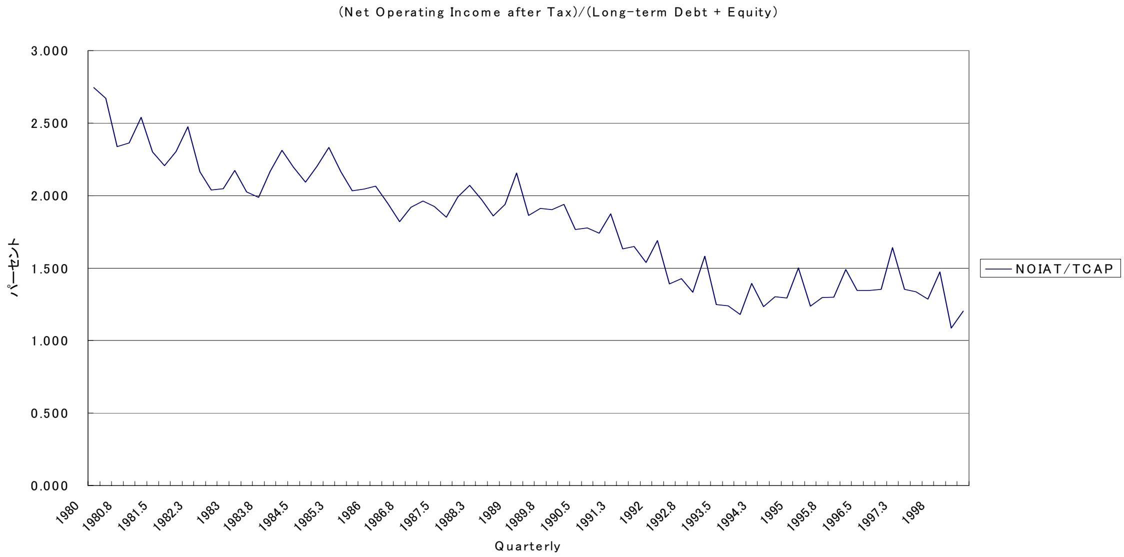

Figure 2 The Trend of Profit Rate for Japanese Firms

The data source: corporate statistics (Houjiin Kigyo Tokei). The data includes all firms that report their statistics to the Ministry of Industry and International Trade and the average number of firms is approximately 20,000 firms.

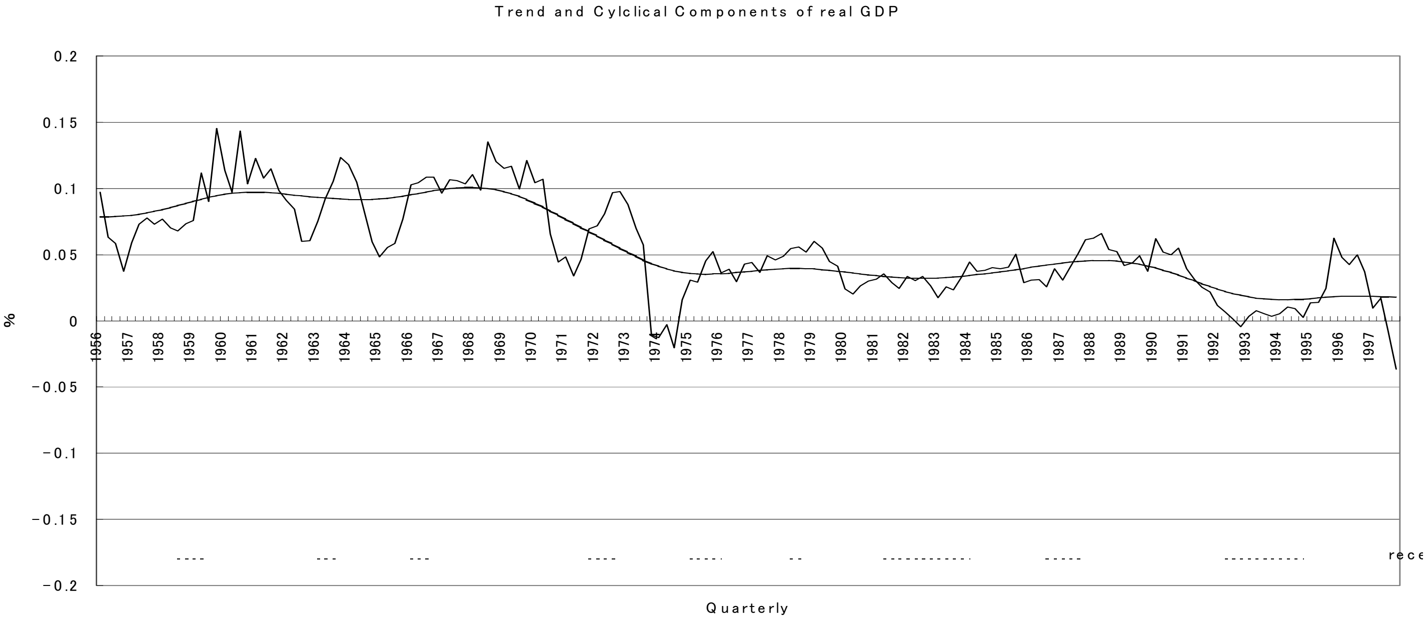

Figure 3. Hodrick-Prescott Filtered Real GDP Growth
Quarterly Data (lambda=1600)

The real shaded line is long term real GDP growth trend after cyclical components are removed. The real line is cyclical component and the light horizontal lines are recessions based on the definition of the Economic Planning Agency.