

# **Opportunity-Seeking Activities of IT engineers in Technical Innovation: An Empirical Study of Startup and Turnover from the Real Options Perspective**

## **1. Introduction**

This paper considers the opportunity-seeking activities of IT engineers for startups and turnover, theoretically and empirically from the viewpoint of real options. IT engineers face uncertainty under technical innovation and they will exercise their options to start businesses and resign their employment if they take such a new opportunity. Since most SMEs do not have adequate IT capabilities and they rely on IT firms, these opportunity-seeking activities of IT engineers invigorate economies. Then, what elements determine the level of their opportunity-seeking activities ? The study adopts an exchange-option model and it supposes that option holders are entitled to exchange two risky assets in the future. IT engineers who hold the options pertaining to startup or turnover may choose their most advantageous future careers; see Figure 1. <sup>1</sup>

(Insert Figure 1)

## **2. Conceptual background**

Real options analysis values the flexibility in the uncertainty (Copeland and Antikarov, 2001) and real options is theoretically useful to develop a more balanced perspective on the role of entrepreneurship (McGrath, 1999 and Ireland et al, 2003). However, previous real option studies pertaining to entrepreneurship are limited. Some researchers estimate the flexibility to defer the startup timing in order to evaluate the obstacles. O'Brien et al. (2003) empirically revealed that increased uncertainty within the entrepreneur's target industry would decrease the probability of

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<sup>1</sup> Financial options include call options (options to buy specific assets in the future at a fixed price), and put options (option to sell specific assets in the future at a contract price). Option to defer and growth option are call type, exit option is put form. Exchange options can be modeled in both call type and put type.

entry. Fujiwara(2014) studied biotech start-ups and license contracts from the viewpoint of compound options, portfolios of real options, with case study for simulation. As for turnover, Moussa et al. (2013) studied job changing under real options approach theoretically and empirically. They supposed that a worker has options to wait for more offer information in the labor market. Our study is different from these previous studies in the point that we focus on technological uncertainty and study intra-industry job mobility from the viewpoint of exchange options model with two risky assets. And we visualize environmental uncertainties around IT firms and IT engineers through the questionnaire survey.

As shown in Figure 2, lifetime revenue generated by IT engineers after exercising his option of either startup or turnover is considered as a new asset  $V_2$ , while the lifetime revenue of the incumbent firm is considered as current asset  $V_1$ . Personal capability refers to skills, knowledge, and his available human network. Furthermore, firms have the organizational capabilities to deploy their resources, tangible or intangible, in order to improve performance (Teece et al. 1997).

(Insert Figure 2)

The impacts of the IT revolution on organizational and personal capabilities differ depending on the technical skill framework. And frameworks of organizational and personal capabilities are not always the same. Some IT firms rely on legacy systems, while their younger engineers, who have studied newest program language, put that knowledge into practice. In other big firms, their local staff has not experienced the upper stages of the IT production system. Simplifying the problem, we suppose that in the incumbent firms the impact of technical change on the lifetime income depends on the technical framework of organizational capability, while at the turnover or startup stage, the impact depends on the technical framework of his/her personal capability. In the new stage, engineers could choose the firm wherein the technical framework is fully compatible with theirs.

### 3. Hypothesis

The hypotheses are derived from the Margrabe (1978) exchange option valuation model (see Appendix2). We suppose that the ratio of option holders increases according to the value of the option.

H1a: The levels of startup or turnover options taken among IT engineers are positively associated with the high volatility of personal capability and the high volatility of organizational capabilities.

H1b: The levels of startup or turnover options taken among IT engineers are positively associated with the high drift rate of personal capabilities and negatively associated with the high drift rate of organizational capabilities.

H1c: The levels of startup or turnover options are negatively associated with the correlation coefficient between organizational and personal capability.

Next, let us consider the characteristics of engineers who take account of startup business, compared with potential job-hoppers.

H2: The levels of startup options taken among IT engineers are positively associated with the opportunities they recognize and their capability levels.

Finally, organizational problems would be considered. Engineers involved in the downstream stage of the software production system and old generation IT infrastructures (legacy systems) sense the difficulties of developing comprehensive ICT skills, broad business knowledge, and a wide human network (METI,2018).

H3: In the setting of relationships between the levels of startup or turnover options taken among IT engineers and the opportunities and personal capabilities, the older generation IT workers and the downstream IT workers negatively moderates the impact.

#### 4. Empirical Study

The data was obtained through an online survey administered by Macromill Co., Ltd. in February 2014.<sup>2</sup> The number of respondents was 1032, of which 91% were male. And 46% of engineers were employed in SMEs. The main analytical method was logistic regression (SPSS).

The dependent variables, *StartUp OPN5* and *Turnover OPN5*, are binary data whether the respondents intended to hold startup or turnover options over five years. As for independent variables, Table 1 shows the impact of technical innovation and variables about uncertainty parameters. *Volatility<sub>1</sub>* means the uncertainty of organizational capability of the current firm, while *Volatility<sub>2</sub>* stands for uncertainty of human assets of engineers. The growth rate of the future value of organizational capabilities is *Drift<sub>1</sub>*, while that of employers' personal capabilities is *Drift<sub>2</sub>*. A correlation coefficient between firms and human capital is denoted by *Correl*. Please note that *Volatility<sub>1</sub>* stands for the uncertainty of the current asset  $V_1$  and *Volatility<sub>2</sub>* stands for the uncertainty of the new asset  $V_2$  in our assumption. Similarly, *Drift<sub>1</sub>* stands for the drift rate of the current asset  $V_1$  and *Drift<sub>2</sub>* the drift rate of the new asset  $V_2$ . *Correl* is the correlation coefficient between the current asset  $V_1$  and the new asset  $V_2$ . In this study, uncertainty parameters were estimated through the operation of Likert-scale questionnaires, shown in Table 1. From the questionnaires of "opportunity" in five scales and "threat" in five scales, we estimated the magnitude of volatility.

(Insert Table 1)

Among the personal capability variables, technical skill and business knowledge were measured in terms of the years that average rookie engineers will spend to reach their levels, while a human network is a composite variable derived from the Likert-scale questionnaires.

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<sup>2</sup> In 2014 Japanese engineers had full realization of the today's IT revolution. In April 2013, the German working group of Industry 4.0 presented the final report in Hannover Messe.

## 5. Concluding remarks

This empirical study based on internet survey data of Japanese IT engineers revealed some significant findings. First, it was confirmed that the exchange option valuation model of Margrabe (1978) projects some significant suggestions (Table a1). For instance, there is significant relationship between the level of startup or turnover options and the uncertainty of the personal capabilities, and the level of startup or turnover options are negatively associated with the correlation coefficient between personal and organizational capabilities. Second, the characteristics of entrepreneurs compared with job hoppers were highlighted (Table a1). It may be concluded that opportunity-seeking is recognized not only among startup option holders but also among turnover option holders. However, startup option holders, significantly, have wide human network, while turnover option holders do not. Third, the negative moderation effects of structural problems in the IT industry were confirmed (Table a2). The regression targeted at system development engineers showed that IT engineers in the downstream IT production process and in the legacy system tend not to have startup or turnover options.

For further consideration, the two-way ANOVA revealed that the engineers in the downstream process and in legacy system both undervalue their own human assets and potential opportunities. The interaction effect between them was not observed. Furthermore, the correlation coefficient between downstream IT engineers and human network is significantly negative. Since human network is critical to starting a new business, these engineers are in a disadvantageous position for startup.

This study implies the importance of creating better conditions for every IT engineers to learn newest technologies and build wide human network, so as to accelerate opportunity-seeking activities. Since most SMEs do not have adequate IT capabilities, these opportunity-seeking activities of IT engineers will invigorate regional economies.