FLEXIBLE LABOR AND INNOVATION PERFORMANCE OF R&D-ORIENTED START-UPS IN JAPAN

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ABSTRACT

Whether to make labor market flexible is a topic of political debate in most developed countries due to the positive impact of flexibility on economic growth. Using a sample of R&D-oriented Japanese start-ups, this paper aims to shed the light on the relationship between flexible labor and innovation of start-ups, which has been overlooked. Our results indicate that numerical flexibility by using temporary employees contributes positively to technological innovation performance while negatively to patent application. External labour turnover of regular employees has a positive impact on patent application. Based on our results, implications to literature and policy-makers are discussed.

INTRODUCTION

Over the last two decades, whether to make labor market flexible is a topic of political debate in most developed countries. Since OECD's Jobs Study in 1994, a stream of literature have been developed in favor of flexible labor markets. Flexibility not only contributes to employment but also allows for higher economic growth and higher productivity growth (Nicoletti & Scarpetta, 2003). In recent years, firm-level analyses on flexible labor contracts as determinants of innovation have suggested a significant impact of labor relations on innovation through their influence on knowledge processes (Amabile et al., 1996; Guest, 1997; Trott, 1998). While functional flexibility through reallocating regular employees in a firm's internal labor market is generally suggested good for innovation (Arvanitis, 2005; Chadwick & Cappelli, 2002; Kleinknecht et al., 2006; Michie & Sheehan, 1999, 2001; Zhou et al., 2011), the effect of numerical flexibility is rather mixed.

Numerical flexibility reflects the ability of firms to make use of external labor market through easy hiring and firing regular employees and to make use of temporary employees by fixed-term contracts or through temporary work agencies, in order to respond quickly to changes in labor demand (Beatson, 1995; Michie & Sheehan, 2003; Zhou et al., 2010). On the one hand, numerical flexibility is considered to bring highly skilled workers to infuse the firm with new ideas and networks that may foster innovation (Malcomson, 1997; Matusik & Hill, 1998); on the other hand, such flexibility can destroy loyalty and commitment of employees by easy firing (Naastepad & Storm, 2006). This might not be good for generating firm-specific knowledge and accumulate knowledge for future learning (Belot et al., 2007; Chadwick & Cappelli, 2002; Michie & Sheehan, 1999, 2001).

Recent studies furthermore indicate that modes of numerical flexibility and the novelty of innovativeness do matter in the relationship. For instance, Arvanitis (2005), using Swiss firm-level data, shows that hiring specialists on a temporary basis has a positive impact on R&D process while using part-time employees is negatively correlated to innovation. Based on Dutch firm-level data, Zhou et al (2011) find that using employees with temporary contracts has a positive effect on new product sales however this effect is mainly captured by the products with less novelty, namely 'imitative products'. While separately examining temporary employees with real 'innovative' innovation, they observe a significantly negative coefficient. Martínez-Sánchez et al (2011), using a sample of Spanish first-tier suppliers of automotive systems/components, show that temporary/fixed-term employees are negatively associated to innovativeness while using employees from consulting/contracting firms have a positive association. In a nutshell, most of these empirical evidences were investigated in the context of European countries and focused on relatively large and old corporations (Laursen & Foss, 2003; Michie & Sheehan, 2003; Kleinknecht et al., 2006; Arvanitis, 2005; Lucidi & Kleinknecht, 2010; Zhou et al., 2011), there is little known about labor flexibility in the context of start-up companies and in the context of Japan whereas empirical evidences in both contexts can be interesting.

For decades, the emergency of start-up companies are generally considered important for economic development by researchers and policy makers. This is due to their roles in spurring innovation, opening new industries, and contributing to job creation and wealth generation (Acs & Audretsch,1987; Audretsch, 1995; Birch, 1987; Folster, 2000; Reynolds, 1997; Rickne & Jacobsson, 1999; Schumpeter, 1934). Although a number of studies have examined various determinants of innovation, such as entrepreneur's personal characteristics (Marcati et al., 2008; Baron and Tang, 2011), organizational context (e.g. Damanpour, 1991; Nonaka & Takeuchi, 1995) and environment characteristics (Edwards et al., 2005; Romijn & Albaladejo, 2002), there still exists knowledge gaps on the factors that may boost innovation of start-up companies (Romero & Martinez-Roman, 2012). To our knowledge, labor flexibility is rarely considered as a factor while examining the innovation of start-ups. This is regrettable, as flexible labor contracts, in particularly numerical flexibility can be an important means for start-ups to innovate due to their resources constraints (Gardon, 2003) and may be critical for new firms such as their growth given their liabilities of newness and size (Autio, 2005; Baughn & Neupert, 2003; Baughn et al., 2008; Hoskisson et al., 2002).

Furthermore, very few studies investigate innovation of start-ups in Japan, with the exception of Lynskey (2004), Honjo et al. (2014) and Kato et al. (2015), due to the fact that there is limited data available on such firms. This is surprising as Japanese government called for structural reform through entrepreneurship in order to revitalize its stagnant economy (Lynskey and Yonekura, 2003; Yonekura and Lynskey, 2000). There is a need for new start-up firms to innovate. Researchers and policy-makers need to understand the innovation behavior of such firms in order to introduce most effective mechanisms that efficiently support this type of firms to innovate. Lynskey (2004) demonstrates that firm-level characteristics such as technological capability, internal funds, venture capital funding, and university-industry linkages are important determinants of innovative activities in Japanese technology-based start-up companies. Though not empirically examine in his paper, he also indicates that lack of labor mobility among experienced and qualified employees and lifetime employment structure impede Japanese start-ups to recruit such employees, who may contribute significantly to the innovative activities of the start-up companies (Lynskey, 2004). The 3rd Arrow of Abenomics advocates promoting innovation and economic growth through increasing labor mobility in Japan. In addition,

government intends to increase the start-up ratio to 10% to achieve economic growth. Yet, the question whether these policy stimulus are mutually complementary, concurrent or counteracting arises[1]. Using an original panel dataset of Japanese start-ups, we are able to shed the light on the nexus between labor flexibility, in particularly numerical flexibility, and innovation in the context of R&D oriented Japanese start-ups. Thereby, we may provide some empirical evidence to current policy strategies of Japanese government.

The reminder of the paper is organized as follows: In section 2, we describe the characteristics of labor relations in the Japanese labor market. Section 3 devotes attention to the existing literature on the relationship between numerical flexibility and innovation. Data and research methodology are presented in section 4. The estimation results are presented in section 5. Section 6 presents discussions and conclusions.

LABOR RELATIONS IN THE JAPANESE LABOR MARKET

Japanese labor market is traditionally characterized by its practice of simultaneous recruiting of new graduates, development of firm-specific skills through lifetime employment for the regular employees, ranking hierarchy, and utilization of functional flexibility within large internal labor markets (Bredgaard & Larsen, 2007; Kato, 2001; Keizer, 2009; Passet, 2003). This traditional lifetime employment system was challenged by the asset bubble collapse in the early 1990s and the following prolonged recession (Aoyagi & Ganelli, 2013; Bredgaard & Larsen, 2007; Passet, 2003). The subsequent employment reform allows Japanese firms to explore alternative labor practices, that is, making use of wage flexibility such as performance-based pay and making use of numerical flexibility such as hiring non-regular employees (Aoyagi & Ganelli, 2013; Keizer, 2009).

In Japan, non-regular employees include part-time employees, 'Arubaito' employees, dispatched employees and contract employees. Except for dispatched employees that have indirect employment with employers, the rest is directly employed by employers. Both 'Arubaito' and contract employees work on full-time basis while 'Arubaito' employees are employed with a shorter fixed-term contracts. Part-time employees can have both fixed-term and open-ended contracts but only work on part-time basis (Aoyagi & Ganelli, 2013). Since the reform, the share of non-regular employees increase to 35% in 2011. Among non-regular employees, Japanese women accounts for 70% and within total female employees 60% of them are part-time employees (Aoyagi & Ganelli, 2013). Compare to regular employees that are hired directly by employers on full-time basis with open-ended contracts, non-regular employees encounter significantly lower level of job and social security and are paid much less wages (Aoyagi & Ganelli, 2013). The principal reason of using non-regular employees does not aim for labor flexibility but for the need of less costly labor and protection against fluctuations in labor demand (Keizer, 2009). Therefore, non-regular employees are common in low-value added service sectors such as retailing, restaurant and hospitality services (Aoyagi & Ganelli, 2013; Keizer, 2009).

[1] De Spiegelaere et al. (2013) raise the same question to the EU policies that aim to increase the competitiveness of the European economies through promoting innovation and labor flexibility

NUMERICAL FLEXIBILITY AND INNOVATION

While labor flexibility can be categorized into – numerical flexibility, functional flexibility and wage flexibility - in the literature (Arvanitis, 2005; Beaston, 1995; De Spiegelaere et al., 2013; Michie and Sheehan, 2003; Zhou et al., 2011), we only focus on the numerical flexibility that might be more relevant to our interested group: R&D oriented start-up companies. Numerical flexibility is defined as the ability of firms to make use of external labor market through easy hiring and firing regular employees and to make use of temporary/fixed-term employees, part-time employees or hiring through temporary work agencies, in order to respond quickly to changes in labor demand (Beatson, 1995; De Spiegelaere et al., 2013; Michie & Sheehan, 2003; Zhou et al., 2010). Common indicators of numerical flexibility are percentages of people on temporary/fixed-term contracts, employees hired from temporary work agencies, freelance workers or external labor turnover, that is, the percentage of regular employees that join or leave the firm (Arvanitis, 2005; Martínez-Sánchez et al., 2011; Zhou et al., 2011).

External labor turnover and innovation

Many mainstream economists tend to be in favour of 'Anglo-Saxon' labor market model that allows easy hiring and firing regular employees (Kleinknecht et al., 2014; Zhou et al., 2011). A number of arguments are developed in favor of more numerical flexibility. First, easier firing enhances the inflow of 'fresh blood' with novel ideas and networks. Ichniowsk & Shaw (1995) show that long tenured employees are more conservative and reluctant towards significant changes and novel innovation. This might be due to the 'lock-in' effect caused by past investment in education. Second, redundant employees can be easily replaced and this might encourage labour-saving process innovations (Bassanini & Ernst, 2002; Nickell & Layard, 1999; Scarpetta & Tressel, 2004). Third, easy firing allows firms to replace weak and underperformed people by better and productive employees. The (latent) threat of firing can also prevent shirking behaviour of employees (Zhou et al., 2011). Fourth, easy hiring and firing could help keeping wages low and this in turn reduces fixed labor cost (Storey et al., 2002; Zhou et al., 2011). Fifth, without strong protection against dismissal, employees may become less powerful in negotiating high wage claims on the profits from innovation. This might stimulate investments in innovation (Malcomson, 1997).

Schumpeterian economists, emphasizing on the firm's stability and continuity of learning and firm-specific knowledge generation, however, provide the counterarguments against high numerical flexibility (Zhou et al., 2011). They argue that a high external labor turnover can diminish the trust, loyalty and committee of employees to their firms (Naastepad & Storm, 2006). Easy hiring and firing leads to shorter job durations. Employees with an expectation of short-stay in the firm will be demotivated to acquire firm-specific knowledge and to share information about knowledge related to their work. The continuity of organizational learning is less likely to occur in the firm (Belot et al., 2007; Chadwick & Cappelli, 2002; Michie & Sheehan, 1999, 2001). Under flexible hiring and firing, it is difficult for firms to store firm-specific historical memory, innovative knowledge and to efficiently implement labor-saving process innovation. This is because 'tacit' knowledge that is ill-documented and idiosyncratic is embedded to individuals (Lorenz, 1999; Malerba & Orsenigo, 1995; Polanyi, 1966). Less loyal and committed employees can easily leak knowledge to competitors and this will discourage investment in knowledge creation and innovation. Short-term employees can conduct shirking behavior as they expect their contracts will be ended anyway (Bentolila & Dolado, 1994). Furthermore, employers are also less

likely to invest in firm-sponsored training due to the high external labor turnover (Coutrots, 2003; Ichniowski & Shaw, 1995).

In the context of start-up companies, numerical flexbility might be in favor of innovation. According to Schumpeter innovation regime I, start-up companies are the drivers of creative destruction. It is observed that countries with more labor flexibilities, that is those typical Anglo-Saxon countries, perform much better on radical innovation. Furthermore, based on resource-based view, start-up companies generally face resource constraints and high risks due to liabilities of newness and size (Autio, 2005; Baughn & Neupert, 2003). High flexibility allows start-ups to utilize labor according to the capital interests. They can easily make adjustment if meeting unexpected changes in demand (Baughn et al., 2008). Less bargaining power of labor allows start-ups to set up lower wages and this reduces fixed labor cost (Storey et al., 2002). Start-ups can allocate more capital to innovation. In addition to financial capital constraints, start-up companies also have limited human capital, therefore, efficiently utilize their personnel is key to success (Baughn et al., 2008). Innovation performance of start-up companies are more vulnerable to individual employee's performance. Therefore, start-ups are less tolerant to underperformed employees in the firm and there is no room of redundancy. Easy hiring and firing allows start-up companies to replace unqualified employees and bring highly skilled workers to infuse the firm with new ideas and networks that may foster innovation (Malcomson, 1997; Matusik & Hill, 1998). Following this logic, we thus propose the following hypothesis:

> Hypothesis 1: A high external labor turnover contributes positively to innovation performance of start-up companies

Temporary employees and innovation

Temporary employees include those hired directly by employers on fixed-term contracts or part-time contracts, and 'temporary agency employees' that hired indirectly through temporary work agencies (Beatson, 1995; Michie & Sheehan, 2003; Zhou et al., 2010). In Japan, temporary employees all belong to non-regular employees while non-regular employees are not necessarily temporary as it is feasible to have an open-ended part-time contract (Aoyagi & Ganelli, 2013). Temporary employees are normally used when firms meet fluctuations in production, aim to reduce fixed labor costs or perform certain tasks at some particular time when regular employees are not available (Storey et al., 2002). Firms rarely consider employees with temporary contracts as magic sources to promote innovation (Storey et al., 2002). Those firms that make use of temporary employees for their innovation activities aim for different reasons, such as using the input of similar knowledge but with a lower labor cost or expecting skilled temporary employees that can bring new ideas and networks to create and implement new knowledge (Kalleberg & Mardsen, 2005; Malcomson, 1997; Matusik & Hill, 1998; Martínez-Sánchez et al., 2011). Due to resource constraints and high internal transaction cost, start-ups typically utilize temporary employees to fulfill non-core activities such as administration in order to be efficient in operation. Therefore, using temporary employees might not be beneficial for innovation capacity of the firm.

The negative association between temporary employees and innovation is also supported by the Schumpeterian view. Temporary workers usually have relatively shorter-term contracts. Temporary employees hired directly by employers might be less committed compared to regular employees due to their short job duration (Michie & Sheehan, 2003, 2005; Posthuma et al.,2005).

Ng & Feldman (2008) indicate that organizational commitment is the factor that ties individual and organization together, which is important to innovation at the firm level. Committed employees are more likely to devote extra time and efforts for innovation while less committed employees are reluctant to acquire firm-specific knowledge and are tend to hind their tacit knowledge on a specific innovation project (Belot et al., 2007; Chadwick & Cappelli, 2002; Michie & Sheehan, 1999, 2001). Temporary agency employees feel even less associated with the company (De Ruyter et al., 2008). They are the outsiders of the company (Mitlacher, 2008), and are hard to organize and often have different objectives from regular employees. This makes them easily to create tensions in labor relations to others (Pfeffer and Baron, 1988). Temporary agency employees have low commitment (Svensson and Wolvén, 2010) and likely to withdraw (at least partially) from work related helping behaviors (Broschak and Davis-Blake, 2006). Therefore, temporary agency workers may contribute negatively to innovation due to their poorer labor relations, lower organizational commitment and being involuntarily left out from innovation team (Martínez-Sánchez et al., 2011; Mitlacher, 2008).

Majority of previous empirical studies support the negative association of using temporary employees on innovation (Beugelsdijk, 2008; Broschak & Davis-Blake, 2006; Byoung-Hoon & Frenkel, 2004), furthermore, research also show that types of temporary employees do matter. For instance, using Swiss firm-level data, Arvanitis (2005) shows that hiring specialists on a temporary basis has a positive impact on R&D process while using part-time employees is negatively correlated to innovation. Martínez-Sánchez et al (2011), using a sample of Spanish first-tier suppliers of automotive systems/components, show that temporary/fixed-term employees are negatively associated to innovativeness while using employees from consulting/contracting firms have a positive association. Based on 143 Greek new ventures, Voudouris et al (2005) find that numerical flexibility affect positively on radical innovation. Following aforementioned arguments, we thus propose:

Hypothesis 2: A higher share of temporary employees hired directly by employers (including fixed-term and part-time employments) contributes negatively to innovation performance of start-up companies.

Hypothesis 3: A higher share of temporary agency employees (including dispatched employees) contributes negatively to innovation performance of start-up companies.

DATA AND METHODOLOGY

Data sources and samples

This study makes a use of an original panel dataset of Japanese start-ups. To the best of our knowledge, there exists no publicly available data sources for R&D activities by start-ups in Japan. In order to construct a panel dataset of start-ups, we conducted four waves of postal questionnaire surveys in 2008 to 2011. We obtain target firms from a company database compiled by Tokyo Shoko Research (TSR). In the questionnaire surveys, we asked the founders about firm-specific characteristics, including R&D activities. In the first survey, we sent questionnaires to 13,582 firms in the Japanese manufacturing and software industries, which had been incorporated between January 2007 and August 2008. The number of effective responses was 1,514

(approximately 11 percent of the target). Among the responses, we selected 1,060 "real" start-ups that had started their businesses during 2007 and 2008, by excluding the firms that were founded before 2006 and incorporated later. One third of the 1,060 start-ups responded to our repeated surveys from 2008 to 2011. After excluding missing values, we obtained an unbalanced panel of 514 firms (931 observations) for this study.

Variables

The dependent variable of the study is innovation performance. We use two indicators, that is, technological innovation including both the number of product and process innovation, and patent measured by number of patent application. Note that we are not able to distinguish novelty of innovativeness in the technological innovation proxy. Nevertheless, we hope that patent variable can compensate this drawback and represents newness in the dimension of innovation. Our key independent variable is numerical flexibility. We used three different indicators: 1) external labor turnover is measured by the change of regular labor inflow and outflow between periods t and t+1; 2) temporary employee is measured by the share of temporary workers including part-time and fixed-term employees to total number of employees; 3) temporary agency employee is measured by the share of dispatched workers ('Haken' in Japanese context) to total number of employees. We also include a set of control variables, such as firm size, firm age, R&D expenditures, industry dummies and year dummies in the model. The descriptions of variables are demonstrated in Table 1.

Estimation methodology

Due to the nature of our dependent variables are count variables, we use negative binomial regression model. In order to examine the effect of numerical flexibility on the subsequent innovation of R&D-oriented start-up companies, we used one year lagged variables for independent and control variables. This approach to a certain extent also reduces potential endogeneity problems (Wooldridge, 2010).

RESULTS

Before estimating our empirical model, we show the summary statistics of variables in Table 2. Regarding dependent variables, the average number of product/process innovations per year is 1.491. On the other hand, the average number of patent applications is 0.402. With respect to independent variables, the average for external labor turnover (*TURN*) is 0.277, indicating that, on average, 28% of employees is hired or fired every year. The average for the share of temporary employees is 13.4%, and the one for the share of temporary agency employees is 1.3%. The correlation matrix of variables is shown in Table 3.

Insert Table 2 here

Insert Table 3 here

Table 4 reports the estimation results. Regarding external labor turnover (*TURN*), we find a significantly positive effect to patent applications (*PAT*) (B=0.846, p<0.05) while there is no significant association with technological innovation (INN). Regarding temporary employees (*TEMP*), our results indicate that *TEMP* has a significantly positive impact on technological innovations (*INN*) (B=1.213, p<0.01) but negatively affect patent applications (*PAT*) (B=-2.263, p<0.01). In a similar vein, temporary agency employees (*DISP*) shows a significantly positive coefficient on technological innovation (*INN*) (B=3.114, p<0.01). However, it has no significant effect to patent applications (*PAT*).

Insert Table 4 here

DISCUSSION AND CONCLUSION

This paper examines the relationship between flexible labor and innovation performance in the context of R&D-oriented Japanese start-up companies. From a macro-economic perspective, promoting start-ups and stimulating innovation through increasing labor mobility are both in the political agenda of Japanese government. However, it is less known whether these two policy stimulus enforce, complement or contradict to each other. Using an original panel dataset of Japanese start-ups, we are able to shed the light on this issue at the firm level. We are able to provide some empirical evidence on how numerical flexibility affects innovation performance of R&D oriented start-up companies. To explore this relationship, we used three different indicators, i.e. external labor turnover of regular employees, share of temporary employees and share of dispatched (Haken in Japanese) employees, to proxy numerical flexibility. Innovation performance is measured in two dimensions, i.e. technological innovation outcome and patent application, to distinguish the level of novelty (low vs. high) in innovation respectively.

Based on negative binomial regression analyses, we first observe a positive impact of external labor turnover on patent application of start-up companies while there is no effect on technological innovation performance. This finding supports the perspective from mainstream economists towards labor flexibility and our hypothesis of such flexibility in the context of start-ups based on the resource based view. Due to resource constraints and high risks (Autio, 2005; Baughn & Neupert, 2003), efficiently utilize and manage the regular personnel is key to the success of start-ups (Baughn et al., 2008). Therefore, start-up companies might be less tolerant to underperformed employees in the firm. There is no room for redundancy. Easy hiring and firing allows start-up companies, with a low cost, to replace unqualified and conservative employees and bring highly skilled workers (fitting their real needs) to infuse the firm with new ideas and networks that may foster innovation (Ichniowsk & Shaw, 1995; Malcomson, 1997; Matusik & Hill, 1998). Furthermore, the need for growth also trigger the high external labor turnover in start-up companies. They need to develop an effective human resource in order to survival and efficiently implement their growth strategies. Our results in subsample analysis of high-tech vs. low-tech start-ups also support this explanation. We only find that external labor turnover contribute positively to patent application in the high-tech start-ups. This is due to the fact that high-tech companies face even high risks and have a strong need to grow in order to survival in the uncertain environment.

Second, we find that temporary employees including both part-time and fixed-term employees have a positive impact on technological innovation performance but a negative effect to patent application of start-up companies. This finding is consistent to recent findings of Zhou et al. (2011) using the Dutch firm-level data. Again, due to limited human resources and available capital, start-ups cannot do everything in-house. Temporary employees can be used to fulfil routinized tasks during the innovation process and to reduce the cost of innovation. The requirement of firm-specific knowledge is trivial. However, this is not the case for writing a patent application in which a need for novel knowledge and the development of firm-specific knowledge is crucial. In subsample analyses, we further observe that temporary employees contribute negatively to patent application in high-tech start-ups while contribute positively in technological innovation performance in both high- and low-tech start-ups. This findings, to a certain extent, validate our explanation. Given Japanese context, our findings can be also explained by the characteristics of temporary employees in Japan. As stated in section 2, female employees constitute the majority of temporary employees in particularly part-time contracts, in order to fulfil their family responsibilities in the meantime. Therefore, they are normally hired to conduct simple tasks such as secretary or administrators. Furthermore in Japan, temporary employees are often found themselves in a grey area of labor law. They might be given the same job profile as regular employees, but with lower payment, and lower job and social security (see examples in the book of Ouchi & Kawaguchi (2014)). Therefore, they are not motivated to engage in the firm-specific knowledge learning.

Last, in a similar vein, we also observe the temporary agency employees have a positive impact on the technological innovation while have no effect to patent application. This finding support the arguments on lack of commitment and loyalty of dispatched employees. Compared to temporary employees that hired directly by the employer, dispatched employees feel even less associated with the company (De Ruyter et al., 2008). Given different employers and they are normally on project-based call, dispatched employees are hard to organize and often have different objectives from regular employees. This can create tension in the labor relationship (Pfeffer and Baron, 1988). Employers will simply exclude them from specific training for innovation projects (Broschak and Davis-Blake, 2006; Martínez-Sánchez et al., 2011; Mitlacher, 2008). Therefore, dispatched employees are de-motivated to contribute to firm-specific knowledge generation. Further analyses using subsamples validate our explanation and show that dispatched employees only contributes positively to technological innovation in low-tech start-ups.

This study should be seen as one of the few exploration of the relationship between labor flexibility and innovation in the context of start-ups and of Japan. Therefore, we contribute new and fresh empirical evidence to the existing literature, the majority of which focuses on EU larger and older corporations. Our findings suggest that the characteristics of start-ups might explain the different relationship between numerical flexibility and innovation in start-up companies compared to it in established larger companies. Numerical flexibility might not be the practices only for reducing fixed labor cost. Easy hiring and firing can help start-up companies optimize their resources for firm-specific knowledge generation. Within non-regular employees, dispatched employees are different from temporary employees while considering their roles in the innovation process of start-up companies.

Based on our empirical findings, we derive a few implications to Japanese government's current policy interests. Similar to EU countries such as Denmark, Japan experiences dual labor market model, namely flexicurity. However, differently, Japanese model puts a lot of emphasis on internal flexibility than external flexibility (Bredgaard & Larsen, 2010). Non-regular employees

are associated with low wages, job and social security. This demotivate non-regular employees, which might be used often by start-ups due to resources constraints, to contribute to innovation of start-ups. Japanese government could learn from Denmark's model, make a transition from job security to employment security (Bredgaard & Larsen, 2010). When temporary employees enjoy same level of security as regular employees, they will be motivated to engage in more firm-specific activities, this may in turn foster innovation of start-up companies. Furthermore, our study indicates that easy using external labor market play an important role in firm-specific knowledge generation of start-ups. This allows them to effectively and efficiently find a right personnel. Strict dismissal protection will discourage start-up companies to actively search and hiring right regular employees. Japanese government might think about some stimulus that can help start-up companies reduce their transaction cost while exchanging with external labor market. For instance, Japanese government can introduce a stimuli that allows start-ups to dismiss regular employees easily in the beginning of the labor relation. The longer the employees stay in the company, the more difficult the company can dismiss the employees. Thereby, start-ups have freedom in searching for right personnel and knowledge whereas they are able to motivate right personnel to engage in firm-specific knowledge learning by giving them security in employment. Last, our study shows that temporary agency employees indeed play a role in the innovation process of start-up companies. Japanese government might consider to corporate with temporary worker agencies to stimulate the commitment and association of these employees to start-ups to which they are outsourced, in order to promote innovation of start-ups.

Our study has a few limitation, thus we propose several directions for future research that might help to deeper into the relationship examined in this paper: first, for better policy implication, it might be interesting to investigate what kinds of employment systems promote innovation by firms. For instance, an optimal value can be calculated based on the division between regular employees and non-regular employees in start-up companies. Second, additional detailed information on employees can bring more insights given types of employees may differ between industries. Last, though we claim that the characteristics of start-up might explain the different relationship between numerical flexibility and innovation compared to it in established companies. Due to the data limitation, we are not able to empirically compare them. Future research could consider to use a dataset including both samples in order to conduct comparative studies.

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Table 1: Definitions of variables

Variable	Definition
(Dependent variable)	
INN	Number of product/process innovations between period t and t+1
PAT	Number of patent applications between period t and t+1
(Independent variable)	
TURN	Number of hired and retired workers between periods *t* and *t*+1, divided by total number of workers at period *t*
TEMP	Number of part-time and fixed-term employees divided by the number of employees (incl. the president), at period t
DISP	Number of employees hired from agency divided by the number of employees (incl. the president), at period t
SIZE	Logarithm of the number of employees (incl. the president), at period t
AGE	Months after the foundation.
B2C	Dummy variable: 1 if B to C industry, 0 otherwise.
RD	Logarithm of annual amount of research and development (R&D) expenditures at period t.
PROFIT	Dummy variable: 1 if the business is profitable, 0 otherwise.
COMP	5-point Likert scale for perceived competitive pressure (1 less competitive ~ 5 fairly competitive)
IND	Dummy variable: 1 if the firm is an independent start-up, 0 if a subsidiary or affiliated firm.

Table 2: Summary statistics for variables

Variable	Obs	Mean	Std.Dev.	Min	Max
(Dependent variable)					
INN	931	1.491	6.125	0	100
PAT	903	0.402	3.360	0	68
(Independent variable)					
TURN	931	0.277	0.948	0	18
TEMP	931	0.134	0.229	0	0.946
DISP	931	0.013	0.076	0	0.833
SIZE	931	1.128	0.965	0	5.994
AGE	931	3.048	0.650	1.386	4.060
B2C	931	0.063	0.244	0	1
RD	931	2.888	2.795	0	12.388
PROFIT	931	0.519	0.500	0	1
COMP	931	2.766	1.366	0	5
IND	931	0.871	0.335	0	1

Table 3: Correlation matrix of variables

Variable	*INN*		*TURN*	*TEMP*	*DISP*	*RD*	*SIZE*	*AGE*	*B2C*	*PROFIT*	*COMP*	*IND*
INN	1											
PAT	0.045	1										
TURN	-0.023	0.035	1									
TEMP	0.124	-0.041	-0.082	1								
DISP	0.127	0.002	-0.008	-0.017	1							
RD	0.142	0.070	0.032	0.038	0.032	1						
SIZE	0.084	0.008	-0.088	0.403	0.195	0.157	1					
AGE	0.017	0.003	-0.051	0.121	-0.001	0.083	0.215	1				
B2C	0.017	-0.021	-0.040	-0.034	-0.025	-0.091	-0.105	-0.273	1			
PROFIT	-0.049	-0.044	0.004	0.012	0.058	-0.003	0.156	0.117	-0.120	1		
COMP	-0.018	0.016	-0.046	-0.102	-0.005	0.109	-0.144	-0.068	-0.004	0.086	1	
IND	-0.019	0.021	0.006	-0.125	-0.097	-0.086	-0.351	0.047	-0.032	-0.037	0.054	1

Table 4: Estimation results: the full sample

Variable	*INN*	*PAT*
TURN	-0.079	0.846**
	(0.066)	(0.333)
TEMP	1.213***	-2.263***
	(0.309)	(0.821)
DISP	3.114***	2.079
	(0.780)	(1.788)
RD	0.233***	0.359***
	(0.025)	(0.060)
SIZE	0.061	0.294
	(0.090)	(0.203)
AGE	0.650***	-1.161**
	(0.237)	(0.520)
B2C	0.588**	-0.038
	(0.292)	(0.665)
PROFIT	-0.366***	-0.506
	(0.142)	(0.309)
COMP	0.020	0.129
	(0.050)	(0.108)
IND	0.615***	1.695***
	(0.224)	(0.537)
Constant term	-3.565***	0.011
	(0.951)	(1.997)
Year dummies	Yes	Yes
Industry dummies	Yes	Yes
ln(α)	1.028***	2.279***
	(0.083)	(0.139)
Log likelihood		
Pseudo R^2	0.070	0.078
Observations	931	903

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1