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AUTHORS	Yuichi Fukuta Hiroshi Osano

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Dynamic Asset Investment Analysis of Japanese Life Insurance Companies Under Regulations

Yuichi Fukuta*, Hiroshi Osano**

Abstract. The purpose of this paper is to give the estimation framework for considering whether or not regulatory constraints imposed on the Japanese life insurance industry can explain the behavior of Japanese life insurance companies with respect to their asset investment and dividend policies.

Key words: life insurance industry, dividend policy, investment decisions, asset investment policy.

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1. Introduction

The Japanese life insurance industry is characterized by a small number of companies (in 1994 it was represented by 16 Japanese mutual insurance companies, 11 Japanese stock insurance companies, and 3 foreign stock insurance companies). On the other hand, the size of the Japanese life insurance market is huge. Life premiums approximately amounted to $208 billion (JPY28 trillion) in 199; this represents the second largest market in the world. The value of assets held by the Japanese insurance companies exceeded $1.5 trillion (JPY150 trillion) in 1994. Although the Japanese life insurance companies occupy such an important economic position, several researchers have expressed strong concern that the industry may not be efficient.[1] If the Japanese life insurance companies seem to make an "irrational" decision, we give two possible interpretations of this "irrational" behavior. One is to suppose that the Japanese life insurance companies may be badly managed. The other is to consider the possibility that this inefficiency is caused by regula-

* Dr., Professor, School of Business Administration, Kobe University.
** Dr., Professor, Kyoto Institute of Economic Research, Kyoto University.

tory constraints imposed on the Japanese life insurance industry, which is one of the most heavily regulated businesses. In case the second interpretation appears to be correct, we need to empirically test the hypothesis that the Japanese life insurance companies subjected to the regulatory constraints behave rationally. However, surprisingly little research has been done on the asset investment performance of the Japanese life insurance companies.[2]

The authors of this paper intend to shed some light on the question of whether or not the Japanese life insurance companies are behaving rationally to perpetuate this business. The purpose of this article is to present the estimation framework for considering the role of regulatory constraints imposed on the Japanese life insurance industry in explaining their seemingly "irrational" behavior. The research is based on the framework suggested by several scholars with respect to the asset investment and dividend policies.

With this in mind, we formalize a dynamic optimizing model of the life insurance firm that maximizes the aggregate utility of policyholder households subjected to regulatory constraints. We then derive the implications for the consumption and wealth accumulation of households and those for the asset investment of insurance firms. In particular, we show the theoretical implications of regulatory constraints by examining Lagrange multipliers associated with external constraints. This approach shares some features similar to the one that has been used previously in the context of estimating the static Averch-Johnson model of a profit-maximizing firm subjected to a regulatory constraint on the rate of return on capital (Cowing (1978)), estimating the permanent income/life cycle model with liquidity constraints (Zeldes (1989)), and estimating the real business cycle model with long-term contracts (Osano and Inoue (1991)).

Since our goal is to examine the effects of regulatory constraints on the asset investment and dividend policies of the Japanese life insurance companies, we consider three kinds of government policies in respect to life insurance companies: the solvency (reserve) regulation, the investment regulation of certain types of assets such as domestic equities and foreign securities, and the dividend payment regulation. The solvency (reserve) regulation constraint requires the life insurance companies to set aside reserves to make certain that funds are available to cover claims. This regulatory constraint causes lower but less risky investment returns to insurance companies, thereby bringing about lower but less risky dividends or higher premiums to the consumers.

The portfolio regulation of risky assets imposes the restriction that the portfolio ratios of domestic equities and foreign securities are limited by upper bounds. If this constraint is effective, it directly suppresses the investment of risky assets and generates lower but less risky dividends or higher premiums to the consumers. The dividend payment regulation constraint is a peculiar kind of constraint the Japanese life insurance companies are subjected to. Under this constraint, the insurance companies are not allowed to pay ordinary dividends to policyholders by selling their own holdings of bonds and equities. The insurance companies are only allowed to transfer the selling revenues of their own holdings of bonds and equities as special dividends to policyholders. This regulation is likely to induce the insurance companies to invest securities that yield high interest income but cause substantial capital loss. Although the dividend payment regulation has been relaxed after 1989, we need to consider the effect for most of our data consist of the samples dated before 1988.

Since some or all of these three regulatory constraints present an important source of departure from the dynamic optimizing behavior of the insurance companies, we understand that the following two points hold true. First, the standard Euler equations derived from the dynamic optimization model without considering the regulatory constraints would be violated. Second, some of the Lagrange multipliers associated with the regulatory constraints - estimated as the part that is unexplained by the standard Euler equations - should be strictly positive.

The remainder of this paper is organized as follows. In section 2, we first investigate the intertemporal consumption/asset investment decision problem of the policyholder household.

We then examine the dynamic maximization problem of the insurance firm subjected to the solvency, risky asset portfolio, and dividend payment regulatory constraints. In section 3, we derive the system of the Euler equation and the first-order conditions with the solvency, risky asset portfolio, and dividend payment regulatory constraints. In section 4, we explore the method for testing the significance of the regulatory constraints. Concluding remarks are presented in the final section.

2. Dynamic Model of the Insurance Firm

We begin with specifying the sequence of events in each period. Then, we consider the optimal decision of households (policyholders) in each generation for a given insurance contract. Given the households' optimal policies, we finally examine the optimal contract and asset investment decisions of the insurance firm that is restricted by the solvency, risky asset portfolio, and dividend payment regulatory constraints.

2.1. Sequence of Events in Each Period

In each period, the model has three dates, indexed 0, 1, and 2. At the initial date 0, each agent observes the prices of assets in the current period, whereas he does not know the asset returns at date 2 in the current period or the prices of assets at date 0 in the next period. Taking the current price information as given, new households enter the insurance market and purchases a life insurance contract from the insurance firm. Old households who purchased a life insurance contract in the preceding periods continue to hold the life insurance contract. Before the mortality state is revealed, households in each generation pay the contracted insurance premium. Because of the law of large numbers, we assume that the insurance firm obtains an unbiased estimate of the mortality of policyholders in each generation.

At date 1, the mortality state is revealed. If the policyholder in a household survives, the household makes the investment decision of asset holdings. If the policyholder in a household does not survive, the surviving members of the household make no investment decisions of asset holdings.

At date 2, each agent observes the household's labor income and asset returns in the current period, and the prices of assets in the next period. If the policyholder in a household survives, the household receives the contracted dividends from the insurance firm; and chooses a consumption plan by taking for granted the realized income including the returns of asset holdings, the labor income, and the contracted dividends paid by the insurance firm. If the policyholder in a household does not survive, the surviving members of the household receive the contracted insurance amount from the insurance firm and the bequest from the dead policyholder, and leave the insurance market in any subsequent periods.

2.2. Optimal Decision of Households in Each Generation

We now describe the optimal decision of the household in each generation by taking for granted an insurance contract offered by the insurance firm. The optimal decision problem of the household in generation *h* (that is, the household that enters into the insurance market in period *h*) for a given insurance contract is to choose the series of the investment of asset holdings at date 1 and the series of consumption at date 2 in each period in order to maximize the expected value of a time-separable lifetime utility function subjected to budget conditions.

Let $U(\cdot)$ be the household's one-period utility function of consumption if the policyholder of the household survives, and $Z(\cdot)$ be the household's utility of the sum of the contracted insurance amount and the bequest if the policyholder of the household does not survive. These functions are assumed to be monotonically increasing and strictly concave over their arguments. Let v_h be the probability of the policyholder's death in the household of generation *h* during period *t* and *t+1*, and ρ be the subject discount factor for households of all generations.

Then, in each period *t*, the household of generation *h* (household *h*) solves the following recursive programming problem for a given insurance contract:

$$J_{ht}(\alpha_{ht}, d_{ht}, x_{ht}, w_{ht}) = \underset{\{c_{ht}, m_{ht}, b_{ht}, s_{ht}, b^*_{ht}, s^*_{ht}\}}{Max} \{ v_h[E_t U(c_{ht})$$

$$+ \rho E_t J_{h,t+1}(\alpha_{h,t+1}, d_{h,t+1}, x_{h,t+1}, w_{h,t+1})] + (1 - v_h) E_t Z(x_{ht} + w_{ht} - \alpha_{ht}) \}, \quad (1)$$

subject to $$w_{ht} = m_{ht} + p_{bt} b_{ht} + p_{st} s_{ht} + \pi_t p^*_{bt} b^*_{ht} + \pi_t p^*_{st} s^*_{ht} + \alpha_{ht},$$

$$w_{h,t+1} - w_{ht} = r_{mt} m_{ht} + (p_{b,t+1} - p_{bt} + r_{bt} p_{bt}) b_{ht} + (p_{s,t+1} - p_{st} + r_{st} p_{st}) s_{ht}$$

$$+ (\pi_{t+1} p^*_{b,t+1} - \pi_t p^*_{bt} + \pi_t p^*_{bt} r^*_{bt}) b^*_{ht} + (\pi_{t+1} p^*_{s,t+1} - \pi_t p^*_{st} + \pi_t p^*_{st} r^*_{st}) s^*_{ht}$$
$$+ d_{ht} - c_{ht} + y_{ht}.$$

Let us explain this problem in detail. The objective function of problem (1) is the expected value of lifetime utility given the probability of the policyholder's death, v_h. The function $J_{ht}(w_{ht}, \alpha_{ht}, d_{ht}, x_{ht})$ is the optimized lifetime utility of household *h* in period *t*, which depends upon the household *h*'s wealth at date 0 in period *t*, w_{ht}, and the insurance contract arrangements. The insurance contract arrangements consist of the parameters defined by $(\alpha_{ht}, d_{ht}, x_{ht})$, where

α_{ht}: the insurance premium paid from household *h* to the insurance firm at date 0 in period *t*,

d_{ht}: the dividends received by household *h* from the insurance firm at date 2 in period *t* if the policyholder of the household survives,

x_{ht}: the insurance amount received by household *h* from the insurance firm at date 2 in period *t* if the policyholder of the household does not survive.

If the policyholder of household *h* survives in this period, household *h* chooses a consumption plan c_{ht} at date 2 in period *t* and remains in the insurance market in the next period *t+1*. If the policyholder of household *h* does not survive, household *h* obtains $x_{ht} + w_{ht}$ at date 2 and leaves the insurance market subsequently. The right-hand side of the objective function characterizes this sequential decision making.

The first constraint of the problem (1) implies that in period *t* household *h* invests in financial assets at date 1 by spending its own wealth after paying the contracted insurance premium, α_{ht}. The household *h*'s holdings of assets are represented by $(m_{ht}, b_{ht}, s_{ht}, b^*_{ht}, s^*_{ht})$, where

m_{ht} : the household *h*'s holdings of domestic money and deposits at date 1 in period *t*,

b_{ht} : the household *h*'s holdings of domestic long-term bonds at date 1 in period *t*,

s_{ht}: the household *h*'s holdings of domestic equities at date 1 in period *t*,

b^*_{ht}: the household *h*'s holdings of foreign bonds in foreign currencies at date 1 in period *t*,

s^*_{ht} : the household *h*'s holdings of foreign equities in foreign currencies at date 1 in period *t*.

The prices of these assets are given by $(1, p_{bt}, p_{st}, \pi_t p^*_{bt}, \pi_t p^*_{st})$, where

p_{bt} : the price of domestic long-term bonds in period *t*,

p_{st}: the price of domestic equities in period *t*,

π_t: the exchange rate of domestic currencies to foreign currencies in period *t*,

p^*_{bt} : the price of foreign bonds in period *t*,

p^*_{st} : the price of foreign equities in period *t*.

The second constraint of the problem (1) shows that the household *h*'s wealth in period *t+1* is made up of the sum of its own wealth in period *t* and net savings during the period *t* and *t+1*. The net savings are defined as (flow revenues accruing from the financial assets) + (capital gains resulting from the change of the financial asset prices) + (dividends from the insurnace company) + (labor income) - (consumption). The variables that remain to be undefined in this constraint are now defined by

r_{mt} : the return rate of domestic money and deposits at date 2 in period *t*,
r_{bt} : the interest rate of domestic long-term bonds at date 2 in period *t*,
r_{st} : the dividend rate of domestic equities at date 2 in period *t*,
r^*_{bt} : the interest rate of foreign bonds at date 2 in period *t*,
r^*_{st} : the dividend rate of foreign equities at date 2 in period *t*,
y_{ht} : the labor income received by household *h* at date 2 in period *t*.

Several remarks on problem (1) are in order. First, the expectation operator E_t is conditional on the information available at date 0 in period *t*, that is, the current period asset prices $(1, p_{bt}, p_{st}, \pi_t p^*_{bt}, \pi_t p^*_{st})$. Secondly, the decision timing of household *h* follows the sequential decision making that is discussed in the preceding subsection. Thus, the asset investment $(m_{ht}, b_{ht}, s_{ht}, b^*_{ht}, s^*_{ht})$ is chosen at date 1 in period *t*, while the consumption c_{ht} is decided at date 2 in period *t*. As a result, the consumption c_{ht} can be contingent on not only the *ex ante* information including the current period asset prices, but also the *ex post* information including the realized current household's labor income and asset returns, and the observable next period asset prices. Third, we neglect the household's holdings of real assets in domestic and foreign countries, those of money and deposits in foregin currencies, and those of foreign bonds in domestic currencies because the data are not available to us. Finally, we assume that the households of all generations always prefer buying insurance contracts to not doing so: $J_{hh}(w_{hh}, \alpha_{hh}, d_{hh}, x_{hh}) \geq \underline{J_h}$ for all *h*, where $\underline{J_h}$ is the lifetime utility of household *h* in period *h* if household *h* does not buy any insurance contracts. To simplify the analysis, we also assume that no policyholders can cancel the original insurance contract arrangements or recontract with another insurance firm.

We now examine the properties of the optimized lifetime utility of household *h* in period *t*, $J_{ht}(w_{ht}, \alpha_{ht}, d_{ht}, x_{ht})$. With this in mind, we obtain the first-order condition with respect to c_{ht} for the problem (1):[4]

$$v_h\left(U'(c_{ht}) - \rho\frac{\partial J_{ht}}{\partial w_{h,t+1}}\right) = 0. \tag{2}$$

Using the envelope theorem, we also have the following conditions:

$$\frac{\partial J_{ht}}{\partial d_{ht}} = \rho v_h \frac{\partial J_{h,t+1}}{\partial w_{h,t+1}}, \tag{3}$$

$$\frac{\partial J_{ht}}{\partial x_{ht}} = (1 - \nu_h)Z'(x_{ht} + w_{ht} - \alpha_{ht}). \qquad (4)$$

Note that both d_{ht} and x_{ht} are paid at date 2. Combining (2)-(4) leads to

$$\frac{\partial J_{ht}}{\partial d_{ht}} = \nu_h U'(c_{ht}), \qquad (5)$$

$$\frac{\partial J_{ht}}{\partial x_{ht}} = (1 - \nu_h)Z'(x_{ht} + w_{ht} - \alpha_{ht}). \qquad (6)$$

In the next section, we use these conditions to discuss the optimal decision of the insurance firm.

To specify the maximization problem of the insurance firm in the next section, we need to construct the aggregate utility of the households that contract with the insurance firm during period 0-period *t*. For the sake of simplicity, we assume that the same number of new households enters the insurance market in each period. We normalize the number of the new households as 1. Then, we obtain the aggregate utility of the households by aggregating the utility of the households of each generation that enter the insurance market during period 0-period *t*:

$$E_t \sum_{h=0}^{h=t} \nu_h^{\,t-h} J_{ht}(\alpha_{ht}, d_{ht}, x_{ht}, w_{ht}). \qquad (7)$$

2.3. Optimal Decision of the Insurance Firm

We are now ready to describe the optimal decision of the insurance firm subjected to feasible and regulatory constraints.

Let us begin with presenting the objective function of the insurance firm. The life insurance industry is organized as mutuals or stock firms. However, since mutual insurance firms have a predominant position in the Japanese life insurance market,[5] we focus on the case of the mutual insurance firm. The objective function of the insurance firm is then represented by (7). For simplicity, we assume that the conflict between policyholders (owners of mutual insurance firms) and managers is costlessly controlled.

In this case, if we additionally assume effective competition within the life insurance market, we can also apply the following model to the the case of the stock insurance firm because stock insurance firms lose their customers if they do not maximize their customers' utility subject to feasible and regulatory constraints.

We next discuss feasible and regulatory constraints faced by the insurance firm. We first specify budget constraints of the insurance firm. At date 1 in period *t*, the insurance firm invests in financial assets by spending its own wealth plus insurance premiums collected from the policyholders of each generation that contract with the insurance firm. This constraint is expressed by

$$W_t = M_t + p_{bt}B_t + p_{st}S_t + \pi_t p^*_{bt}B^*_t + \pi_t p^*_{st}S^*_t - \sum_{h=0}^{h=t} v_h^{t-h}\alpha_{ht}, \tag{8}$$

where

W_t: the insurance firm's wealth at date 0 in period t,

M_t : the insurance firm's holdings of domestic money and deposits at date 1 in period t,

B_t: the insurance firm's holdings of domestic long-term bonds at date 1 in period t,

S_t: the insurance firm's holdings of domestic equities at date 1 in period t,

B^*_t: the insurance firm's holdings of foreign bonds at date 1 in period t,

S^*_t: the insurance firm's holdings of foreign equities at date 1 in period t.

Note that the final term in the right-hand side of (8) denotes the sum of insurance premiums paid by the policyholders of generations 0, 1,..., t.

The insurance firm's wealth in period $t+1$, W_{t+1}, is accumulated by net savings of the insurance firm. This accumulation process is described by

$$W_{t+1} - W_t = r_{mt}M_t + (p_{b,t+1} - p_{bt} + r_{bt}p_{bt})B_t + (p_{s,t+1} - p_{st} + r_{st}p_{st})S_t$$

$$+ (\pi_{t+1}p^*_{b,t+1} - \pi_t p^*_{bt} + \pi_t p^*_{bt}r^*_{bt})B^*_t + (\pi_{t+1}p^*_{s,t+1} - \pi_t p^*_{st} + \pi_t p^*_{st}r^*_{st})S^*_t$$

$$- \sum_{h=0}^{h=t} v_h^{t-h}\left[v_h d_{ht} + (1-v_h)x_{ht}\right]. \tag{9}$$

Note that the final term in the right-hand side of (9) represents the sum of dividends and insurance amounts paid to the households of the policyholders of generations 0, 1,..., t.

We now proceed to present regulatory constraints of the insurance firm. Although we can examine several kinds of regulatory constraints, we restrict our attention to the following three types of regulations: the solvency (reserve), risky asset portfolio, and dividend payment regulations.

We first discuss the solvency (reserve) regulation constraint in each period. Since this regulation aims to prevent insurance firms from becoming insolvent, insurance firms must at all times have enough assets to cover the future net expected contract payments on all contracts.[6] More specifically, under this constraint, insurance firms are required to set up reserve accounts for the excess of the value of benefits payable in future years over the value of premiums to be collected for each contract in future.[7] In the subsequent analysis, we consider the following solvency regulation constraint in period t:

$$W_t - E_t\left\{\sum_{\tau=t}^{\tau=\infty}\sum_{h=0}^{h=\tau}\prod_{m=t}^{m=\tau}\delta_m v_h^{\tau-h}\left[v_h d_{h\tau} + (1-v_h)x_{h\tau} - \alpha_{h\tau}\right]\right\}$$

$$\geq \eta_t E_t\left\{\sum_{\tau=t}^{\tau=\infty}\sum_{h=0}^{h=\tau}\prod_{m=t}^{m=\tau}\delta_m v_h^{\tau-h}\left[v_h d_{h\tau} + (1-v_h)x_{h\tau} - \alpha_{h\tau}\right]\right\}. \tag{10}$$

Here, δ_m $(0 < \delta_m < 1)$ is the market discount factor from period m to period $m+1$, and η_t the degree of strength of the solvency regulation constraint in period t. The left-hand side of (10) represents the expected reserve for solvency protection in period t, whereas the expectation value in the right-hand side of (10) indicates the expected present value of the excess of benefits payable from period t onward over premiums to be collected from period t onward. For example, the expected present value of the excess of benefits over the value of premiums for household h in period τ $(\geq t)$ is calculated by $\prod_{m=t}^{m=\tau} \delta_m \nu_h^{\tau-h}\left[\nu_h d_{h\tau} + (1-\nu_h)x_{h\tau} - \alpha_{h\tau}\right]$ because ν_h is the probability of the policyholder's death in household h during period t and $t+1$. For future use, we rearrange (10) as follows:

$$W_t \geq (1+\eta_t)E_t\left\{\sum_{\tau=t}^{\tau=\infty}\sum_{h=0}^{h=\tau}\prod_{m=t}^{m=\tau}\delta_m \nu_h^{\tau-h}\left[\nu_h d_{h\tau} + (1-\nu_h)x_{h\tau} - \alpha_{h\tau}\right]\right\}. \tag{11}$$

We next describe the portofolio regulation constraints of risky assets in period t. Japanese life insurance companies are required to limit the holding ratios of risky assets such as domestic equities and foreign securities. More specifically, the holding ratio of domestic equities is restricted by the upper bound 30%; and the holding ratio of foreign securities is also constrained by the upper bound 30% (see Ikeo (1994) and Iguchi (1994)). In the following analysis, we impose the following regulatory constraints of risky asset portfolios:

$$\kappa_S W_t \geq p_{st} S_t, \tag{12}$$

$$\kappa_B^* W_t \geq \pi_t p^*_{bt} B^*_t, \tag{13}$$

$$\kappa_S^* W_t \geq \pi_t p^*_{st} S^*_t, \tag{14}$$

where $0 < \kappa_S, \kappa_B^*, \kappa_S^* < 1$. Constraints (12), (13), and (14) are the regulation of the holding ratios of domestic equities, foreign bonds, and foreign equities, respectively. Note that the holding ratio of domestic long-term bonds is not restricted. This feature corresponds to the actual regulation of Japanese life insurance companies.

We finally introduce the dividend payment regulation constraint in period t. In the regulation of the Japanese life insurance industry, until recently insurance firms were ordinarily able to use only the income gain to pay ordinary dividends to their policyholders. Under this regulation, insurance firms were not allowed to pay ordinary dividends to their policyholders by selling their own holdings of bonds and equities.

Insurance firms were only allowed to transfer to their policyholders the selling revenues of their own holdings of bonds and equities as special dividends. Although this dividend payment regulation has been relaxed after 1989, we need to consider the regulation effect for most of our data include the samples dated before 1988.

To simplify the analysis, we assume that under the dividend payment regulation in each period, the income gained from asset holdings of the insurance firm is greater than or equal to the threshold value of (expected dividend ratio)$\times$(insurance firm's wealth). Then, the dividend payment regulation constraint in period t is written by

$$r_{mt}M_t + r_{bt}p_{bt}B_t + r_{st}p_{st}S_t + \pi_t p^*_{bt} r^*_{bt} B^*_t + \pi_t p^*_{st} r^*_{st} S^*_t \geq r_{dt} W_t, \tag{15}$$

where r_{dt} is the expected dividend ratio in period *t*. The excess of the realized dividend over the expected dividend in period *t*, $\sum_{h=0}^{h=\tau} v_h^{t-h+1} d_{ht} - r_{dt}W_t$, can be interpreted as the fluctuations of special dividends.

We are now in a position to discuss the optimal decision problem of the insurance firm. Since the objective function of the insurance firm is reprersented by the aggregate utility of the households that contract with the insurance firm during period 0-period *t*, the insurance firm solves the following recursive problem in period *t*:[8]

$$V_t(W_t) = \underset{\substack{\{(d_{0t},\ldots,d_{tt}),(x_{0t},\ldots,\\ x_{tt}),M_t,B_t,S_t,B^*_t,S^*_t\}}}{Max} \left[\sum_{h=0}^{h=t} v_h^{t-h} E_t J_{ht}(\alpha_{ht}, d_{ht}, x_{ht}, w_{ht}) + \rho E_t V_{t+1}(W_{t+1})\right], \tag{16}$$

subject to (8), (9), and (11)-(15). Here, $V_t(W_t)$ is the optimized aggregate utility in period *t*.

Several comments on the maximization problem (16) are in order. First, the set of the decision variables of the insurance firm does not include the premium rates $(\alpha_{0t},\ldots,\alpha_{tt})$. This assumption can be justified because computation of the premium rate is regulated in the Japanese life insurance industry even though some deregulation of the premium rate is proposed (see Iguchi (1994)). Second, the expectation operator E_t is conditional on the information available at date 0 in period *t*, that is, the current period asset prices $(1, p_{bt}, p_{st}, \pi_t p^*_{bt}, \pi_t p^*_{st})$. Third, the decision timing of the insurance firm follows the sequential decision making that is discussed in subsection 2-1. Thus, the asset investment decisions $(M_t, B_t, S_t, B^*_t, S^*_t)$ are made at date 1 in period *t*, while the contracted dividends $(d_{0t},\ldots,d_{tt})$ and the contracted insurance amounts $(x_{0t},\ldots,x_{tt})$ are paid at date 2 in period *t*. As a result, $(d_{0t},\ldots,d_{tt})$ and $(x_{0t},\ldots,x_{tt})$ can be contingent on the *ex post* information in period *t*. Finally, we neglect the insurance firm's holdings of real assets in domestic and foreign countries, its holdings of money and deposits in foreign currencies, and its holdings of foreign debt in domestic currencies because the data are not available to us.

3. Testable Restrictions of the Model

In this section, we characterize the testable restrictions of the model given in the preceding section.

3.1. Assumptions About the Preferences of Households

To test the restrictions of the model, we need to assume the preferences of households. Let us assume that the one-period utility function of households whose policyholders survive, $U(\cdot)$, is of the constant relative risk aversion form

$$U(c_{ht}) = (c_{ht})^{\sigma} / \sigma, \tag{17}$$

where 1-σ is the coefficient of relative risk aversion. We also assume that the lifetime utility function of households whose policyholders do not survive, $Z(\cdot)$, is also of the constant relative risk aversion form

$$Z(x_{ht} + w_{ht} - \alpha_{ht}) = (x_{ht} + w_{ht} - \alpha_{ht})^{\theta} / \theta, \tag{18}$$

where 1-θ is the coefficient of relative risk aversion. The parameters σ and θ are assumed to be equal across all households and to be restricted by $0 \neq \sigma < 1$ and $0 \neq \theta < 1$.

3.2. Estimating Equations

Applying the Kuhn-Tucker first-order conditions to the recursive problem (16) and rearranging them with (5), (6), (17) and (18), we have[9]

$$E_{t+1}\left(\frac{c_{h,t+1}}{c_{ht}}\right)^{\sigma-1} = E_{t+1}\left(\frac{x_{h,t+1} + w_{h,t+1} - \alpha_{h,t+1}}{x_{ht} + w_{ht} - \alpha_{ht}}\right)^{\theta-1}, \tag{19}$$

$$E_t\left[X_{bt}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}\right] = E_t\left[X_{bt}\mu_{st}(1+\eta_t)\delta_t - R_{bt}\mu_{dt}\right], \tag{20}$$

$$E_t\left[X_{st}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}\right] = E_t\left[X_{st}\mu_{st}(1+\eta_t)\delta_t - R_{st}\mu_{dt} + \mu_{pst}\right], \tag{21}$$

$$E_t\left[X^*_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}\right] = E_t\left[X^*_{it}\mu_{st}(1+\eta_t)\delta_t - R^*_{it}\mu_{dt} + \mu^*_{pit}\right], \quad = b,\ s. \tag{22}$$

Here,

$X_{it} = r_{it} + \Delta p_{it} - r_{mt}$ *for i = b, s,*

$X^*_{it} = r^*_{it} + \Delta(\pi_t p^*_{it}) - r_{mt}$ *for i = b, s,*

$R_{it} = r_{it} - r_{mt}$ *for i = b, s,*

$R^*_{it} = r^*_{it} - r_{mt}$ *for i = b, s,*

$\Delta p_{it} = (p_{i,t+1} - p_{it}) / p_{it}$ *for i =b, s,*

$\Delta(\pi_t p^*_{it}) = (\pi_{t+1} p^*_{i,t+1} - \pi_t p^*_{it}) / \pi_t p^*_{it}$ *for i =b, s.*

The nonnegative Lagrange multipliers in period *t*, ($\mu_{st}, \mu_{pst}, \mu^{*}_{pbt}, \mu^{*}_{pst}, \mu_{dt}$), are associated with the solvency regulation constraint (11) in period *t*, the portofolio regulation constraints (12)-(14) in period *t*, and the dividend payment regulation constraint (15) in period *t*, respectively. Note that the conditional expectation operator E_t is made at date 0 in period *t*. Since C_{ht} is unknown to any agent at date 0 in period *t*, C_{ht} may be correlated with expectation errors at date 0 in period *t*.

The multiplier μ_{st} can be viewed as an increase in the aggregate utility of households contracting with the insurance firm; this increase will result if the solvency regulation constraint at period *t* is relaxed by one unit. Equations (20)-(22) imply that the marginal aggregate utility of households from investing an extra unit in each financial asset except domestic money and deposits is *greater than* that in domestic money and deposits if the solvency regulation constraint alone is binding. The remaining parameters can be interpreted in a similar way.

By estimating equations (19)-(22), we will test several competing hypotheses. Under the null hypothesis, the insurance firm can choose its holdings of assets and offer insurance contracts without considering any of the regulation constraints in any period. This hypothesis implies that ($\mu_{st}, \mu_{pst}, \mu^{*}_{pbt}, \mu^{*}_{pst}, \mu_{dt}$) are equal to zero in each period. As alternative hypotheses, we can consider several possibilities. The first possibility is that the decisions of the insurance firm are restricted by the dividend payment regulation constraint alone. Then, μ_{dt} must be positive in some periods, whereas ($\mu_{st}, \mu_{pst}, \mu^{*}_{pbt}, \mu^{*}_{pst}$) are equal to zero in each period. The second possibility corresponds to the case in which only some of the risky asset portfolio restrictions are effective. In this case, some of ($\mu_{pst}, \mu^{*}_{pbt}, \mu^{*}_{pst}$) are positive in some periods, while (μ_{st}, μ_{dt}) are equal to zero in each period. The third possibility arises from the situation in which only the dividend payment and risky asset portfolio regulations are effective although the solvency regulation is ineffective. Then, μ_{dt} and some of ($\mu_{pst}, \mu^{*}_{pbt}, \mu^{*}_{pst}$) are positive in some periods, while μ_{st} is equal to zero in each period. The final possibility occurs if the solvency regulation constraint is binding. In this case, μ_{st} must be positive in some periods. Note that the final possibility includes all the cases in which the dividend payment and (or) some of the portfolio regulation constraints of risky assets are binding.

4. Empirical Method

In the empirical work, to simplify analysis we must assume that the growth rates of C_{ht} and $x_{ht} + w_{ht} - \alpha_{ht}$, and the level of C_{ht} in each period are the same for any household of all generations. Thus, we use average consumption expenditure and average household wealth data. From now on, we will drop the subscript *h* from each variable.

To test the theoretical model, we need to use a two-step procedure discussed below. First, consider the Euler equation (19). We estimate the parameters of (19) and test the estimates by exploiting its orthogonality conditions using Hansen's (1982) generalized method of moments (GMM). In fact, if σ or θ is directly estimated from (19), the estimated values $\hat{\sigma}$ and $\hat{\theta}$ converge to the trivial value zero. To avoid this problem, we need to divide both-hands sides of (19) by $\sigma - 1$ and estimate the modified Euler equation.[10] Since this procedure imposes additional restrictions, we need to examine its robustness. For this purpose, we fix the values $\sigma = -5, -4, -3, -2, -1, 0$ and estimate the Euler equation (19) for these different values

σ.[11] To perform the GMM estimation, we also need to test the stationarity of the growth rates of both consumption expenditures, c_t, and household wealth including the insurance amount minus the insurance premium, $x_t + w_t - \alpha_t$, because Hansen (1982) shows that the sufficient conditions for the asymptotic properties of the GMM include the stationarity of the data.

Second, if the Euler equation (19) is not violated, we can test the remaining four equations (20)-(22) using the value $\hat{\theta}$ consistent with the estimated Euler equation. Indeed, these four equations cannot be tested by the GMM method because none of the Euler equations generated by (20)-(22) can be defined if some combinations of the Lagrange multipliers ($\mu_{st}, \mu_{pst}, \mu^*_{pbt}, \mu^*_{pst}, \mu_{dt}$) make the denominators of the Euler equations equal to zero in some periods. To circumvent this difficulty, we need to exploit the restrictions implied by the first-order conditions (20)-(22). The value of each term inside the conditional expecation operator at time *t* in the left-hand sides of (20)-(22) - $X_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ and $X^*_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ for *i* = *b, s* - defines an error term that should have conditional meaning of zero if ($\mu_{st}, \mu_{pst}, \mu^*_{pbt}, \mu^*_{pst}, \mu_{dt}$) are equal to zero in period *t*. To calculate the conditional means of these terms, we must make Nadaraya-Watson nonparametric regression using the realized values ($\hat{x}_{ht} + \hat{w}_{ht} - \hat{\alpha}_{ht}$, $\hat{X}_{bt}$, $\hat{X}_{st}$, $\hat{X}^*_{bt}$, $\hat{X}^*_{st}$) and the particular value $\hat{\theta}$ consistent with the estimated Euler equation.[12] Then, the conditional means of $X_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ and $X^*_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ (for *i* = *b, s*) are equal to zero over the sampling periods if ($\mu_{st}, \mu_{pst}, \mu^*_{pbt}, \mu^*_{pst}, \mu_{dt}$) are equal to zero throughout the sampling periods. This prediction suggests that one or some combinations of the solvency, risky asset portfolio, and dividend payment regulation constraints are binding if the conditional means of $X_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ and $X^*_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ calculated by $(\hat{x}_{ht} + \hat{w}_{ht} - \hat{\alpha}_{ht}$, $\hat{X}_{bt}$, $\hat{X}_{st}$, $\hat{X}^*_{bt}$, $\hat{X}^*_{st})$ and $\hat{\theta}$ are not equal to zero over the sampling periods. To justify the use of the nonparametric regression, we need to test the stationarity of $X_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ and $X^*_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ (for *i* = *b, s*) because the nonparametric regression needs the stationarity of the data.

Our empirical testing procedure is now summarized as follows:

(i) Estimate the Euler equation (19) of which both-hands sides are divided by $\sigma - 1$, and check whether or not the Euler equation (19) is violated. Note that if the model is correct, the Euler equation (19) must be satisfied irrespective of whether or not the regulatory constraints are binding.

(ii) If the Euler equation (19) is not violated, then we conduct the nonparametric test of the restrictions of the first-order conditions implied by (20)-(22) using the $\hat{\theta}$ consistent with the estimated Euler equation. These implications are summarized in Table 1, given the sign of the non-negative Lagrange multipliers.[13] Note that X_{it} and X^*_{it} $(i = b, s)$ may be negative.

Since the solvency regulation constraint hypothesis cannot be distinguished from the one that not only the solvency but also the other regulatory constraints are binding, we can state that the solvency regulation constraint hypothesis is the weakest one.

5. Concluding Remarks

We have considered the dynamic optimizing model that maximizes the aggregate utility of policyholder households subjected to the regulatory constraints of the solvency, risky asset portfolio, and dividend payment. We have then derived the theoretical implications for consumption and wealth accumulation of households and those for asset investment of insurance firms.

Appendix

The purpose of this Appendix is to derive (19)-(22) from the optimization of (16) under the assumptions about the preferences of households, (17) and (18). To this end, we first rearrange (8) as

$$M_t = W_t - p_{bt}B_t - p_{st}S_t - \pi_t p^*_{bt}B^*_t - \pi_t p^*_{st}S^*_t + \sum_{h=0}^{h=t} \nu_h^{t-h}\alpha_{ht}. \qquad \text{(A1)}$$

Substitute (A1) into (9) and solve it with respect to W_{t+1}. Then, further substituting such W_{t+1} with the objective function of the recursive problem (16) and rearranging it with (5), (6), (17) and (18), we obtain the following first-order conditions to the recursive problem (16) with respect to $\{(d_{0t},\ldots,d_{tt}), (x_{0t},\ldots,x_{tt}), B_t, S_t, B^*_t, S^*_t\}$:

$$\nu_h^{t-h+1}(c_{ht})^{\sigma-1} - \rho V'_{t+1}(W_{t+1})\nu_h^{t-h+1} - \mu_{st}(1+\eta_t)\nu_h^{t-h+1}\delta_t = 0, \qquad \text{(A2)}$$

$$\begin{aligned}\nu_h^{t-h}(1-\nu_h)(x_{ht}+w_{ht}-\alpha_{ht})^{\theta-1} - \rho V'_{t+1}(W_{t+1})\nu_h^{t-h}(1-\nu_h)\\ - \mu_{st}(1+\eta_t)\nu_h^{t-h}(1-\nu_h)\delta_t = 0,\end{aligned} \qquad \text{(A3)}$$

$$\rho E_t\{V'_{t+1}(W_{t+1})[p_{b,t+1} + r_{bt}p_{bt} - (1+r_{mt})p_{bt}]\} + \mu_{dt}(r_{bt} - r_{mt})p_{bt} = 0, \qquad \text{(A4)}$$

$$\rho E_t\{V'_{t+1}(W_{t+1})[p_{s,t+1} + r_{st}p_{st} - (1+r_{mt})p_{st}]\} - \mu_{pst}p_{st} + \mu_{dt}(r_{st} - r_{mt})p_{st} = 0, \qquad \text{(A5)}$$

$$\begin{aligned}\rho E_t\{V'_{t+1}(W_{t+1})[\pi_{t+1}p^*_{b,t+1} + \pi_t p^*_{bt}r^*_{bt} - (1+r_{mt})\pi_t p^*_{bt}]\}\\ - \mu^*_{pbt}\pi_t p^*_{bt} + \mu_{dt}(r^*_{bt} - r_{mt})\pi_t p^*_{bt} = 0,\end{aligned} \qquad \text{(A6)}$$

$$\begin{aligned}\rho E_t\{V'_{t+1}(W_{t+1})[\pi_{t+1}p^*_{s,t+1} + \pi_t p^*_{st}r^*_{st} - (1+r_{mt})\pi_t p^*_{st}]\}\\ - \mu^*_{pst}\pi_t p^*_{st} + \mu_{dt}(r^*_{st} - r_{mt})\pi_t p^*_{st} = 0,\end{aligned} \qquad \text{(A7)}$$

where μ_{st}, μ_{pst}, μ^*_{pbt}, μ^*_{pst}, and μ_{dt} are the nonnegative Lagrange multipliers associated with the solvency regulation constraint (11) in period *t*, the portofolio regulation constraints (12)-(14) in period *t*, and the dividend payment regulation constraint (15) in period *t*, respectively. Note that $(d_{0t},\ldots,d_{tt})$ and $(x_{0t},\ldots,x_{tt})$ can be contingent on the ex post information in period t because these variables are determined at date 2 in period t. Combining (A2) and (A3) and rearranging them, we see

$$\rho V'_{t+1}(W_{t+1}) = (c_{ht})^{\sigma-1} - \mu_{st}(1+\eta_t)\delta_t, \tag{A8}$$

$$(c_{ht})^{\sigma-1} = (x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}. \tag{A 9}$$

The Euler equation resulting from (A9) leads to (19). Substituting (A8) with (A4)-(A7) and rearranging them, we obtain (20)-(22), where the conditional expectation operator E_t is made at date 0 in period t. Note that c_{ht} is unknown to any agent at date 0 in period t and may be correlated with the expectation error at date 0 in period t.

Notes

1. See Tachibanaki and Chuma (1993) and Ikeo (1994). Table 0A reports the asset investment ratios of Japanese life insurance companies during 1969-1991. Even though these figures are quite broad, they show that Japanese life insurance companies increased the ratio of foreign securities in the period after 1985 when the exchange rate of Yen was appreciated. Furthermore, Table 0B suggests that the investments in government bonds by Japanese life insurance companies in 1986 are 10.85 times as large as those in 1977, while the outstanding government bonds in 1986 are only 4.75 times as large as those in 1977. This finding corresponds to the "stylized fact" that Japanese life insurance companies preferred the interest income to the capital gain in the government bond market during this period.

2. Several recent interesting studies have examined the asset investment behavior of the Japanese life insurance companies (see Asako and Kurasawa (1992) and Tachibanaki and Chuma (1993)). Nevertheless, they neither construct a formal model nor consider the regulatory constraints of the Japanese life insurance industry.

3. For the implications of differences between the organization forms of stock and mutual insurance companies, see Mayers and Smith (1981, 1988).

4. Solve the second constraint of the problem (1) with respect to $w_{h,t+1}$ and substitute such $w_{h,t+1}$ into $J_{h,t+1}$ of the objective function of the problem (1). Partially differentiating it with respect to c_{ht} leads to the first-order condition (2).

5. The mutual insurance firms' shares of the insurance premiums and total assets in the Japanese life insurance industry at the end of 1989 are 92% and 94%, respectively.

6. However, no other solvency fund is maintained for the benefits of policyholders in Japan.

7. See Kunizaki (1977), Skalicky (1991), Ikeo (1994), and Altman and Vanderhoof (1995).

8. We do not consider the reinsurance problem of the insurance firm.

9. The derivation procedure is relegated to the Appendix.

10. We also divide both-hands sides of equation (19) by $\sigma-\theta$ or $(\sigma-\theta)(\theta-1)$ or $(\theta-1)$. The estimation results are robust enough even though these changes are considered.

11. The chosen values σ generate the values of the coefficient of relative risk aversion of 1,2,3,4,5,6, respectively, which are in line with previous empirical estimates. See Friend and Blume (1975), Mankiw (1981), and Hansen and Singleton (1983). This test seems to be robust enough because similar results are obtained by fixing the parameters of θ.

12. For the Nadaraya-Watson nonparametric regression, see Hardle (1990). As an alternative approach, we can estimate (20)-(22) with the GMM method. To do so, we need to check the conditions that X_{it}, X^*_{it} ($i = b, s$), and $x_{ht} + w_{ht} - \alpha_{ht}$ are stationary. However, it is highly

probable that $x_{ht} + w_{ht} - \alpha_{ht}$ is nonstationary. On the other hand, under the Nadaraya-Watson nonparametric regression, we are only required to show that $X_{it}(x_{ht} + w_{ht} - \alpha_{ht})^{\theta-1}$ is stationary. Furthermore, although the GMM estimation depends on the choice of instrumental variables, the Nadaraya-Watson nonparametric regression do not depend on such arbitrariness. We may notice that the latter approach is affected by the choice of kernel or bandwidth. However, it is known that the choice of kernel does not have a strong effect on estimation results. The choice of bandwidth does not cause serious problems either because we use the method that minimizes the cross-varidation. Thus, the Nadaraya-Watson nonparametric estimation is preferred to the GMM estimation to our purposes.

13. In fact, there is a small possibility that all the conditional meanings in the left-hand sides of (20)-(22) calculated by $\hat{X}_{it}$, $\hat{X}^*_{it}$ ($i = b, s$), $\hat{x}_{ht} + \hat{w}_{ht} - \hat{\alpha}_{ht}$, and $\hat{\theta}$ are equal to zero even if not all the Lagrange multipliers of the regulatory constraints are equal to zero over the sampling periods. However, since this is an exceptional event, we neglect the possibility.

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The Development of Government Policies for the Promotion of Exports – Especially during the 1950s

Haruhito Takeda*

Abstract. The paper is devoted to research of the development of government policies for the promotion of export in Japan. Attention was paid to the period of time during the 1950s. The evolution of government policies promoting exports was considered in details. Export inspection system as an instrument of facilitating developing export opportunities of Japanese companies was investigated and assessed.

Key words: promotion of export, government policy, Japanese exporters, tax system.

Issues in the Promotion of Exports

In the course of Japan's industrialization the promotion of exportation has from the very beginning been a central consideration in government policy. Before the Second World War, in addition to the contribution made by the production of raw silk as a Japanese specialty export product for the acquisition of foreign currency, the expansion of colonies in East Asia, based on military aggression, enabled Japan to secure its export market through strong measures. However, these conditions changed drastically as a result of the defeat. Upon the appearance of rayon and nylon, the competitive export strength of raw silk weakened, and Japan, choosing to align itself with the nations of the West during the Cold War, faced the situation where it was unable to hope for expansion of trade with China, which had been its largest market before the war. In addition, Japan's aggressive exportation of cotton goods to former countries of the British Commonwealth caused deep distrust of Japan. Besides, in the nations of Southeast Asia, where the issue of war reparations remained unsettled, anti-Japanese sentiment resulting from the ravages of war did not easily dissipate. Post-World War II export expansion operated under these major limitations.

These conditions continued to have an obvious effect on economic recovery well into the early 1950s until the attainment of autonomy with the effectuation of the San Francisco Peace Treaty. Although it can be said that recovery up to 1951 had been much more rapid than anticipated, the circumstances of Japan's economy in that year were the following compared with the pre-war period (taking the years 1934-1936 as 100), the production of mining and manufacturing industries stood at 131, agriculture at 100, exports at 36 (30, when excluding special procurements), imports at 49, consumption levels at 86, industrial investment at 119, and per capita income at 93. That is to say, despite the recovery of mining and manufacturing productivity, the amount of trade remained at record low levels, the recovery of export levels was especially slow, and the recovery was conspicuously uneven.

The problems of the contemporary Japanese economy were even more apparent when compared with the situation in major nations of the West. With the exception of the United States, there was not a major gap in the recovery of production of mining and manufacturing industries, but in comparison with other countries in which trade volume recovered in step with productivity levels to exceed pre-war levels, the level of Japanese trade was exceedingly slow in recovering.

* Ph.D, Professor, Institute of Economic Research, Tokyo University, Tokyo, Japan.