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Firm Age, Size, and Employment Dynamics: Evidence from Japanese firms[1]

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Abstract

This study examines the effects of firm age and size on employment dynamics based on large scale panel data from Japan. It contributes to the literature by examining age and size effects on firm-level job creation and job destruction, which have not been clear in previous studies. The empirical results indicate that firm age has significantly negative effects on both job creation and destruction rates; however, firm size has a significantly negative effect on job creation while it has a significantly positive effect on job destruction. The theoretical background of this study is the standard theory on job creation and destruction in labor economics theories, which considers that job creation is determined by expected profit from newly created jobs, and job destruction is determined by whether the job is expected to be profitless. The age and size of firms affect their expected profit and therefore lead to effects on the behaviors of job creation and destruction. Finally, the results are similar for manufacturing firms and service firms.

Keywords: Firm age, Firm size, Job creation, Job destruction, Productivity
JEL classification: J23, J63

[1]This study is conducted as a part of the RIETI Data Management project undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the micro data of the questionnaire information based on the “Basic Survey of Japanese Business Structure and Activities” which is conducted by the Ministry of Economy, Trade and Industry (METI). The author would like to thank Makoto Yano, Masayuki Morikawa, Atsushi Nakajima, Yoko Konishi, Yoichi Sekizawa, Yukiko Saito, Keisuke Kondo, and Kenta Yamanouchi for their valuable comments. All remaining errors are the author's own.

1. Introduction

Policies in many countries provide subsidies for small and young firms to achieve growth goals while academic studies have provided critical evidence or mixed opinions (Neumark et al. 2011; Arkolakis 2017). Many studies have found that net employment growth rates are higher in smaller and younger firms, while different evidence has been found in some economies (Shanmugam and Bhaduri 2002). As the net employment growth of a firm is the difference between job creation and destruction of the firm, the effects on job creation and destruction are still unknown with those results on the net employment. To fill this gap, this study uses a large-scale dataset from Japan to examine age and size effects on firm-level job creation and destruction.

In standard labor economic theory (Cahuc and Zylberberg 2004; Pisserides 2000), job creation and destruction are considered optimal behaviors for existing firms. Firms observe expected return from new created jobs, and then decide on their job creation behavior. At the same time, if there are any old jobs, whose expected return are below zero, firms destroy those jobs. Firms' age and size affect the expected return from new created jobs, as well as the number of old jobs, whose expected return drop below zero; those lead to effects on firms' behaviors of job creation and destruction. This, in turn, is the theoretical framework of this study.

Past studies have found that age and size significantly affect firm's profitability and productivity. Loderer and Waelchli (2010) found that profitability declines, as firms grow older, for the reason that as firm ages, costs rise, growth slows, assets become obsolete, and investment and R&D activities decline. Chay (2015) found also that firm value, as measured by the market-to-book equity ratio, has a downward sloping relation with firm age; furthermore, they found that profitability and capital expenditures decline as firms age. On the contrary, the theoretical models of Jovanovic (1982) considered that older firms enjoy better performance; specifically, the study developed an opinion of "selection effects," which arise when less productive firms are forced to exit the business, leading to higher average productivity in the cohort even if the productivity levels of the individual firms do not change over time (Akben 2016). Indeed, Capasso (2015), which used a large sample of Italian wineries, showed that the oldest wineries outperform the youngest wineries, which is explained significantly by the longevity factor.

Similarly, for firm' size, on the one hand, a larger firm size could increase productivity because of economies of scale, however, on the other hand, larger firms could also face more difficulties of management and a larger decline of returns to scale. Diaz and Sanchez (2008) examined firm size and productivity in Spain, finding that "that small and medium-sized firms tend to be less inefficient than the large firms are." However, Majumdar (1997) found that larger firms are less productive than smaller firms, using firm data from India. A literature review in Halkos and Tzeremes (2007) summarized that "On one hand, it is claimed that large firms could be more efficient in production because they could use more specialized inputs, better coordinate their resources, etc. On the other hand, it is emphasized that small firms could be more efficient because they have flexible, non-hierarchical structures, and do not usually suffer from the so-called agency problem. "

Age and size effect on firm-level job creation and destruction has not been examined in previous studies, probably because firm-level data, with detailed information on job creation and destruction, were usually unavailable. Instead of job creation and destruction, the difference between them, which is net employment growth,

is to be easily calculated by the number of employed workers, and, thus, widely examined previously. Numerous previous studies, most of which concentrated on the net employment growth of manufacturing industries, found that younger firms are more likely to grow faster than older firms (Santarelli, Klomp, and Thurik 2006; Farinas and Moreno 2000; Park et al. 2010; Choi 2010; Lawless 2014; Akben-Selcuk 2016). However, some exceptions have been found. Shanmugam and Bhaduri (2002) found that in the Indian manufacturing sector, firm age positively influences growth. Das (1995) showed also a positive effect of firm age on employment growth in the computer hardware industry in India. Moreover, the findings on the effect of firm size on net employment growth vary also across studies. Gibrat's Law, i.e., firms' growth rates are independent of their sizes (Gibrat 1931; Santarelli, Klomp, and Thurik 2006), has led to numerous empirical studies, although the results are mixed. Santarelli, Klomp, and Thurik (2006) reviewed 60 papers and stated: "one cannot conclude that the Law is generally valid nor that it is systematically rejected."

In Japan, Yasuda (2005) examined manufacturing firms using a two-year panel data of 1992 and 1998, and control variables of R&D activity and subcontracting relations. They found that firm size and firm age have negative effects on firm growth (measured by net employment growth). However, the regression result in Fukao and Kwon (2011, pp. 34–38) showed a positive effect of firm size for the net employment growth rate, the analysis of which is based on existing firms of all industries in 2001 and 2006, with the control variables of overseas parent and subsidiary companies.

Different from that of the previous studies, this study examines firm-level job creation and destruction, which is hidden behind the net employment growth that was examined in the previous studies. For an individual firm, because of the relationship that *net employment growth rate = job creation rate − job destruction rate*, a negative effect on the net employment growth, could hide several possibilities, such as, a negative effect on job creation and a smaller negative effect on job destruction, a positive effect on job creation and a larger negative effect on job creation, a negative effect on job creation and a positive effect on job destruction. The same is the case with a positive effect on net employment growth.

Furthermore, for the growing role of the service industry in the Japanese economy and its contribution to Japanese employment (Morikawa 2016), this study includes both manufacturing and service firms, and further conducts a comparison estimation between manufacturing and service firms on job creation and destruction, in a departure from most previous studies in other countries that concentrated on the manufacturing industry.

The remainder of this manuscript is designed as follows. Section 2 introduces an estimation model and Section 3 describes the data. The results are reported in Section 4, with robustness checks in Section 5. Finally, Section 6 concludes.

2. Theoretical background and estimation Model

This study includes models of job creation, job destruction, and net employment growth. It starts from a general specification in related previous studies on age and size effects, and steps forward into extended models of job creation and destruction in the standard economic theory (Cahuc and Zylberberg 2004; Pisserides 2000).

2.1 Specifications in previous studies on net employment growth

First, one of the most used specifications in previous studies, which examine age and size effects on net employment growth, is as follows:

$$\mathrm{g} = \alpha \ \mathrm{age} + \beta \ \mathrm{size} + \gamma \ size^2 + \delta \ control \ variables + \varepsilon, \quad (1)$$

where *g* is the increased or decreased size of employment, *age* is the current age of the firm, *size* is measured as the lagged size of the firm (Lawless 2014).

The control variables in the above equation are chosen from various fields of interest. For instance, Lawless (2014) controls ownership of the firm, GDP growth, a sector dummy, and the initial size of the firm. Regression models in BarNir et al. (2003), which concentrates on the magazine publishing industry, include type of questionnaire (online or mail), nature of the business (for profit/not for profit), and magazine type (trade or consumer publication). In the Japanese context, Yasuda (2005) considers R&D intensity and the subcontracting transactions of the firm. Fukao and Kwon (2011) include various overseas activities of the firm.

Our estimation model starts from the general form in proceeding studies, i.e., Equation (1), and proceeds a step further into job creation and destruction, which are hidden behind the net employment growth. First, the net employment growth for firm *i* in year *t*, is the difference between job creation and job destruction of firm *i* in year *t* as follows:

$$G_{it} = JC_{it} - JD_{it}. \quad (2)$$

In equation (2), JC_{it} and JD_{it} are obtained based on firm's optimal behavior, which are discussed in the following subsections.

2.2 Theoretical effects on job creation

In standard economic theory (Cahuc and Zylberberg 2004; Pisserides 2000), job creation behavior of a firm is determined by its expected return from creating new jobs. The job creation equation is obtained by combining equations of firm's expected profit from creating a vacant job, expected profit from the job if it is occupied, together with equilibrium conditions and endogenous wage determinations (Pisserides 2000).

According to Pisserides (2000, p.19), job creation equation is obtained as follows.

$$(1-\beta)(p-\mathrm{z}) - \frac{r+\lambda+\beta\theta q(\theta)}{q(\theta)} pc = 0 \quad (3)$$

$$\text{where } \theta = \frac{v}{u}. \quad (4)$$

In the above equations, β is wage bargaining power of workers, p is product of a job, namely, job productivity, z is unemployment benefit, r is interest rate, λ is exogenous job destruction rate, c is hiring cost index, v is job creation, and v is job seekers.

In this study, we consider a Cobb-Douglas production function as follows.

$$\mathrm{Y} = \mathrm{A}K^{\alpha}L^{\delta}, \text{ with } \alpha > 0, \delta > 0 \tag{5}$$

where A is technology, K is capital, L is total employment.

Job productivity, p, defined by product of a job, is obtained as follows.

$$p = \frac{Y}{L} = Ak^{\alpha}L^{\alpha+\delta-1} \tag{6}$$

where k is capital per worker, defined by $k = K/L$

Assume *A* in equation (6) is a function of firm age, denoted by η, R&D behavior, μ, and patent, π, as follows.

$$\mathrm{A} = \mathrm{A}(\eta, \mu, \pi) \tag{7}$$

From equations (3), (4), (6), and (7), a reduced form of job creation determination is obtained as follows.

$$\mathrm{v} = \mathrm{v}(\eta, \mathrm{L}, \mu, \pi, \mathrm{k}, \beta, \mathrm{z}, \mathrm{r}, \lambda, \mathrm{c}, \mathrm{u}) \tag{8}$$

Therefore, the effect of firm size on job creation is as follows.

$$\frac{\partial \mathrm{v}}{\partial \mathrm{L}} > 0 \text{ , if } \alpha + \delta > 1 \tag{9}$$

$$\frac{\partial \mathrm{v}}{\partial \mathrm{L}} = 0 \text{ , if } \alpha + \delta = 1 \tag{10}$$

$$\frac{\partial \mathrm{v}}{\partial \mathrm{L}} < 0 \text{ , if } \alpha + \delta < 1 \tag{11}$$

Furthermore, the effect of firm age on job creation is obtained as follows.

$$\frac{\partial \mathrm{v}}{\partial \eta} > 0 \text{ , if } \frac{\partial A}{\partial \eta} > 0 \tag{12}$$

$$\frac{\partial \mathrm{v}}{\partial \eta} = 0 \text{ , if } \frac{\partial A}{\partial \eta} = 0 \tag{13}$$

$$\frac{\partial \mathrm{v}}{\partial \eta} < 0 \text{ , if } \frac{\partial A}{\partial \eta} < 0 \tag{14}$$

Based on the theoretical discussion of job creation, a reduced form for age and size effect on job creation estimation includes independent variables of age, size, variables that determines job's productivity other than age and size, and other variables indicated by theoretical job creation equation (Pisserides 2000, p.18). Among them, variables that determines job productivity include R&D investment, patent, and capital per worker. Further, other variables indicated by theoretical job creation equation are wage bargaining power, unemployment benefit, hiring cost index, interest rate, exogenous shocks that destroy jobs, and the number of job seekers. In this study, we use GDP growth rate as a proxy for exogenous shocks that caused job destruction. Further, we use rate of *seishain* workers as a proxy for hiring cost index, for the reason that the cost of hiring a *seishain* worker is much higher than that of hiring a non-*seishain* worker because the former is granted lifetime employment and firms have to be very careful in their selection and evaluation. In addition, effects of foreign capital rate, oversea investment of the firm, 3-digit industry dummies, and year dummies are also controlled.

Thus, the estimation equation for job creation is as follows:

$$JC_{it} = \alpha_{jc}\ln(age_{it}) + \beta_{jc} size_{i,t-1} + \gamma_{jc} size_{i,t-1}^2 + C_{it}^{jc}(other\ \ variables) + \varepsilon_{it}^{jc}, \qquad (15)$$

where *age* is the current age of the firm, *size* is measured as lagged size of the employment of the firm, similarly to Lawless (2014). Further, $C_{it}^{jc}(other\ \ variables)$ include R&D investment, patent, capital per worker, wage bargaining power, unemployment benefit, *seishain* rate, interest rate, GDP growth rate, number of job seekers, foreign capital rate, 3-digit industry dummies, and year dummies. Note that because the data are year-based panel data, we assume $\ln(age_{it})$ instead of a linear assumption of wage, to avoid misspecification and multicollinearity with year dummies. Similar formulation of age can also be found in related studies of Fukao and Kwon (2011).

2.3 Theoretical effects on job destruction

Endogenous job destruction theory considers that firms destroy jobs whose expected return drop below zero. Reservation productivity for each firm, which is the productivity level leading to zero (presented-discounted and expected) value of the expected profit of an existing (occupied) job in the firm, exists. When an idiosyncratic shock arrives, job's productivity moves from its initial value to some new value, which is drawn from a general distribution *G(x)*. Firms destroy jobs whose productivity drop below reservation productivity, and continue to produce in jobs whose productivities are above the reservation productivity (see details of model description in Pissarides 2000; p.39-45). The job destruction condition is given as follows (Pissarides 2000; p.44).

$$\mathrm{R} - \frac{z}{p} - \frac{\beta c}{1-\beta}\theta + \frac{\lambda}{r+\lambda}\int_R^1 (s-R)dG(s) = 0 \qquad (16)$$

In equation (16), R is the reservation productivity of the firm. A higher R indicates more job destructions of the firm, as discussed in the model.

In this study, we consider two effects caused by the firm's age and size. First, age and size affect general productivity of all jobs in the firm, as shown in equations (6) and (7). Second, firm age and size affect the distribution of jobs' idiosyncratic productivity, G(x), in the firm. For instance, a firm with higher age could be more experienced in work reallocation, which affects the distribution of jobs' idiosyncratic productivity, and further leads to few jobs whose productivity drops below the reservation level; on the other hand, a larger firm may have more difficulties in work management, thus, more jobs whose productivity could fall below the reservation level.

Following the above discussion, and equations (6), (7), and (16), a reduced form of job destruction determination, *d*, is obtained as follows.

$$d = d(\eta, L, \mu, \pi, k, \beta, z, r, \lambda, c, \theta) \tag{17}$$

Age and size effects on job destruction, $\partial d/\partial \eta$, and $\partial d/\partial L$, are ambiguous. For instance, on the one hand, if age or size effect leads to lower general productivities of all jobs, the reservation productivity becomes higher and more jobs are destroyed. However, on the other hand, if age or size affects the distribution of idiosyncratic productivities of jobs, the number of jobs that dropped below reservation productivity could either increase or decrease. Therefore, the total effect of age (or size) on job destruction throughout the productivity could be positive, negative, or none.

Similarly to job creation, the estimation equation for job destruction is as follows:

$$JD_{it} = \alpha_{jd} \ln(age_{it}) + \beta_{jd} size_{i,t-1} + \gamma_{jd} size^2_{i,t-1} + C^{jd}_{it}(other\ \ variables) + \varepsilon^{jd}_{it}, \tag{18}$$

where $C^{jd}_{it}(other\ \ variables)$ include R&D investment, patent, capital per worker, wage bargaining power, unemployment benefit, hiring cost, interest rate, exogenous shocks, labor market tightness, hiring cost index, foreign capital rate, 3-dig industry dummies, and year dummies.

Furthermore, the effects of age and size on G_{it} are determined by their effects on JC_{it} and JD_{it} as follows:

$$G_{it} = (\alpha_{jC} - \alpha_{jd})\ln(age_{it}) + (\beta_{jc} - \beta_{jd}) size_{i,t-1} + (\gamma_{jc} - \gamma_{jd}) size^2_{i,t-1} + [C^{jc}_{it}(other\ \ variables) - C^{jd}_{it}(other\ \ variables)] + (\varepsilon^{jc}_{it} - \varepsilon^{jd}_{it}) \tag{19}$$

3. Data and definitions

3.1 Data

The data used in this study come from a large annual survey conducted by the Ministry of Economy, Trade and

Industry, namely, the *Basic Survey of Japanese Business Structure and Activities*. This core survey is conducted according to Japan's Statistics Act and companies are required to respond to the survey. The survey has a high response rate of over 80%, with reliable responses. This study use individual data of 1995-2014 in this survey, and the adjusted sample period is 1996-2013 after calculation of job creation and destruction.

The strong point of the data is that it is a large scale, annual dataset with consistent firm ID for every year, and the information covers both detailed employment and firm activity and performance. The coexistence of those advantages does not occur in any other current dataset in Japan. The weak point of the data is that firms with fewer than 50 employees, and firms whose capital are lower than 30,000,000 yen, are not included. The result of our study, therefore, is limited to large, medium, and small firms with more than 50 workers, whose capital are over 30,000,000 yen.

Further, this study concentrates on existing firms. The idea of the model is based on standard labor economic theory on job creation and destruction: firms make optimal decisions on how many jobs to create and how many job to destruct. Therefore, even though the entry and exit of firms cause job creation and job destruction also, they are essentially different from job creation and job destruction in existing firms and are excluded.

Data were carefully checked before the estimation. Employment of all divisions and branch offices in every individual firm were summed up to check if it equals the data of total employment reported by the firm. Those unequaled values were considered error data and the observations were deleted. Further, established year, which was used for age calculation, was checked whether it is a constant throughout sample time series of 18 years for each firm. Obvious typo errors were corrected. Furthermore, firms that went through a merger may change their established year into the merging year. In those cases, we used their real established years, and deleted data in the years when the merger occurs, because in those years, job creation and destruction are due to the merging, instead of the expected profits of firms.

3.2 Data of firm- level job creation, job destruction, and other variables

The definitions of firm- level job creation and job destruction are different from gross job creation and job destruction, which are based on an aggregate level (Davis et.al. 1996). In this study, for an individual firm, job creation is defined as "the aggregation of increased jobs in expanding divisions" and job destruction is defined as "the aggregation of decreased jobs in diminishing divisions[2]." The difference between job creation and job destruction is the net employment growth of the firm. For instance, if a firm increases jobs in the R&D and international divisions by six while cutting five jobs in the marketing and manufacturing divisions, then job creation is calculated as six, job destruction is five, and the net employment increase for the firm is one.

Further, R&D investment is measured by intensity of R&D expenditures, which are calculated by the ratio of R&D expenditures to sales。 Patent is the number of patent owned by the firm. Capital per worker is the amount of fixed capital per worker. *Seishain* rate is the ratio of *seishain* workers to total employment in the firm. The foreign capital rate is the current ratio of foreign capital to total capital of the firm;

Moreover, GDP growth rate, interest rate, number of job seekers in the labor market, wage bargaining power,

[2] Branch offices are treated the same as divisions.

labor market tightness, and unemployment benefits are yearly data, sourced from other databases. Among them, GDP growth rate is real annual percent change reported by Cabinet Office, government of Japan. Interest rate is the annual interest rate reported by the Bank of Japan (BOJ). Number of job seekers in the labor market includes both job seekers of new graduates and job seekers in job agencies (*syokugyou anntei jyo* in Japanese). Data of job seekers are the sum of new graduates and job seekers in job agencies: the number of new graduates come from annual surveys conducted by Research Works Institute, and data of job seekers in job agencies (excluding new graduates from universities) are from e-Stat. Further, because labor unions in Japan usually conduct wage bargaining, this study uses the rate of labor union number of workers to total workers, as a proxy for wage bargaining power, the data of which are reported by Ministry of Health, labour and Welfare, cited from s-Stat (b). Moreover, because unemployment benefit is a fixed proportion to the wage level before being unemployed, while it was reduced in 2003 from 60–80% to 50–80% (MHLW 2013, page 7), we denote 0.70 for the year before 2003, and 0.65 for year after 2003. Finally, labor market tightness is the ratio of job vacancies for new graduates from universities to total number of new graduates from universities who are seeking jobs, cited from RWI. Table 1 shows a statistical summary of all the variables. Further, the numbers of observations of each age and size group are reported in Figure 1.

4. Estimation results

Hausman specification test results show that random-effects models are not rejected in almost all specifications in this study. Therefore, we prefer random-effects model while report fixed-effects model results for comparison and confirmation[3]. Further, robust standard errors, developed by White (1980), are used to control for potential heteroscedasticity. Results are reported in Table 2

4.1 Age effects

Interestingly, the result indicates that age could have a negative effect on job creation; however, its effect on job destruction is also negative. Further, the negative effect on job creation is larger than job destruction, which is consist with the estimated negative effect on net employment growth.

According to the theoretical model of this study, the explanation could be as follows. For the effect on job creation, as age increases, the productivity of newly created jobs in the firm could decline (e.g. rising cost and obsoleted asset that stated in Loderer and Waelchli (2010)), thus leading to a lower and expected return form for job creation, and, therefore, fewer new jobs are created in older firms.

Further, there could be two opposite effects on job destruction. Age could affect both the distribution of idiosyncratic productivities of all jobs and the general productivity of jobs in the firm. On the one hand, as the firm ages, general productivity declines and this leads to higher reservation productivity of job destruction. The higher reservation productivity causes more job destruction. However, on the other hand, age could affect the

[3] Fixed effects model was applied in Akben-Selcuk (2016) to examine effect of age on net employment changes, with crisis dummy controlled.

distribution of idiosyncratic productivities of all jobs and lead to fewer jobs whose productivity drop below the reservation productivity. For instance, a firm that is being operated over a long time could be more efficient in terms of work allocation; thus, jobs with low idiosyncratic productivities could share some work from high-productivity jobs before they drop below the reservation productivity. Because the latter negative effect wherein age causes fewer jobs' productivity to drop below the reservation productivity could exceed the former positive effect wherein higher age reduces general productivity of all jobs, age could have a negative effect on job destruction as indicated by the estimation result of this study.

4.2 Size effects

The result shows a significantly negative effect of firm size on job creation, and a significantly positive effect on job destruction. It is indicated that in larger firms, fewer jobs are created and more jobs are destroyed, than smaller firms. The difference between effects on job creation and destruction is negative, which is consistent with estimated negative effect of firm size on net employment growth.

The explanation could be that, according to the theoretical model of this study, in larger firms, expected return from newly created jobs are lower than smaller firms, therefore few jobs are created. Further, in larger firms, there are more existed jobs whose expected return dropped below zero, which lead to more job destructions. The reason could be due to the decline of productivity in larger firms, which has been found in previous studies (e.g. Majumdar 1997). Further, more management difficulties in larger firms could also lead to more existing jobs whose expected return dropped below zero.

4.3 Effects of control variables

Among the control variables, patent number has a significantly positively effect on job creation, and a significantly negative effect on job destruction. It is indicated that in firms with more patents, which could be those with higher technology, may create more new jobs and destroy fewer old jobs. Further, capital per worker has a significantly positive estimate in job creation, for the reason that a higher level of capital per worker lead to higher productivity of jobs, which contribute to job creation.

Moreover, the result indicates that higher hiring cost, measured by the proxy of *seishain* worker, could lead to fewer job creations and more job destructions, which are consistent with prediction of theory (Pissarides 2000). Also, it is indicated that when there are more job seekers in the labor market, firms are likely to create more jobs. Finally, in firms that invest more in other countries, including those of investment in stocks and long-term loans, job creations are higher and job destructions are lower. Also, firms who have high rates of foreign capital could create more jobs.

5. Robustness check

The first check of robustness is dividing total samples into manufacturing and service firms. Table 3 and 4 report results on manufacturing firms and service firms, respectively. Similarly as estimation results on the entire sample, age could have both negative effects on job creation and destruction, and size could negatively affect job creation and positively affect job destruction, in manufacturing firms and service firms, respectively. All the estimates of

age and size are very significant in estimations of job creation, destruction, and net employment growth, except size effect on job destruction in manufacturing firms. It is indicated that as the firm expands, fewer jobs could be destroyed in manufacturing firms than in service firms. A possible explanation could be that the management of a large firm could be easier for the manufacturing group than that of service group, which leads to fewer jobs dropped below zero value of expected return.

The second robustness check is including variables of parent and affiliated firms, in which case the sample period is reduced largely to 2010-2014. If a firm has a parent firm or affiliated firms, the behavior of job creation and destruction of firms may be affected by them. However, estimation results in Table 5 indicates that results on age and size effects are consist with the major model of this study.

Finally, because in the starting stages, firms are usually unsure of their productivity and market situation of their product, thus, optimal job creation and destruction behaviors could be affected by large uncertainty. To exclude those effects, the third robust check is conducted by excluding firms whose age is less than 10 years. Still, the result reported in Table 6 shows similar estimate as in the total sample.

6. Conclusion

The effects of firm age and size on net employment growth have been extensively discussed in literature, while effects on firm-level job creation and destruction have not been clear. To fill this gap, this study starts from a theoretical idea of the firms' optimal behavior on job creation and job destruction, and examines firm and age effects on job creation and destruction based on Japanese firm-level data.

The result indicates that in older firms, both job creation rate and job destruction rate are smaller than in younger firms; however, in larger firms, job creation rate is lower and job destruction rate is higher than in smaller firms. The explanation could be that, as the firm ages, expected return from newly created jobs declines, while there are fewer existing jobs whose expected return dropped below zero. Further, in larger firms, expected return from newly created jobs is lower, and there are more existing jobs whose expected return dropped below zero.

The limitation of this study is that the dataset does not include very small firms whose number of employees is below 50 workers, and firms whose capital are below 30,000,000 *yen*. However, it might be better to exclude them in this study because a different model is preferred for such firms. Many small and immature firms face large uncertainties in terms of their productivity and the available market of their product. Thus, different theories, such as uncertainty and risk preference models, are better-fit for this analysis.

Finally, the study could inform policy makers by providing evidence on job creation and destruction. Polices which aim to create more new jobs may provide more support for smaller or younger firms. Further, to reduce job destructions, policy support for larger or younger firms could be effective.

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Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
job creation rate(%)	434164	¥14.02	¥21.79	0.00	196.07
job destruction rate(%)	434164	¥14.13	¥21.29	0.00	195.02
employment growth rate (%)	434164	¥-0.18	¥15.22	-194.92	195.60
age	549559	¥39.02	¥17.67	0.00	663
size (thousand)	453960	¥0.43	¥1.77	0.05	133.32
R and D intensity	558943	¥0.01	¥0.10	0.00	62.48
oversea investment(billion)	558943	¥1.07	¥21.54	0.00	2613.62
patent (thousand)	558943	¥0.03	¥0.65	0.00	96.97
seishain rate	558943	¥0.34	¥0.43	0	1
foreign capital rate	554938	¥0.02	¥0.11	0	1
capital per worker (million)	548261	¥11.10	¥36.62	0.00	12582.34
job seeker number (million)	558943	¥2.79	¥0.27	2.30	3.25
unemployment benefit	558943	¥0.67	¥0.02	0.65	0.70
wage bargaining power	558943	¥19.74	¥1.99	17.50	23.80
labor market tightness	558943	¥1.43	¥0.32	0.99	2.14
interest rate	558943	¥0.36	¥0.19	0.10	0.75
GDP growth rate	558943	¥0.88	¥1.76	-3.50	3.50
have subsidiary companies	150114	¥0.44	¥0.50	0	1
have parent companies	150114	¥0.40	¥0.49	0	1

Table 2 Estimation Results of Total Sample

	Model			Comparison		
	JC	JD	EC	JC	JD	EC
age	-3.02	-1.81	-1.18	-2.88	-1.09	-1.81
	[-29.03]***	[-17.81]***	[-18.59]***	[-7.89]***	[-3.08]***	[-6.48]***
size	-1.82	0.29	-1.51	-5.00	2.43	-7.43
	[-13.75]***	[3.35]***	[-11.33]***	[-14.02]***	[10.32]***	[-14.05]***
size^2	0.02	-0.002	0.01	0.03	-0.02	0.05
	[6.16]***	[-1.54]	[5.25]***	[6.57]***	[-4.79]***	[6.24]***
R and D intensity	-0.07	-0.07	-0.02	-0.44	-0.37	-0.06
	[-0.31]	[-0.26]	[-0.33]	[-2.05]**	[-1.55]	[-0.27]
oversea investment	0.01	-0.01	0.02	-0.003	-0.003	0.001
	[2.88]***	[-3.48]***	[3.78]***	[-0.68]	[-1.01]	[0.13]
patent	0.44	-0.16	0.54	-0.05	-0.08	0.03
	[2.41]**	[-2.70]***	[2.96]***	[-0.42]	[-0.88]	[0.22]
seishain rate	-6.82	2.32	-8.43	-7.31	4.51	-11.79
	[-18.03]***	[6.71]***	[-25.76]***	[-15.64]***	[10.42]***	[-25.16]***
foreign capital rate	1.24	-0.46	1.53	-0.14	-0.72	0.63
	[3.12]***	[-1.09]	[5.32]***	[-0.23]	[-1.12]	[1.17]
capital per worker	0.01	-0.004	0.01	0.01	-0.003	0.01
	[3.45]***	[-1.03]	[2.15]**	[2.16]**	[-0.67]	[1.53]
job seeker	1.12		0.16	3.11		-5.89
	[2.59]***		[0.48]	[4.10]***		[-26.96]***
bargaining power	0.37	2.25	-1.26	1.06	2.78	-2.16
	[3.77]***	[33.32]***	[-22.09]***	[6.79]***	[29.86]***	[-21.92]***
interest rate	12.75	—	—	—	—	—
	[10.84]***	—	—	—	—	—
GDP growth rate	0.08	0.22	-0.11	-0.58	-0.01	0.65
	[1.52]	[4.50]***	[-2.64]***	[-9.57]***	[-0.34]	[16.23]***
labor market tightness		2.03	1.55		1.45	6.02
		[6.53]***	[6.16]***		[5.95]***	[24.43]***
constant	27.09	-15.95	33.19	13.91	-33.06	67.29
	[6.13]***	[-4.25]***	[13.30]***	[1.81]*	[-5.75]***	[15.64]***
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
3-digit industry dum.	Yes	Yes	Yes	Yes	Yes	Yes
Model	Random effect	Random effect	Random effect	Fixed effect	Fixed effect	Fixed effect
R-squared	0.04	0.03	0.01	0.03	0.02	0.04
N	419217	419217	419217	419217	419217	419217

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01; Estimated variable of unemployment benefit is omitted because of collinearity, as well as "—" in the table.

Table 3 Estimation Results of Manufacturing Firms

	Model			Comparison		
	JC	JD	EC	JC	JD	EC
age	-2.07	-1.27	-0.83	-1.53	-0.43	-1.13
	[-15.10]***	[-9.32]***	[-10.51]***	[-3.06]***	[-0.85]	[-3.23]***
size	-1.79	0.16	-1.33	-5.03	3.15	-8.19
	[-12.55]***	[1.49]	[-10.63]***	[-11.33]***	[8.33]***	[-12.59]***
size^2	0.03	-0.002	0.02	0.06	-0.03	0.09
	[7.03]***	[-1.40]	[6.35]***	[7.92]***	[-6.37]***	[8.18]***
R and D intensity	-0.27	0.02	0.21	-3.84	0.19	-3.95
	[-0.13]	[0.01]	[0.18]	[-1.33]	[0.08]	[-2.26]**
oversea investment	0.01	-0.01	0.01	-0.01	-0.004	-0.001
	[2.11]**	[-2.40]**	[2.95]***	[-1.09]	[-0.80]	[-0.11]
patent	0.25	-0.14	0.33	-0.04	-0.15	0.11
	[1.97]**	[-2.09]**	[2.89]***	[-0.36]	[-1.39]	[0.94]
seishain rate	-6.26	0.59	-6.35	-6.68	1.56	-8.22
	[-10.97]***	[1.10]	[-16.41]***	[-10.05]***	[2.49]**	[-15.97]***
foreign capital rate	1.27	0.75	0.32	0.74	0.38	0.36
	[2.24]**	[1.21]	[0.82]	[0.95]	[0.43]	[0.56]
capital per worker	0.05	-0.04	0.07	0.13	-0.06	0.19
	[5.79]***	[-5.13]***	[5.72]***	[9.20]***	[-4.52]***	[9.15]***
job seeker number	2.54		1.31	2.29		-4.83
	[4.44]***		[3.41]***	[2.42]**		[-19.55]***
bargaining power	0.18	1.69	-0.99	0.65	1.86	-1.43
	[1.31]	[17.07]***	[-14.69]***	[3.14]***	[14.41]***	[-13.11]***
interest rate	12.01	—	—	—	—	—
	[7.90]***	—	—	—	—	—
GDP growth rate	-0.03	0.16	-0.14	-0.50	0.14	0.41
	[-0.42]	[2.48]**	[-2.80]***	[-6.56]***	[3.04]***	[9.04]***
labor market tightness		—	—		—	—
		—	—		—	—
constant	5.19	1.70	0.00	3.45	-25.12	40.05
	[1.22]			[0.51]	[-6.37]***	[12.30]***
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
3-digit industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Model	Random effect	Random effect	Random effect	Fixed effect	Fixed effect	Fixed effect
R-squared	0.03	0.02	0.02	0.03	0.02	0.04
N	201799	201799	201799	201799	201799	201799

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01

Estimated variable of unemployment benefit is omitted because of collinearity, as well as "—" in the table.

Table 4 Estimation Results of Service Firms

	Model			Comparison		
	JC	JD	EC	JC	JD	EC
age	-3.59	-2.14	-1.42	-3.48	-1.72	-1.79
	[-24.19]***	[-14.90]***	[-15.09]***	[-6.68]***	[-3.43]***	[-4.34]***
size	-1.96	0.40	-1.74	-5.15	2.49	-7.64
	[-12.16]***	[3.56]***	[-9.98]***	[-11.49]***	[9.03]***	[-11.75]***
size^2	0.02	-0.003	0.01	0.03	-0.02	0.05
	[6.79]***	[-1.74]*	[5.40]***	[7.48]***	[-4.71]***	[6.85]***
R and D intensity	-0.08	-0.06	-0.06	-0.38	-0.48	0.10
	[-0.34]	[-0.25]	[-0.79]	[-3.78]***	[-4.52]***	[1.26]
oversea investment	0.01	-0.01	0.01	0.01	-0.004	0.01
	[1.84]*	[-2.82]***	[3.56]***	[0.97]	[-1.11]	[1.55]
patent	0.74	-0.21	0.75	0.36	-0.10	0.47
	[2.60]***	[-2.68]***	[2.88]***	[0.73]	[-0.54]	[0.95]
seishain rate	-8.11	3.31	-10.44	-8.65	6.65	-15.25
	[-16.18]***	[7.23]***	[-22.27]***	[-13.36]***	[11.07]***	[-21.66]***
foreign capital rate	1.20	-1.28	2.27	-1.29	-2.24	1.06
	[2.21]**	[-2.31]**	[5.51]***	[-1.31]	[-2.28]**	[1.14]
capital per worker	0.01	0.00	0.01	0.01	-0.001	0.01
	[3.91]***	[-0.74]	[1.93]*	[2.35]**	[-0.45]	[1.45]
job seeker number	-0.23		-0.95	3.47		-3.75
	[-0.36]		[-1.86]*	[2.74]***		[-4.84]***
bargaining power	0.78	2.86	-1.38	1.90	3.78	-2.98
	[5.34]***	[29.27]***	[-16.34]***	[7.64]***	[23.19]***	[-14.94]***
interest rate	13.43	—	—	—	—	—
	[7.61]***	—	—	—	—	—
GDP growth rate	0.18	0.27	-0.09	-0.66	-0.23	0.13
	[2.24]**	[3.77]***	[-1.30]	[-6.57]***	[-5.39]***	[2.00]**
labor market tightness		—	—		—	—
		—	—		—	—
constant	-0.47	-3.38	-4.77	-7.55	-60.53	93.86
	[-0.00]		[-0.00]	[-0.75]	[-6.98]***	[11.45]***
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
3-digit industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Model	Random effect	Random effect	Random effect	Fixed effect	Fixed effect	Fixed effect
R-squared	0.04	0.03	0.01	0.04	0.03	0.04
N	210190	210190	210190	210190	210190	210190

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01

Estimated variable of unemployment benefit is omitted because of collinearity, as well as "—" in the table.

Table 5 Results of Estimation Including Variables of Parent and Affiliated Firms

	Model			Comparison		
	JC	JD	EC	JC	JD	EC
age	-2.82	-2.05	-0.84	-2.46	-2.01	-0.51
	[-18.23]***	[-13.76]***	[-9.01]***	[-1.66]*	[-1.49]	[-0.44]
size	-1.49	0.03	-0.99	-10.81	5.77	-16.58
	[-10.97]***	[0.30]	[-9.85]***	[-7.91]***	[5.80]***	[-7.44]***
size^2	0.01	-0.001	0.01	0.09	-0.05	0.14
	[4.40]***	[-0.93]	[4.72]***	[3.40]***	[-3.05]***	[3.31]***
R and D intensity	-0.03	-0.10	0.02	-0.32	-0.52	0.20
	[-0.10]	[-0.40]	[0.41]	[-4.50]***	[-7.46]***	[3.64]***
oversea investment	0.01	-0.01	0.01	0.00	0.00	0.01
	[2.08]**	[-2.77]***	[2.79]***	[0.69]	[-0.70]	[1.21]
patent	0.50	-0.14	0.48	0.15	-0.08	0.23
	[2.66]***	[-1.95]*	[3.13]***	[0.50]	[-0.94]	[0.64]
seishain rate	-10.76	3.89	-11.52	-25.76	19.14	-44.89
	[-19.76]***	[8.01]***	[-25.27]***	[-17.68]***	[13.96]***	[-24.34]***
foreign capital rate	2.33	0.68	1.17	1.35	0.90	0.44
	[3.78]***	[1.11]	[2.67]***	[0.71]	[0.50]	[0.28]
capital per worker	0.02	-0.02	0.03	0.06	-0.05	0.10
	[3.57]***	[-3.77]***	[5.46]***	[2.01]**	[-1.79]*	[1.99]**
job seeker number	0.97		25.48	—		—
	[0.89]		[2.73]***	—		—
bargaining power	0.66	2.45	-22.68	—	—	—
	[0.94]	[7.02]***	[-2.80]***	—	—	—
GDP growth rate	0.09	0.19	-0.14	0.59	0.81	-0.23
	[1.62]	[3.70]***	[-3.45]***	[9.08]***	[13.28]***	[-4.85]***
labor market tightness		-1.07	17.89		—	—
		[-1.44]	[2.68]***		—	—
subsidiary companies	0.51	-0.29	0.62	0.54	0.54	-0.01
	[3.05]***	[-1.85]*	[6.08]***	[1.26]	[1.30]	[-0.03]
parent companies	0.31	0.03	0.20	2.48	1.84	0.61
	[1.77]*	[0.15]	[1.93]*	[3.76]***	[2.83]***	[1.09]
constant	32.45	-11.07	323.94	72.72	5.24	67.63
	[2.85]***	[-1.42]	[2.94]***	[3.46]***	[0.25]	[3.13]***
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
3-digit industry dum.	Yes	Yes	Yes	Yes	Yes	Yes
Model	Random effect	Random effect	Random effect	Fixed effect	Fixed effect	Fixed effect
R-squared	0.03	0.02	0.02	0.03	0.02	0.12
N	132280	132280	132280	132280	132280	132280

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01. Estimated variables of unemployment benefit and interest rate are omitted because of collinearity, as well as "—" in the table.

Table 6 Estimation Results of Firms Aged over Ten Years

	Model			Comparison		
	JC	JD	EC	JC	JD	EC
age	-3.56	-2.01	-1.52	-4.19	-1.05	-3.15
	[-25.85]***	[-14.92]***	[-19.15]***	[-6.84]***	[-1.80]*	[-7.30]***
size	-1.82	0.32	-1.43	-5.03	2.66	-7.68
	[-10.40]***	[4.59]***	[-11.22]***	[-12.43]***	[11.85]***	[-13.51]***
size^2	0.02	-0.004	0.02	0.04	-0.02	0.06
	[4.03]***	[-4.90]***	[5.31]***	[4.50]***	[-6.41]***	[5.13]***
R and D intensity	0.99	1.34	-0.36	-3.16	-0.10	-3.02
	[0.44]	[0.58]	[-0.48]	[-1.30]	[-0.05]	[-2.03]**
oversea investment	0.01	-0.01	0.01	-0.003	-0.003	0.000
	[2.96]***	[-3.40]***	[3.89]***	[-0.72]	[-0.86]	[0.00]
patent	0.39	-0.16	0.47	-0.05	-0.09	0.05
	[2.30]**	[-2.62]***	[2.83]***	[-0.43]	[-1.01]	[0.35]
seishain rate	-6.59	2.10	-7.90	-7.17	4.08	-11.22
	[-16.90]***	[5.96]***	[-24.18]***	[-14.92]***	[9.26]***	[-23.45]***
foreign capital rate	0.85	-0.84	1.43	-0.46	-1.23	0.82
	[2.06]**	[-1.90]*	[4.87]***	[-0.72]	[-1.84]*	[1.46]
capital per worker	0.01	-0.004	0.01	0.01	-0.002	0.01
	[3.38]***	[-0.92]	[2.11]**	[2.12]**	[-0.63]	[1.48]
job seeker number	1.03		0.09	3.13		-5.86
	[2.35]**		[0.27]	[4.04]***		[-26.35]***
wage bargaining power	0.38	2.22	-1.23	0.99	2.71	-2.21
	[3.79]***	[32.33]***	[-21.54]***	[6.08]***	[26.66]***	[-21.24]***
interest rate	12.18	—	—	—	—	—
	[10.19]***	—	—	—	—	—
GDP growth rate	0.08	0.19	-0.10	-0.55	-0.01	0.66
	[1.39]	[3.91]***	[-2.21]**	[-8.91]***	[-0.31]	[16.04]***
labor market tightness		1.90	1.51		1.38	5.78
		[6.00]***	[5.97]***		[5.52]***	[23.20]***
constant	28.96	-14.56	33.87	19.88	-31.78	73.10
	[6.38]***	[-3.74]***	[13.47]***	[2.46]**	[-5.06]***	[15.61]***
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
3-digit industry dum.	Yes	Yes	Yes	Yes	Yes	Yes
Model	Random effect	Random effect	Random effect	Fixed effect	Fixed effect	Fixed effect
R-squared	0.04	0.03	0.01	0.03	0.02	0.04
N	396708	396708	396708	396708	396708	396708

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01

Estimated variables of unemployment benefit and unemployment benefit are omitted because of collinearity, as well as "—" in the table.

Fig. 1a The numbers of observations (thousand) of each age group

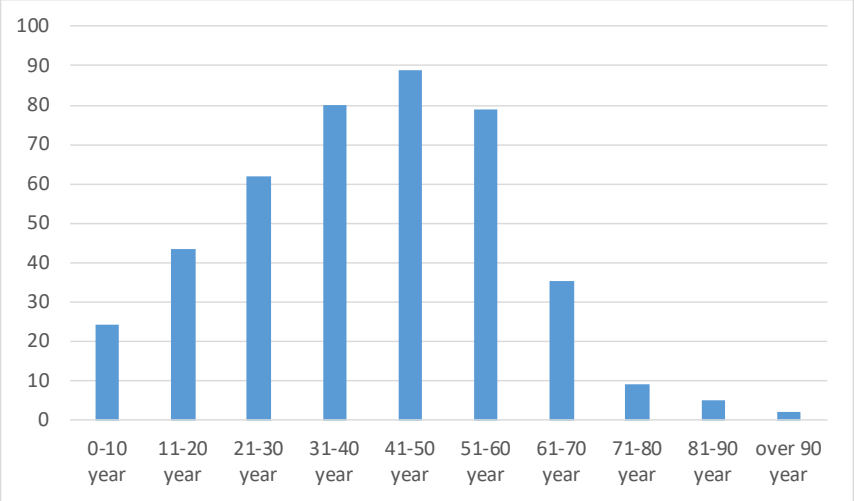

Fig.1b The numbers of observations (thousand) of each size group