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# The Effects of Business Strategy on Economic Evaluation Techniques of Capital Investment*

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## Abstract

This paper explains firms' adoption of economic evaluation techniques according to differences in their business strategy and their business environment using mail survey data. Many recent studies focus only on the discount cash flow (DCF) methods, while our research examines the factors determining the use of non-DCF methods as well as DCF methods, and shows the rationality of their use. We discover that the use of non-DCF methods, such as payback method and accounting rate of return, is rational when the use of DCF methods is not valid. We find that business environment characteristics, such as (1) the complexity of the environment, (2) uncertainty, and (3) automation of the production line,

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affect the choice of the evaluation technique. Furthermore, we find that whether a firm's strategic type is an analyzer or not affects the adoption of the economic evaluation technique.

Key Words: capital budgeting, capital investment, economic evaluation technique, strategic type, business environment, logit analysis

## 1. Introduction

The economic evaluation technique is the main element of capital budgeting in managerial accounting. While researchers endorse the discount cash flow (DCF) method because it is theoretically superior, the diffusion of the DCF method has been very slow. Table 1A shows the economic evaluation techniques used by firms in three developed countries. We can see that there is variation among those countries, and the only the half of US firms use DCF methods, such as net present value and internal rate of return. The knowledge of managerial accounting diffused through the developing countries in the age of globalization. Table 1B shows the economic evaluation techniques used by firms in the Asia/Pacific countries. These results may not be able to compare with the results of Table 1A, however, surprisingly more firms in Asia/Pacific countries use DCF methods. This research attempts to explain universally the different usage of the economic evaluation technique among countries.

In particular, very few Japanese firms have adopted the DCF method, although other firms around the world are beginning to choose the DCF method (Shimizu et al. (2008)[1)]. Table 2 presents the main economic evaluation techniques used by Japanese firms and shows that simple methods, such as the payback method and accounting rate of return, have

1) However, there is no evidence that theoretically superior economic evaluation techniques lead to better financial performance than do theoretically inferior techniques (Shimizu et al. (2008)). This illustrates the gap between theoretical research and practice with respect to capital budgeting.

**Table 1A: Use of Economic Evaluation Techniques in three Developed Countries**

| Countries (Year of Survey) | United States (1990) | Canada (1995) | United Kingdom (1990) |
|---|---|---|---|
| Payback method | 35% | 50% | 70% |
| Internal rate of return | 45% | 62% | 81% |
| Net present value | 50% | 41% | 80% |
| Accounting rate of return | 5% | 17% | 56% |
| Other | 8% | 8% | 31% |

Source: Horngren et al. (2005, p. 735, partly modified)

**Table 1B: Use of Economic Evaluation Techniques in the Asia/Pacific Countries**

| Country (Year of survey) | Australia (1996) | Hong Kong (1997) | Indonesia (1997) | Malaysia (1996) | Philippines (1996) | Singapore (1996) |
|---|---|---|---|---|---|---|
| Payback method | 93% | 100% | 81% | 94% | 100% | 98% |
| Internal rate of return | 96% | 86% | 94% | 89% | 94% | 88% |
| Net present value | 96% | 88% | 94% | 91% | 81% | 86% |
| Accounting rate of return | 73% | 80% | 56% | 69% | 78% | 80% |
| Other | 21% | 8% | 19% | 9% | 9% | 6% |

Source: Kester et al. (1999, partly modified)

**Table 2: Economic Evaluation Techniques Used by Japanese Firms(number of firms, and percentage of total responses)**[2)]

| | Payback method | Accounting rate of return | Net present value | Internal rate of return | Number of firms |
|---|---|---|---|---|---|
| Tsumagari and Matsumoto (1972) | 108 (61.7%) | 60 (34.3%) | 17 (9.7%) | 15 (8.5%) | 175 (100.0%) |
| Kato (1989) | 133 (83.6%) | 56 (35.2%) | 23 (14.5%) | 25 (15.7%) | 159 (100.0%) |
| Sakurai (1992) | 109 (76.2%) | 46 (32.2%) | 25 (17.5%) | 29 (20.3%) | 143 (100.0%) |
| Shimizu and Tamura (2010d) | 89 (90.8%) | 38 (38.8%) | 33 (33.6%) | 24 (24.5%) | 98 (100.0%) |

been used in the past and currently by Japanese firms. While there is variation among countries, we can see that Japanese firms use the payback method and accounting rate of return more than the net present value and internal rate of return.

In Japan, many firms use the payback method, while very few firms use

2) For instance, 175 firms used economic evaluation techniques in Tsumagari and Matsumoto (1971).

the DCF method, such as net present value or internal rate of return, which is theoretically superior. Many studies have examined why the payback method is adopted and the DCF method is not. Many researchers have considered this "gap between theory and practice" in capital budgeting, and their conclusions can be classified into two viewpoints (Shimizu et al. (2008)).

The first viewpoint is that Japanese firms are still in the process of development, and as a result use the payback method despite its inferiority. Many studies have pointed out why theoretically superior economic evaluation techniques were not widely adopted in Europe or the US in the past. For instance, Gordon et al. (1979) presented four obstacles to the diffusion of superior economic evaluation techniques: emotional obstacles, political obstacles, technical obstacles, and information obstacles. In addition, the studies in the introduction of managerial accounting systems clarify the importance of the management of labor and organizations properly, because organizational resistance can follow the introduction of a new system (Tani (2004)).

The second viewpoint recognizes some rationality in the use of the payback method under certain circumstances faced by firms. For instance, Weingartnar (1969) and Furukawa (1988) recognized the value of the payback method as a stable index under uncertainty. Sakurai (1992) explained why a reduction in the lifecycle of goods and equipment supported the adoption of the payback method. Kazusa (2003) suggested that adopting the payback method or net present value to determine capital investment is rational when firms are highly dependent on bank loans. Shinoda (2010) discussed how firms use different economic evaluation methods for various components of the investment decision. Furthermore, he argued that the selection of economic evaluation methods in Japan recognized the need for adequate rationality and proper diversification and flexibility.

This paper discusses why using a range of economic evaluation techniques is rational as Shinoda (2010) argued, and analyzes the adoption of economic evaluation techniques relevant to the strategic type and

business environment of firms. The next section provides a review of the previous literature and sets up the hypotheses regarding economic evaluation techniques depending upon a firm's strategic type and business environment. In Section 3, we describe the mail survey used, the process of classifying a firm's business environment and strategic type, and the research methods applied. In Section 4, we test the hypotheses from Section 2 using logit analysis, with the adoption of each economic evaluation technique as the dependent variable. Finally, in Section 5, we summarize the results of our analysis and discuss the limitations of our study and future research objectives.

## 2. Previous Studies and Hypotheses

This section summarizes the results of previous studies and develops hypotheses regarding the economic evaluation techniques consistent with a firm's business environment and strategic type.

### 2.1. Findings from Previous Studies

Previous studies examining the economic evaluation techniques used by firms have made the following findings.

F1: Larger firms adopt DCF methods (Pike (1996), Graham and Harvey (2001), Shimizu et al. (2007)).

No theory exists at present to explain this fact. Graham and Harvay (2001) discovered that CEOs with an MBA favor DCF methods more than do CEOs without an MBA. In Japan, senior management at larger firms tend to have an MBA; therefore, larger firms are more likely to use DCF methods.

F2: Firms in environments with greater uncertainty adopt non-DCF methods (Schall and Sundem (1980)).

This fact is consistent with the disproof of the hypothesis "Firms in environments with greater uncertainty use DCF methods."

F3: The higher the level of product standardization, the more likely firms are to adopt DCF methods (Chen (2008)).

Chen developed this hypothesis from the fact that the necessary information for the use of DCF methods is available to firms with higher product standardization, and the hypothesis was statistically verified.

The above discussion suggests the following: F2 connotes H2, and F3 connotes H5. We will not explain F1 theoretically but rather examine it in our analysis.

### 2.2. Economic Evaluation Techniques Depending on the Business Environment

First, we introduce uncertainty and complexity into the business environment, and examine whether they are consistent with the various economic evaluation techniques. These two environment factors are essential in characterizing the business environment.

We analyze the main economic evaluation techniques, namely, (1) payback method, (2) discounted payback method, (3) internal rate of return, (4) net present value, and (5) accounting rate of return. The discounted payback method calculates the payback period from the discounted cash flow using the cost of capital. The discounted payback method is included among the payback methods in Table 1, however, we separate them because Shinoda (2008) found that it is fairly spread among firms[3)].

From our empirical results for 2005 and 2009, many firms use capital equipment over a period of 5 to 10 years (Shimizu and Tamura (2010a)). Meanwhile, it is difficult to forecast the demand and price of raw materials over a 5-year period because of rapidly changing economic environments. Therefore, the availability of the information necessary for economic evaluation techniques strongly affects the choice of the method. Myers (1984) explained why firms need the following information for DCF

3) Shinoda (2008) performed a cluster analysis on the usage of economic evaluation techniques, and found that the discounted payback method is closer to the net present value of the internal rate of return than is the simple payback method or accounting rate of return. We also performed a cluster analysis and obtained the same results. However, it is important to note that the discounted payback method has characteristics of both the payback method and DCF, with respect to the calculation method.

**Table 3: Main Economic Evaluation Techniques and the Information of Cash Flows**

| Main economic evaluation technique | Necessary cash flow information |
|---|---|
| Payback method | Payback period |
| Discounted payback method | Payback period |
| Accounting rate of return | Cash flows until depreciation |
| Net present value | All cash flows until abandonment |
| Internal rate of return | All cash flows until abandonment |

calculations: (1) the project's future cash flows, (2) the risk-adjusted discount rate, (3) the project's impact on the cash flows of the firm's other businesses, and (4) the project's impact on the firm's future investment opportunities. Table 3 shows the necessary information for point (1), above, the project's future cash flows, for each economic evaluation technique.

The payback method and discounted payback method do not need cash flow information until depreciation or abandonment, while net present value and internal rate of return need all cash flow information until abandonment.

Naturally, it will be difficult to use net present value and internal rate of return when the main product market is uncertain and unable to forecast future demand for the product. On the other hand, firms can use the payback method and discounted payback method under significant uncertainty. As we already discuss as F2, which Schall and Sundem (1980) found, can be explained in same logic. Therefore, we set up the following hypotheses[4].

H1: Under low uncertainty of the business environment, more firms will adopt net present value or internal rate of return.

H2: Under high uncertainty of the business environment, more firms will

4) We exclude accounting rate of return from the hypotheses regarding uncertainty. Legal durable period is as short as 5 years for electronic parts, and less than 10 years for other industries. For steel equipment, it is about 12 years according to the Ministry of Finance HP in Japan. When use accounting rate of return, it is easy to estimate the depreciation cost during legal durable years, but there is uncertainty after more than 5 or 10 years. Therefore, it will be difficult to determine whether uncertainty affects usage of the accounting rate of return or not.

adopt the payback method or discounted payback method.

Next, regarding point (2), above, the risk adjusted discount rate, payback method and accounting rate of return do not use a discount rate, but the discounted payback method, net present value, and internal rate of return face the problem of the discount rate. Each discount rate should be adjusted by a firm's capital cost for the risk of the project. If the project is an extension of the existing business, namely, it has the same risk, firms can use the cost of capital of the existing business. However, it is difficult to adjust the discount rate if the risk is different (Brealey et al. (2006)). The cause of this difficulty lies in the complexity of the environment, or if the relationship with the existing business is unclear. In addition, point (3), above, the project's impact on the cash flows of the firm's other businesses, and point (4), above, the project's impact on the firm's future investment opportunities, are examples of the externality problem in economics, which is caused by the complexity of the environment. Therefore, we set up the following hypotheses.

H3: In less complex environments, more firms will adopt the discounted payback method, or net present value, or internal rate of return.

H4: In more complex environments, more firms will adopt the payback method or accounting rate of return.

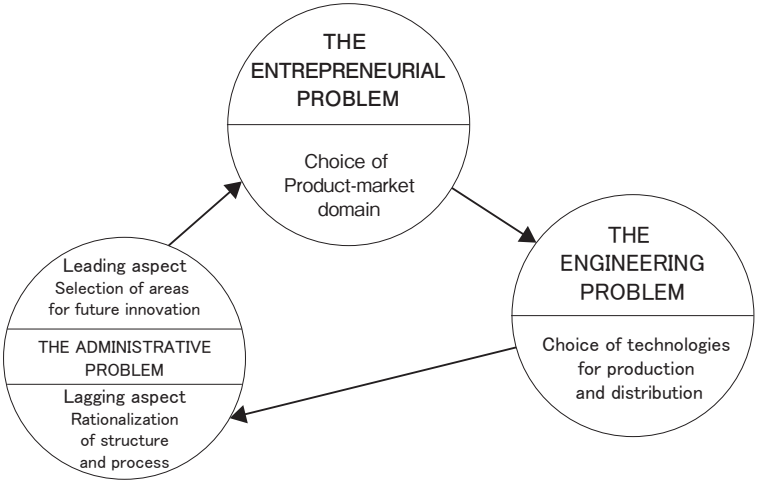
The uncertainty and complexity of business environments are part of a firm's external environment, but production standardization (F3), which Chen (2008) verified, is a component of the internal environment of a firm. Product standardization occurs when firms produce large quantities of the same products, assuming strong demand for the product. Under these circumstances, the automation of the product line would progress rapidly. In other words, the automation of the product line corresponds to a strong demand for the product. Then, we set up the following hypothesis.

H5: With a higher level of automation of the product line, more firms adopt net present value or internal rate of return.

### 2.3. Economic Evaluation Technique Consistent with Strategic Type

Shimizu (2011) clarified to some extent that "there is a capital budgeting

Figure 1. The Adaptive Cycle, from Miles and Snow (1978, p. 24)




process appropriate for each different strategic type" according to the strategic theory of Miles and Snow (1978). This paper also examines the economic evaluation technique appropriate for each strategic type according to Miles and Snow (1978).

One way of thinking about the strategic types that Miles and Snow (1978) proposed is as follows. (1) The organization develops a strategy in order to adapt to its environment and to choose and create an adaptive environment. (2) To implement the strategy effectively, an organizational structure adapted to this strategy is required. (3) The organization needs management processes adapted to the strategy to employ efficient behavior. (4) The structure and processes that the organization already has are conditions for the strategy developed next. (5) Therefore, the subject of the dominant coalition of the organization is to adapt strategy, structure and process interactively for the organization to be effective and to behave efficiently. (6) There are four forms of possible adaptive behavior for the organization: the Defender, the Prospector, the Analyzer, and the Reactor (Tsuchiya (1983)).

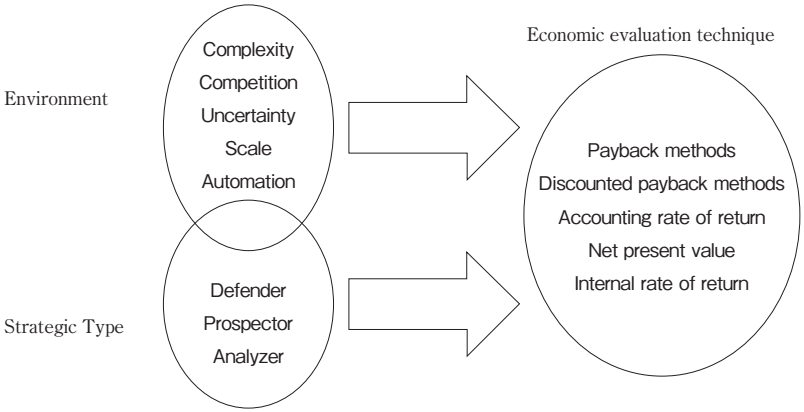
Put another way, and as shown in Figure 1, firms survive in a

competitive environment by controlling the following series of processes: (1) deciding upon the organizational domain in which they behave (the entrepreneurial problem), (2) deciding what system they will use to operate the activity (the engineering problem), and (3) formulating and implementing the management processes needed to operate these systems successfully (the administrative problem). There are four possible patterns of adaptation. Drawing on Miles and Snow (1978), these four environmental adaptations of organizations (strategic types) have the following characteristics.

- Defender: this strategic type limits its operational area to a relatively narrow product market where it improves efficiency and cost competitiveness, and establishes firm status.
- Prospector: this strategic type always searches for market opportunities to obtain profits. It aggressively creates change and uncertainty and develops new products and markets.
- Analyzer: this strategic type establishes firm status in existing product markets but also searches for market opportunities that it can cope with using its existing technology, and rapidly seizes these if they appear promising.
- Reactor: this strategic type does not function properly. It cannot adapt; rather, it merely reacts to environmental change and lacks consistent organizational activity.

The Defenders can forecast long-term demand because they establish a stable status in their limited operational area; also, they can easily estimate the cost because their operations do not change significantly. Therefore, the Defenders will be able to use net present value or internal rate of return. Meanwhile, it is difficult for the Prospectors to predict demand as they enter a new market, and it is difficult to estimate the cost of starting up a new business. Therefore, the Prospectors will not use net present value or internal rate of return, because it is difficult for them to estimate long-term cash flow. It is easy for the Analyzers to estimate cost, because they develop their business based on existing methods. In addition, the Analyzers do not have to forecast long-term demand, because they only

Figure 2. Analytical Framework




correspond to short-term demand. Thus, the Analyzers will adopt methods without considering the value of time, because they do not need to estimate long-term cash flow. We cannot set up a hypothesis for the Reactors, because they lack consistent organizational activity.

We set up the following hypotheses regarding economic evaluation techniques consistent with strategic type.

H6: The Defenders will adopt net present value or internal rate of return[5].

H7: The Prospectors will adopt the payback method, discounted payback method or accounting rate of return.

H8: The Analyzer will adopt the payback method or accounting rate of return.

Figure 2 shows the analytical framework of the above hypotheses briefly. This study attempts to analyze how business strategy and environment affect the choice of economic evaluation technique. We include firm scale as an environment characteristic as searching examination.

5) Chen (2008) developed a hypothesis regarding the relation between Miles and Snow's strategic type and economic evaluation techniques that is the same as H6, but Chen (2008) did not test the hypothesis.

## 3. Research Methods

### 3.1. Data Collection[6)]

We sent our mail survey to the 853 Japanese manufacturing firms listed on the Tokyo Stock Exchange First Section as at March 1, 2009 and received responses by April 30, 2009. We mainly addressed the questionnaires to the management planning sections, requesting them to respond regarding capital investment for their main product. The response rate to the survey was 11.72% (100 of the 853 companies). Using a Chi-squared test, we confirm that the respondent firms' distribution by industry is comparable to all manufacturing firms listed on the First Section of the Tokyo Stock Exchange. We also compare firm scale (total assets and capital stock) across respondent and nonrespondent firms, and find no significant difference.

### 3.2. Measurement Scale

#### 3.2.1 Environmental Variables

We use 18 question items about market environment, technical environment, and competitive environment from DeSarbo et al. (2005). We will describe these question items later. The scale used for each question item uses a 5-point Likert scale (1 = do not agree at all, 5 = strongly agree).

One question addressed the automation of the product line, and the responses on the 5-point Likert scale ranged from 1 = the most negative attitude to 5 = the most positive attitude. We use capital stock data from "Japan Company Handbook, Toyo Keizai Shinpousha (ed.)" as a measure of the scale of the firms.

#### 3.2.2 Strategic Type

To classify the respondent firms into four strategic types, we adopt the

6) See Shimizu and Tamura (2010a, 2010b, 2010c, 2010d) for a detailed summary of our mail survey.

Table 4: Results of Classification: Number in each Strategic Type

| Strategic type | Number of firms (%) |
|---|---|
| Defender | 21 (21.0) |
| Prospector | 16 (16.0) |
| Analyzer | 44 (44.0) |
| Reactor | 18 (18.0) |
| Missing observations | 1 (1.0) |
| Total | 100 (100.0) |

classification of strategic types described by Conant et al. (1990). This method has been successful in many studies as a useful way of grouping firms into Miles–Snow strategic types (DeSarbo et al. (2005)). The classification procedure proposed by Conant et al. (2005) is as follows[7]. To start with, we prepared 11 questions that explicated the three basic problems in Miles and Snow's (1978) adaptive-cycle model. These comprised four questions regarding the entrepreneurial problem that develops the strategy, three questions concerning the engineering problem that creates the systems to operate the strategy, and four questions about the administrative questions in managing the system. We then constructed four distinct response options characterizing the four possible strategic types (Defender, Prospector, Analyzer, and Reactor) for each of the 11 questions[8]. Next, the sample firms were classified into one of the four strategic types depending on the response option selected most often. For instance, we classified the firm as a Defender if it most often chose Defender response options. However, if the number of response options tied between Defender, Prospector, and/or Analyzer response options, the firm was classified as an Analyzer, while if they tied involving Reactor response options, the firm was classified as a Reactor.

Table 4 provides the results of the classification of the respondent firms by the procedure described.

7) See Conant et al. (1990), DeSarbo et al. (2005) and Shimizu (2011) for details.

8) We thank Julia Salle Yongue (Hosei University) for her valuable suggestions to grasp the subtle meanings of these questions and responses and to translate them into Japanese.

### 3.3. Research Methods

First, we examine the adoption of economic evaluation techniques by strategic type. Then we perform a factor analysis for the business environment and extract the factors such as the complexity and uncertainty of the environment. Finally, we perform logistic regression analysis (logit analysis) using the choice of economic evaluation technique as the dependent variable to examine our hypotheses.

## 4. Empirical Analyses

### 4.1. Economic Evaluation Technique by Strategic Type

The response for the choice of economic evaluation technique is available for 98 firms among the respondent firms. We asked whether the firm uses each economic evaluation technique. Table 5 summarizes the usage of economic evaluation techniques by strategic type. As we have already shown in Table 1, 89 firms use the payback method, which means that those firms use the payback method and/or discounted payback method in Table 5. (Apparently, 13 firms (77 + 25 – 89) use both the payback method and discounted payback method.) In Table 5, the percentage of usage is more important than the number of firms.

The final column reports the overall tendency: the payback method is most commonly used by the firms, accounting rate of return is second, net present value is third, the discounted payback method is fourth, and internal rate of return is fifth. Consistent with the results of Shinoda (2008, 2010), the discounted payback method is used to the same extent as the internal rate of return.

Next, we list the economic evaluation techniques from the most used to the least used by strategic type:

Defenders: Payback method > Net present value > Discounted payback method > Internal rate of return > Accounting rate of return

Prospectors: Payback method > Accounting rate of return > Net present value > Discounted payback method > Internal rate of return

Table 5: Use of Economic Evaluation Technique by Strategic Type

| | Defenders (20 firms) | Prospectors (16 Firms) | Analyzers (44 firms) | Reactors (18 firms) | Total (98 firms) |
|---|---|---|---|---|---|
| Payback method | 14 (70.0%) | 13 (81.3%) | 36 (81.8%) | 14 (77.8%) | 77 (78.6%) |
| Discounted payback method | 7 (35.0%) | 4 (81.3%) | 7 (15.9%) | 7 (38.9%) | 25 (25.5%) |
| Accounting rate of return | 5 (25.0%) | 8 (50.0%) | 18 (40.9%) | 7 (38.9%) | 38 (38.8%) |
| Net present value | 9 (45.0%) | 5 (31.3%) | 11 (25.0%) | 8 (44.4%) | 33 (33.7%) |
| Internal rate of return | 5 (25.0%) | 3 (18.8%) | 10 (22.7%) | 6 (33.3%) | 24 (24.5%) |

Analyzers: Payback method > Accounting rate of return > Net present value > Internal rate of return > Discounted payback method

There are some differences in the order of the choice of the economic evaluation technique by strategic type; however, there is no statistically significant difference in the usage rates when compared by one-way analysis of variance. We will examine carefully how the strategic types affect the usage of economic evaluation technique later, using logistic regression.

### 4.2. Business Environment: Complexity, Competition, and Uncertainty

Table 6 reports the results of the 18 question items relating to the business environment (DeSarbo et al. (2005)) and descriptive statistics of the responses to these question items.

Next, we perform factor analysis for these 18 question items to investigate potential environmental factors. As a result, we extract three factors (complexity, competition, and uncertainty) from 14 question items. Table 7 reports the results. Here, the principal factor method is used as the factor extraction method, and a varimax rotation is adopted as the factor rotation method. We found three factors with eigenvalues greater than 1, with an accumulation contribution rate of 68.14%. In addition, we find no problem with internal consistency.

The first factor is related to technology change, competitive move, and change of preference and needs, and thus we interpret it as “Complexity”

**Table 6: Descriptive Statistics of Environmental Variables (obs.: 99 respondent firms)**

| Question items | Mean | Standard deviation | Question items | Mean | Standard deviation |
|---|---|---|---|---|---|
| Preferences change through time | 2.98 | 1.1116 | New product ideas from technology | 3.34 | 0.871 |
| Customers look for new products | 3.13 | 1.017 | Technological developments are minor | 3.92 | 1.075 |
| Price relatively unimportant | 3.21 | 1.052 | Technological changes are frequent | 3.07 | 1.023 |
| Product-related needs are different | 2.62 | 0.724 | Competition is cutthroat | 4.06 | 0.780 |
| Cater to many of the same customers | 2.26 | 0.764 | Many 'promotion wars' in industry | 3.57 | 1.022 |
| Difficult to predict marketplace changes | 3.09 | 0.980 | Competitors can match offers readily | 2.91 | 0.846 |
| Technology changing rapidly | 3.16 | 0.997 | Price competition in industry | 3.76 | 1.070 |
| Technological change provides opportunities | 3.76 | 0.846 | New competitive moves every day | 2.74 | 0.975 |
| Difficult to forecast technology | 2.79 | 1.003 | Competitors are relatively weak | 3.43 | 0.810 |

**Table 7: Factor Analysis of Environmental Variables**

| Variables | 1st factor: Complexity | 2nd factor: Competition | 3rd factor: Uncertainty |
|---|---|---|---|
| Technological change provides opportunities | 0.788 | –0.139 | 0.174 |
| Technology changing rapidly | 0.780 | 0.017 | 0.135 |
| New product ideas from technology | 0.710 | 0.021 | –0.120 |
| Technological changes are frequent | 0.674 | 0.021 | 0.386 |
| New competitive moves every day | 0.550 | 0.259 | 0.126 |
| Customers look for new products | 0.548 | 0.028 | 0.293 |
| Product-related needs are different | 0.483 | 0.245 | 0.317 |
| Price competition in industry | –0.039 | 0.707 | 0.110 |
| Competition is cutthroat | 0.174 | 0.698 | 0.287 |
| Many 'promotion wars' in industry | 0.284 | 0.637 | 0.029 |
| Competitors can match offers readily | –0.155 | 0.590 | –0.141 |
| Difficult to predict marketplace changes | 0.049 | 0.145 | 0.625 |
| Difficult to forecast technology | 0.368 | -0.078 | 0.565 |

Note: Items for which the factor loading is greater than 0.400 are in halftone.

of the business environment. The second factor is related to the degree of competition, and thus we label it "Competition". The third factor is related to the difficulty of forecasting, and thus we interpret it as "Uncertainty" of the business environment. Furthermore, we calculate the factor scores based on this factor analysis using regression methods, and we use them as

**Table 8: Descriptive Statistics of Automation and Firm Scale (environmental variables)**

| | Defenders (20 firms) | Prospectors (16 Firms) | Analyzers (44 firms) | Reactors (18 firms) | Total (98 firms) |
|---|---|---|---|---|---|
| Automation | 3.19(0.873) | 3.31(1.138) | 3.20(0.734) | 3.44(1.097) | 3.26(0.899) |
| Firm scale (ln(capital stock)) | 9.16(0.932) | 9.60(1.672) | 9.87(1.369) | 9.59(1.431) | 9.62(1.362) |

Notes: All values are means, with standard deviations in parentheses.

environmental variables. We will use these three environmental variables in our logistic regression as independent variables.

Next, Table 8 presents the descriptive statistics for the response about the automation of product lines and the logarithm of a firm's capital funds as a measure of scale. There are no statistically significant differences with respect to automation and scale of firms by strategic types.

### 4.3. Determinant Analysis of the Adoption of Economic Evaluation Techniques

We perform hypothesis testing related to the adoption of economic evaluation techniques using logistic regression (logit analysis). The dependent variables equal 1 when the firm adopts the corresponding economic evaluation technique, and equal 0 when the firm does not use that particular economic evaluation technique. The independent variables are three strategic-type dummy variables, three environmental variables from the factor analysis, automation and firm scale. Table 9 presents the results of the logit analysis.

First, we can see that uncertainty of the business environment has a significantly negative effect on net present value. In other words, firms are more likely to use net present value in a low uncertainty environment. Thus, this represents partial support for H1 "Under low uncertainty of the business environment, more firms will adopt net present value or internal rate of return." H2 "Under high uncertainty of the business environment, more firms will adopt the payback method or discounted payback method" is not statistically supported.

Next, we can see that complexity of the business environment has

Table 9: Determinants of Adoption of Economic Evaluation Technique

| | Adoption ofpayback method | Adoption ofdiscounted payback method | Adoption of accounting rate of return | Adoption of net present value | Adoption of internal rate of return |
|---|---|---|---|---|---|
| Defender dummy | −.172 (.855) | −.429 (.795) | −.552 (.775) | −.168 (.855) | −.287 (.859) |
| Prospector dummy | −.268 (.955) | −.429 (.850) | .296 (.740) | −1.150 (.956) | −1.066 (.973) |
| Analyzer dummy | .024 (.792) | −1.398* (.746) | −.142 (.613) | −1.710** (.798) | −.693 (.745) |
| Complexity | .539* (.322) | −.466 (.306) | .491* (.263) | .265 (.307) | .132 (.313) |
| Competition | .343 (.334) | −.327 (.324) | −.084 (.270) | −.194 (.320) | −.181 (.331) |
| Uncertainty | .383 (.379) | −.323 (.364) | −.303 (.307) | −1.281*** (.436) | −.386 (.364) |
| Automation | −.717** (.343) | .529 (.322) | −.084 (.278) | .994*** (.365) | .787** (.347) |
| Firm scale | −.013 (.230) | .386* (.221) | .226 (.184) | .619*** (.241) | .506** (.229) |
| Constant | 4.034* (2.324) | −5.945*** (2.215) | −2.271 (1.775) | −9.182*** (2.438) | −8.300*** (2.387) |
| Log likelihood | 91.154 | 94.667 | 121.115 | 91.454 | 91.335 |
| Observations | 98 | 98 | 98 | 98 | 98 |

Note: The figures in parentheses are standard deviations. * indicates significance at 10% level, ** indicates significance at 5% level, *** indicates significance at 1% level, by two-sided test.

positive effects on the adoption of the payback method and accounting rate of return. Thus, we can say that H4 “In more complex environments, more firms will adopt the payback method or accounting rate of return” is statistically supported. Meanwhile, H3 “In less complex environments, more firms will adopt the discounted payback method, or net present value, or internal rate of return” is not statistically supported.

Automation of the product line has a strong positive effect on net present value and internal rate of return, while it has strong negative effect on the payback method. Therefore, H5 “With a higher level of automation of the product line, more firms adopt net present value or internal rate of return” is supported. In addition, we found that firms adopt the payback method at lower levels of automation.

Furthermore, we examined how each strategic type affects the usage of economic evaluation techniques. We found that only the Analyzer has a negative effect on the usage of the discounted payback method and net

present value. This means that net present value and the discounted payback method are inconsistent with the Analyzer. Thus, H8 "The Analyzer will adopt the payback method or accounting rate of return" may be moderately supported. However, H6 and H7 are not statistically supported.

Finally, firm scale has a positive effect on the discounted payback method, net present value, and internal rate of return. Thus, larger firms use the discounted payback method, net present value, and internal rate of return, so we confirm that F1 "Larger firms adopt DCF methods" is supported as in previous studies, even though it cannot be explained theoretically.

## 5. Conclusion

In this paper, we examined the economic evaluation techniques used in Japanese firms using empirical analyses, incorporating mail survey data on the economic evaluation techniques, business environments and strategic types. As a result, business environment characteristics, such as complexity, uncertainty and automation of product line, affect the selection of the economic evaluation technique used. Regarding strategic type, Analyzers affect the usage of the economic evaluation technique. Our research examines the factors determining the use of non-DCF methods, which is a contribution of this paper. Many recent studies only focus on DCF methods, while our research examines the factors determining the use of non-DCF methods as well as DCF methods, and shows the rationality in the use of them. We discover that the use of non-DCF method, such as payback method and accounting rate of return, is rational when the use of DCF methods is not valid.

One of the main limitations of our research is that we only investigated firms' capital budgeting of the main product. Shinoda (2010) pointed out that firms use different economic evaluation techniques for different investment projects, when firms use more than one method. Research on each investment project would be difficult because we would need to collect

detailed data from the firms. One option is to interview the firms for detailed information. In addition, our sample contains only 99 firms, so we would require a larger sample for such an extension of our analysis.

In future research, we would like to develop a theoretical explanation for the diversity of economic evaluation techniques used by firms. What other factors affect the selection of economic evaluation technique? For instance, governance structure may affect this choice. Alternatively, it may be affected by whether the manager is stockholder oriented or employee oriented. In addition, we have to develop a theoretical explanation for why "larger firms adopt DCF methods". Furthermore, diversity of economic evaluation techniques exists in other countries as seen in Table 2, so we must study technique choice in an international context. This study is the first stage of the development of a theoretical model of economic evaluation technique choice, and therefore there are many related research issues that need to be addressed in the future. We expect that this topic will be the great research interest in the field of managerial accounting.

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