RIETI Discussion Paper Series 24-E-032

Rise in Wage Inequality between Firms: Evidence from Japan 1995-2013

KAMBAYASHI, Ryo
RIETI

TANAKA, Satoshi
University of Queensland

YAMAGUCHI, Shintaro
University of Tokyo

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 24-E-032
March 2024

Rise in Wage Inequality Between Firms: Evidence from Japan 1995-2013*

Ryo Kambayashi†
Satoshi Tanaka‡
and Shintaro Yamaguchi§

Abstract

Using firm employer-employee matched data, we document changes in wage inequality in Japan from 1995 to 2013. We find that between-firm logwage variance rose and led to the rise in the overall logwage variance for male full-time workers, while within-firm logwage variance remain unchanged. The rise of between-firm variance is driven by changes in returns based on firms' technology and other characteristics, firm fixed effects, and the entry and exit of firms. By contrast, changes in the distribution of observed firm characteristics and returns to human capital had little effect on the between-firm logwage variance.

JEL Classification: J30, J31, J24.
Keywords: Wage Inequality, Between Firms, Employer-Employee Matched Data.

*This study is conducted as a part of the project "Wage Inequality and Industrial Dynamics" undertaken at the Research Institute of Economy, Trade and Industry (RIETI), based on the former mimeograph "Report of Changes in Wage Inequality Between and Within Firms: Evidence from Japan 1993-2013," by Ryo Kambayashi, Satoshi Tanaka, and Shintaro Yamaguchi on 9th Sep. 2019. Access to microdata had been permitted through the following research projects; JSPS 16K21741, Project Researchers at Joint Usage and Research Center Programs ("Economic Research on Japan's Foreign Workers" and "An Economic Analysis on the Guest Workers in Japan: Part II"). The draft and materials of this paper were presented at a RIETI Discussion Paper seminar and other places. The authors are grateful to RIETI staff, especially Shota Araki, as well as the seminar participants at Hitotsubashi University, 2017 KDI Journal of Economic Policy Conference, Kobe University, Tokyo Labor Workshop, Monash University, 2017 Workshop of the Australasian Macroeconomic Society, and the Discussion Paper seminar at RIETI. This project was supported by a research grant from the Japan Center for Economic Research.

† Musashi University, Email: ryo.kambayashi@cc.musashi.ac.jp
‡ University of Queensland, Email: s.tanaka@uq.edu.au
§ University of Tokyo, Email: syamaguchi@e.u-tokyo.ac.jp

1 Introduction

Rise in wage inequality in the developed countries has been one of the prevailing topics discussed among economists and policy makers in recent years. A huge literature has been established on the causes and consequence of the rise in wage inequality in the U.S. (See Katz and Autor (1999) and Acemoglu and Autor (2011) for reviews). While earlier papers attribute the rise of wage inequality to workers' observed and unobserved characteristics, a few recent papers use matched employer-employee data and find that a large part of the rising wage inequality among workers in the U.S. can be accounted for by the rise of wage inequality between firms or establishments (Barth, Bryson, Davis, and Freeman (2016) and Song, Price, Guvenen, Bloom, and Von Wachter (2019)).

In this paper, we document the trends of wage inequality and examine whether between-firm inequality rose in Japan during the period 1995-2013 using employer-employee matched data. We find that between-firm logwage variance rose in 1995-2013, while within-firm logwage variance has been stable. This feature is robustly observed across different subsectors economy defined by sex, industry, and firm size.

We then decompose the change in between-firm logwage variance, based on fixed effect wage regression. We regress a log of firm-average wage on human capital variables and firm's technology and other characteristics. Human capital variables include average age and tenure, female worker share, the share of university-educated worker, and so on. Firm's technology and other characteristics include the expenditure share of information and communication technology (ICT) and imported goods, the sales share of exported goods, the foreign ownership ratio, etc.

Our decomposition indicates that changes in returns to firm's technology and other characteristics, firm fixed effects, and entry and exit of firms substantially contributed to the rise in the between-firm logwage variance. By contrast, changes in the distribution of observed firm characteristics and changes in the returns to human capital variables had little effect on the between-firm logwage variance.

This paper is related to the recent and growing literature that sheds light on the rise of wage inequality between firms or establishments. In the U.S., Barth, Bryson, Davis, and Freeman (2016) use the Longitudinal Employer-Household Dynamics (LEHD) data and document that about two thirds of the rise in earnings inequality can be attributed to the rise in between-establishment inequality for the period 1992-2007. Song, Price, Guvenen, Bloom, and Von Wachter (2019) made another important contribution. They use more comprehensive data from the Social Security Administration (SSA) office for the period 1978-2013 and find that the rise of between-firm earnings inequality accounts for about two thirds of the rise of earnings inequality in the U.S. They also find that the increase in between-firm inequality has been driven by increased employee segregation.

There are also several studies outside of the US. Card, Heining, and Kline (2013) use administrative data from West Germany and find the rise in wage inequality is driven by rising heterogeneity between workers, rising dispersion in the wage premiums at different establishments, and increasing assortativeness of worker-plant matching. Changes in between- and within-establishment (or firm) are also reported from other countries. Examples include Mueller, Ouimet, and Simintzi (2017) and Faggio, Salvanes, and van Reenen (2010) for the U.K., Håkanson, Lindqvist, and Vlachos (2021) for Sweden, and Helpman, Itskhoki, Muendler, and Redding (2017) and Alvarez, Benguria, Engbom, and Moser (2018) for Brazil. This paper uses the data from Japan, and add new insights to this literature.

2 Data

We use a Japanese establishment survey and firm survey to create the matched-employer-employee data for our analysis. The former data set, the Basic Survey on Wage Structure (BSWS) is an annual establishment survey conducted by the Ministry of Health, Labour and Welfare (MHLW). The BSWS is designed for the purpose of collecting the information on worker's wages and salaries in various work environment. In the survey, workers are randomly sample within an establishment and not followed across years. Hence, BSWS does not provide worker panel data, although establishment panel data can be constructed.

The latter data set, the Basic Survey of Japanese Business Structure and Activities (BSJBSA), is an annual firm survey administrated by the Ministry of Economy, Trade and Industry (METI). The survey was started for the purpose of collecting information on various firm activities, and guiding the Japanese government's policies. We discuss the details of the two surveys in Appendix A.1.

We merge the BSWS and the BSJBSA to create employer-employee matched data for our analysis. As the two data sets don't have a common firm identifier, we use the information on firm's name, and the telephone number and the postcode of the firm's headquarter to merge the two data sets. An important limitation of our data is that no workers are tracked for more than one years. In other words, our data are firm panel data augmented by worker cross-section data. The details of the merging procedure are explained in Appendix A.2. We set the starting year of our analysis as 1995, since we cannot extend the BSWS before 1995. The end year of our data set, 2013, is due to the availability of the BSJBSA. The merged, match-employer-employee data have observations of roughly 5,000 of private firms and 0.3 millions of their workers per year, for the period 1995 – 2013.

We calculate the real hourly wage for each worker, which we use in the analysis in Section 3, from the information provided in the BSWS. We also calculate the average log hourly wage and the average worker characteristics within a firm. The average worker characteristics variables include the share of females, the average age, the average tenure, the share of high school graduates, the share of two-year college graduates, and the share of four-year university graduate. We also create firm characteristics variables from the information in the BSJBSA. Those firm characteristics variables include firm's size, asset they hold, foreign ownership ratio, the share of information and communication technology (ICT) cost in total intermediate input cost, the share of exports in total sales, the share of import in total intermediate input cost. Finally, we calculate total factor productivity and labor productivity for each firm from the information in the BSWS and the BSJBSA. The details of variable definitions can be found in Appendix A.3. Tables 5 and 6 also reports the mean and standard deviation of those variables.

3 Changes in Wage Inequality in Japan in 1995-2013

In this section we show that logwage variance has increased in Japan during the 1995-2013 period. By decomposing the total logwage variance into between- and within-firm logwage variance, we find that this rise in the total logwage variance is almost entirely driven by the growth of between-firm logwage variance, while within-firm logwage variance remains almost constant. These patterns are largely observed for both men and women and across industry and firm size.

3.1 Between- and Within-Firm Logwage Variance

The total logwage variance can be decomposed into between- and within-firm components so that

$$V(w) \quad = \quad V(E(w|j)) + E(V(w|j)), \tag{1}$$

where w is logwage and j is an index for firms. The first term of Equation (1) is between-firm logwage variance, and the second term is within-firm logwage variance. We apply this variance decomposition method to several subgroups from 1995 to 2013.

The top panel of Figure 1 shows changes in the total, between-firm, and within-firm logwage variances for fulltime male workers. The corresponding statistics are available in Table 4. The total logwage variance was 0.1934 in 1995, increased to 0.2252 in 2005, and has been stable thereafter. This rise in the logwage variance until the early 2000's is largely driven by the growth of between-firm variance. It was 0.0679 in 1995, increased to 0.1095 in 2005, and has been stable thereafter. By contrast, the within-firm logwage variance has been stable around 0.1200.

The bottom panel of Figure 1 presents changes in logwage variances for fulltime female workers. The total logwage variance among female workers was 0.1128 in 1995, increased to 0.1866 in 2005, and has been stable thereafter. Like men, this is largely driven by the between-firm logwage variance, but within-firm logwage variance also increased. The between-firm logwage variance was 0.0638 in 1995, increased to 0.1213 in 2005, and became stable until 2013 since then. The within-firm logwage variance increased from 0.0489 to 0.0733 from 1995 to 2013.

A noticeable difference between men and women is that the growth of female logwage variance is faster than male's. This might be explained by changes in the composition of female fulltime workers. Namely, an increasing number of women with lower unobserved skills are likely to enter the labor market over time, which may have contributed to the rise in wage inequality among women.

3.1.1 By Industry

We decompose logwage variance for fulltime male workers by industry. The worker share of agriculture, mining, and construction is low and stable around 2%. The worker share of manufacturing industry was high at about 75% in 1995, but it decreased to about 50% by 2005 and was stable thereafter. By contrast, the worker share of service industry was only at 23% in 1995, but it increased to about 50% by 2005 and was stable thereafter.

Figure 2 shows decomposition of logwage variance by industry. In all of the three major industries, between-firm logwage variance increased, while within-firm logwage variance has been stable or slightly decreasing. This result suggests that international trade is unlikely to be the primary explanation for why logwage variance, particularly between-firm logwage variance, increased in the last two decades.

3.1.2 By Firm Size

We decompose logwage variance for fulltime male workers by firm size measured by the number of employees. Firms are classified into one of four categories: fewer than 1,000 employees, 1,000-4,000 employees, 5,000-9,999 employees, and 10,000 and more employees. About 80% of the firms hire fewer than 1,000 employees, 15% is firms with 1,000-4,000 employees, 3% is firms with 5,000-9,999 employees, and 1-2% is firms with 10,000 or more employees. These shares are stable over the period of analysis. Note that, even though only 20% of the firms hire 1,000 or more employees, their employment share is about 50%. Hence, large firms have substantial influence on the total logwage variance.

Figure 3 shows logwage variances by firm size. In all subgroups, between-firm logwage variance increased, while within-firm logwage variance was almost constant over the last two decades. The between-firm logwage variance increased more for large firms (i.e. firms with more than 1,000 employees) than smaller firms (i.e. firms with fewer than 1,000 employees). This result implies that the rising between-firm logwage variance is not driven by a small number of gigantic employers. Instead, the rise of between-firm logwage variance is broadly observed across different sizes

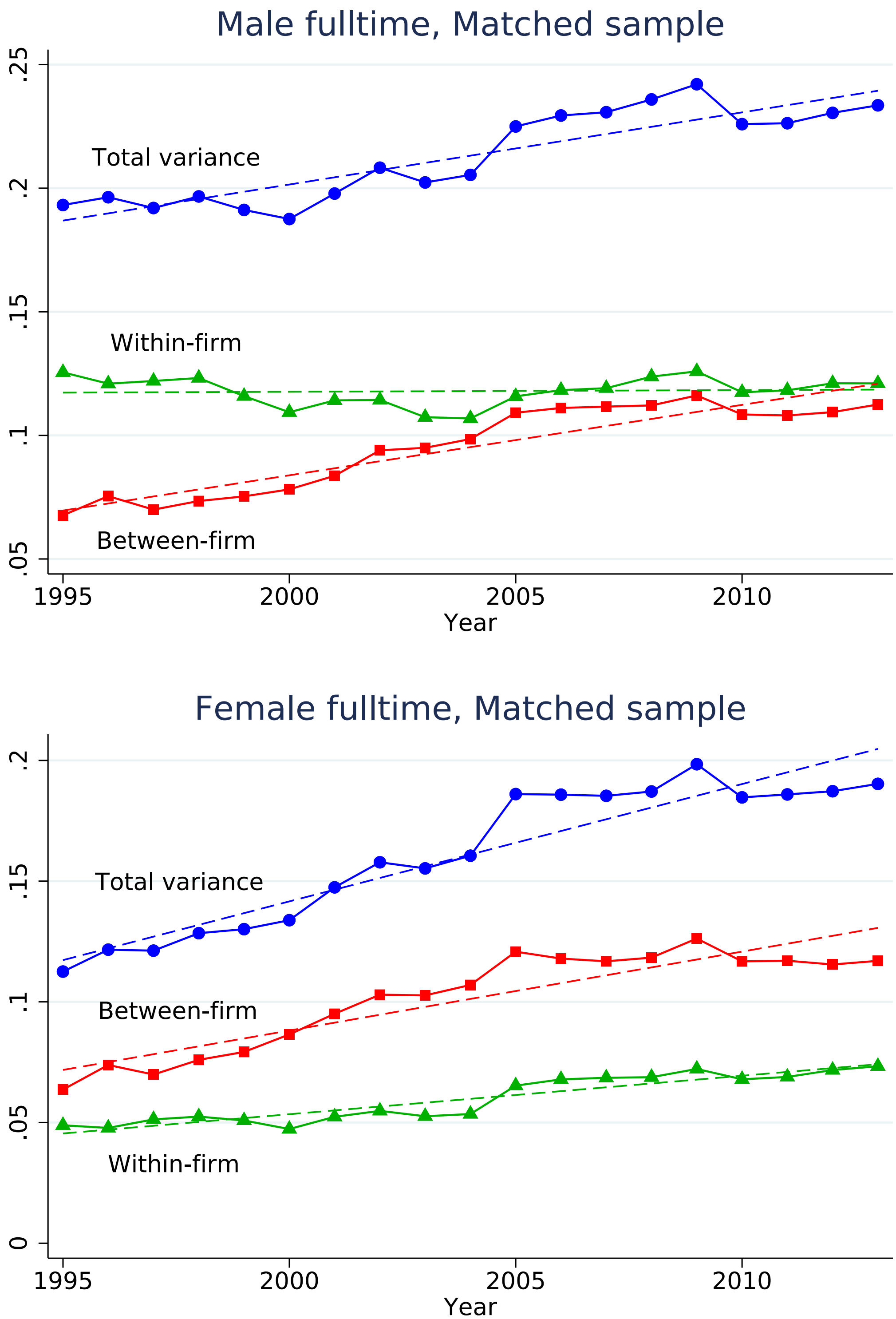

Figure 1: Changes in Between- and Within-Firm Logwage Variance (Fulltime Workers)

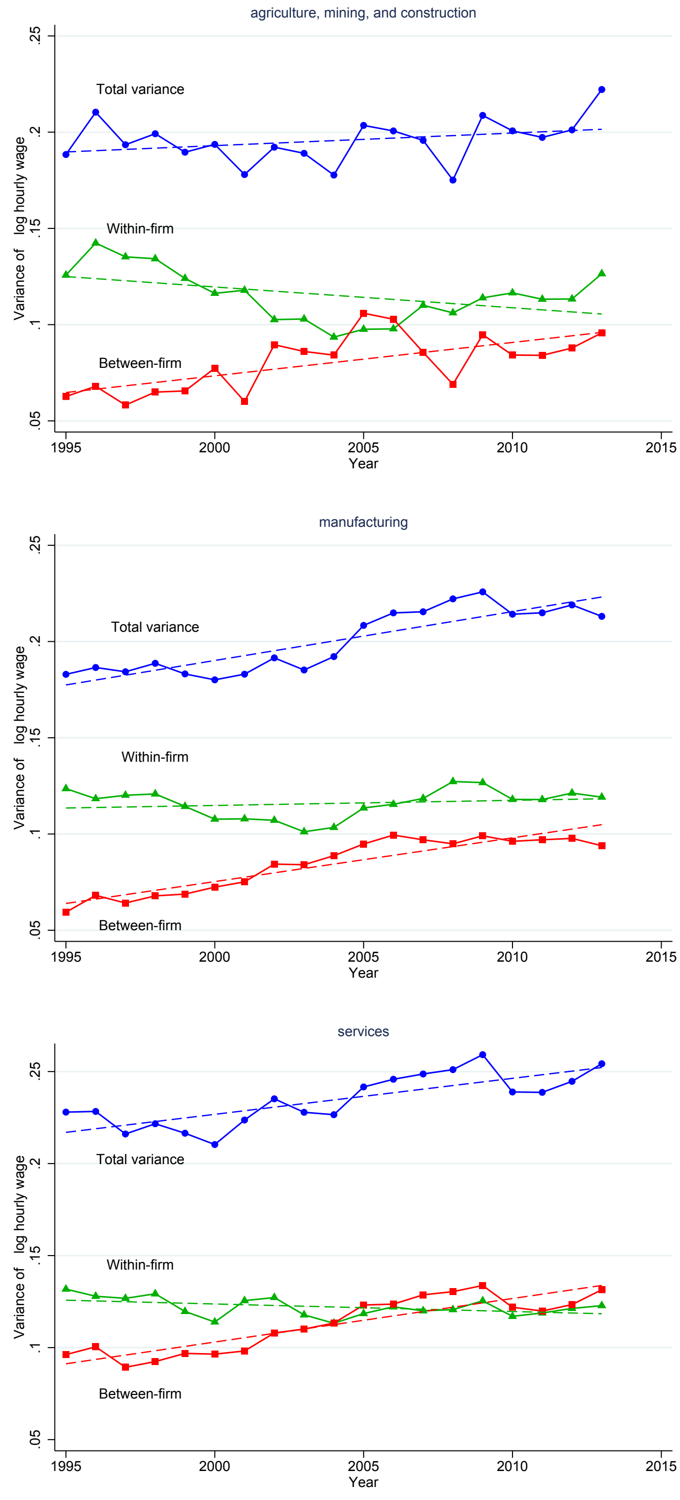

Figure 2: Changes in Between- and Within-Firm Logwage Variance By Industry
Note: Fulltime male workers.

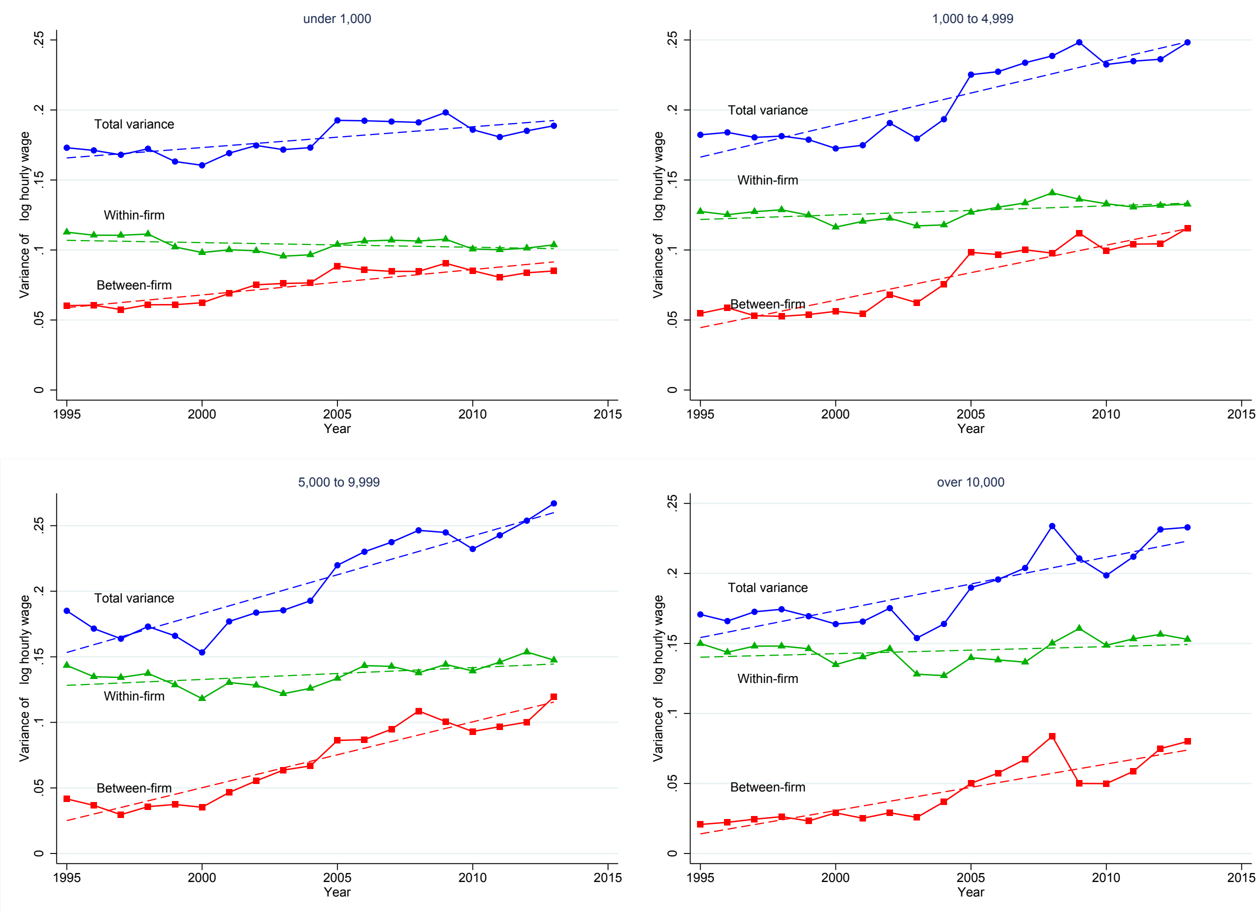

Figure 3: Changes in Between- and Within-Firm Logwage Variance By Firm Size
Note: Fulltime male workers.

of firms.

3.2 Decomposing Changes of Between-Firm Logwage Variance

In the following, we try to understand the sources of the rise in between-firm logwage variances among fulltime male workers. We consider male workers only, because their composition is more stable than female workers throughout the period of analysis.

3.2.1 Analytical Framework

We decompose changes in between-firm logwage variance from the 1995-1999 to 2005-2009 periods. Consider the following model for logwage

$$w_{it} = x_{it}'\beta + \theta_i + u_{it},$$

where w_{it} is log of average wage for firm i in year t, θ_i is firm fixed effect, and u_{it} is an iid error term. We take a sample of firms that appear in both periods and split it into two subsamples A and B. Then, we run the fixed effect regression separately for each sample.

The logwage variance for period A is given by

$$Var(w_{A,it}) \quad = \quad Var(x_{A,it}^{'}\beta_A + \theta_{A,i}) + \sigma_{A,u}^2,$$

where $\sigma_{A,u}^2 \equiv Var(u_{A,it})$. The logwage variance for period B is similarly given. The change of variances between two periods is given by

$$\begin{aligned} Var(w_{B,it}) - Var(w_{A,it}) \quad = \quad & \Big(Var(x_{B,it}^{'}\beta_B + \theta_{B,i}) - Var(x_{A,it}^{'}\beta_B + \theta_{B,i})\Big) + \\ & \Big(Var(x_{A,it}^{'}\beta_B + \theta_{B,i}) - Var(x_{A,it}^{'}\beta_B + \theta_{A,i})\Big) + \\ & \Big(Var(x_{A,it}^{'}\beta_B + \theta_{A,i}) - Var(x_{A,it}^{'}\beta_A + \theta_{A,i})\Big) + \\ & \left(\sigma_{B,u}^2 - \sigma_{A,u}^2\right). \end{aligned} \tag{2}$$

The first and second terms on the right hand side are the effects of changes in observed characteristics x and fixed effects θ, respectively. The sum of them is referred to as the composition effect. The third and the fourth terms capture the effects of changes in coefficients β and residual variances σ_u^2, respectively. The sum of them is referred to as the wage structure effect. Note that decomposition is not uniquely determined. The change of variances between two periods can also be decomposed as

$$\begin{aligned} Var(w_{B,it}) - Var(w_{A,it}) \quad = \quad & \Big(Var(x_{B,it}^{'}\beta_A + \theta_{B,i}) - Var(x_{A,it}^{'}\beta_A + \theta_{B,i})\Big) + \\ & \Big(Var(x_{A,it}^{'}\beta_A + \theta_{B,i}) - Var(x_{A,it}^{'}\beta_A + \theta_{A,i})\Big) + \\ & \Big(Var(x_{B,it}^{'}\beta_B + \theta_{B,i}) - Var(x_{B,it}^{'}\beta_A + \theta_{B,i})\Big) + \\ & \left(\sigma_{B,u}^2 - \sigma_{A,u}^2\right). \end{aligned} \tag{3}$$

We will use both of the decomposition to see how results are affected.

In addition to the decomposition method outlined above, we assess the effects of entry and exit of firms on logwage variances by comparing logwage variance of all firms and logwage variance of firms that appear in both periods.

3.2.2 Changes in Firm Characteristics

Before we decompose changes in logwage variance according to the method outlined above, we show how distributions of firm characteristics changed over time. The firm characteristics can be broadly categorized into two groups. The first group is human capital variables that include age, tenure, share of female workers, and education. The second group is technology and other variables that include firm size, asset, foreign ownership ratio, share of ICT costs, export share, import share, labor productivity, and TFP. Tables 5 and 6 in Appendix present means and standard deviations of firm characteristics in 1995-2013.

3.2.3 Wage Regression

We regressed log of firm-average wage on several observed firm characteristics using a fixed-effect model. Note that the regression coefficients are not necessarily interpreted as causal, even though firm fixed effects are controlled. The first set of columns in Table 1 presents estimates for the 1995-1999 period. The share of female workers is positively associated with average wage. Average age and tenure are also positively correlated with wage, and the predicted wage profiles along age and tenure are concave, which is well-known in the literature. Education is positively associated with wage. The estimates imply that 4-year university educated workers earn 26.4% higher hourly wage than high school educated workers. Firm's technology variables and other characteristics such as foreign ownership and import share are not strongly correlated with firm-average wage. Firms assets and export share are positively correlated with wage, but the magnitude is small (elasticity is about 0.01-0.02) and their p-values are around 0.10.

The next sets columns present estimates for the three subsequent periods including 2000-4, 2005-9, and 2010-13. The coefficient for female share is decreasing over time. A possible explanation for this is selection. The employment-population ratio for women aged 25-54 was about 64% in 1995-1999, but it increased to about 70% in 2010-2013 (See OECD employment and labor market statistics). Over time, more and more women with lower unobserved skills may have entered the workforce. The return to age also decreases over time. In 1995-9, a 40-year-old worker earn 12% higher wage than a 30-year-old worker. This age premium between 40- and 30-year-old workers stayed the same in 2000-2004, but decreased to 9% and 8% in 2005-9 and 2010-13, respectively. By contrast, return to tenure increased over time. Compared to a new employee, an employee with 10 years of tenure earn 21% higher wage. This return to 10-year tenure increased to 23%, 25%, and 25% in the subsequent three periods. Returns to education changed, but not monotonically. The return to 4-year university education decreased slightly from 26% to 25% in 2000-4, but then increased to 31% in 2005-9 and stayed the same level in 2010-13.

Table 1: Wage Regression

Sample	matched sample																			
Unit of observation	firm by year																			
period	1995～1999					2000～2004					2005～2009					2010～2013				
Estimation method	FE (12)					FE (13)					FE (14)					FE (15)				
dependent variable				mean	s.d.				mean	s.d.				mean	s.d.				mean	s.d.
mean of log hourly wage[1]				3.12	0.26				3.13	0.29				3.09	0.32				3.09	0.32
Explanatory variables	coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.
[productivity] :otal factor productivity																				
hourly labor productivity																				
[human capital][2] share of female	0.167	0.023	0.00	0.25	0.18	0.135	0.020	0.00	0.23	0.18	0.087	0.019	0.00	0.26	0.19	0.042	0.023	0.06	0.25	0.19
average age	0.057	0.006	0.00	37.65	5.14	0.046	0.006	0.00	38.54	5.01	0.039	0.005	0.00	39.19	5.30	0.030	0.006	0.00	40.03	5.00
average age^2/100	-0.065	0.008	0.00	14.44	3.94	-0.049	0.008	0.00	15.10	3.92	-0.043	0.007	0.00	15.64	4.20	-0.031	0.008	0.00	16.28	4.06
average tenure	0.022	0.002	0.00	12.51	4.94	0.026	0.002	0.00	13.08	5.12	0.028	0.002	0.00	12.34	5.45	0.029	0.003	0.00	12.61	5.24
average tenure^2/100	-0.008	0.007	0.25	1.81	1.38	-0.029	0.008	0.00	1.97	1.47	-0.033	0.007	0.00	1.82	1.48	-0.041	0.008	0.00	1.86	1.43
share of junior high	-0.124	0.015	0.00	0.12	0.15	-0.161	0.017	0.00	0.07	0.11	-0.122	0.028	0.00	0.05	0.08	-0.145	0.037	0.00	0.03	0.06
share of 2-yr-college	0.091	0.013	0.00	0.10	0.12	0.062	0.012	0.00	0.12	0.14	0.131	0.016	0.00	0.13	0.14	0.102	0.017	0.00	0.15	0.15
share of 4-yr-university	0.264	0.012	0.00	0.22	0.19	0.246	0.012	0.00	0.27	0.23	0.313	0.012	0.00	0.30	0.25	0.300	0.014	0.00	0.32	0.25
[firm tech] log of firm size	0.005	0.008	0.52	5.93	1.22	0.019	0.007	0.01	5.82	1.23	-0.002	0.008	0.82	5.90	1.26	0.000	0.010	0.97	5.98	1.28
log of firm asset	0.013	0.008	0.11	9.15	1.58	0.029	0.007	0.00	9.09	1.63	0.020	0.008	0.01	9.07	1.67	0.034	0.011	0.00	9.06	1.65
foreign owenership ratio	0.000	0.000	0.17	14.07	85.69	0.000	0.000	0.36	9.46	64.57	0.000	0.000	0.63	2.51	11.06	0.000	0.000	0.08	2.63	11.45
share of ICT cost in intermediates	-0.012	0.013	0.36	0.01	0.05	-0.050	0.074	0.50	0.01	0.03	0.004	0.024	0.87	0.01	0.04	-0.020	0.140	0.89	0.01	0.03
share of export in sales	0.019	0.011	0.09	0.02	0.08	0.036	0.021	0.08	0.03	0.10	0.056	0.029	0.06	0.03	0.11	-0.053	0.030	0.07	0.04	0.12
share of import in intermediates	-0.018	0.014	0.20	0.01	0.06	0.002	0.025	0.93	0.02	0.08	0.016	0.031	0.60	0.03	0.09	0.025	0.030	0.41	0.03	0.10
# of observation	23361					27736					25399					19603				
# of firm	9950					12438					12502					10894				
s.d. of predicted fixed effects	0.191					0.210					0.229					0.223				
s.d. of predicted error	0.082					0.087					0.107					0.109				

Note: Fixed-effect models. Male full-time workers are in the sample.

Unlike human capital variables, many of firm's technology and other characteristics are not strongly associated with average wage throughout 1995-2013. The coefficients for asset and export share are statistically significant, but they do not change monotonically over time.

As an additional exercise, we include the measured TFP as a control variable in the wage regression. The estimates are reported in Table 7 in Appendix. TFP is positively associated with average wage. The coefficient increased in 2000-2004 and was stable thereafter. Including TFP does not affect other coefficients substantially.

3.2.4 Wage Variance Decomposition

We decompose a change in the logwage variance from the 1995-9 to 2005-9 periods. The first column of Table 2 presents decomposition based on equation (2), while the second column presents decomposition based on equation (3). Between the two periods, the logwage variance changed by 0.031. The change of observed characteristics contributed modestly by 0.003-0.001. The change of firm fixed effects affected the logwage variance by 0.009-0.013. Another major contributor is the change of coefficients, which increased the logwage variance by 0.009-0.007. The change of residual variance had little effects. Lastly, entry and exit of firms account for 0.009 of the change of logwage variance. This implies that the new entrants that appear only in the 2005-9 period are more dissimilar to incumbent firms than the exiting firms that appear only in the 1995-9 period.

We further decompose the effect of the change of coefficients by separating them into human capital variables and firm's technology and other characteristics (not in the table). For both models, the effect is mostly driven by the changes in coefficients for firm's technology and other characteristics (0.008-0.009), while the changes in the returns to human capital had little effects (-0.001 to 0.000).

Table 2: Decomposition of Logwage Variance from the 1995-1999 to 2005-2009 periods

	Model (2)	Model (3)
Change of observed characteristics x	0.003	0.001
Change of firm fixed effects θ	0.009	0.013
Change of coefficients β	0.009	0.007
Change of residual variance σ_u^2	0.001	0.001
Entry and Exit	0.009	0.009
Total Change in variance	0.031	0.031

Note: Fixed-effect models. Male full-time workers are in the sample.

4 Concluding Remarks

In this paper we document changes in the logwage variance from 1995-2013 in Japan. This change is largely driven by the rise of between-firm logwage variance, while within-firm logwage variance has been stable. This feature is robustly found across gender, industry, and firm size.

As a first step toward understanding the sources of the rise of between-firm logwage variance, we decompose the changes of logwage variance into several factors. The decomposition indicates that changes in returns to firm's technology, firm fixed effects, and entry and exit of firms substantially contributed to the rise of between-firm logwage variance. By contrast, changes in the distribution of observed firm characteristics, returns to human capital, and residuals had little effects.

A few questions still remain unanswered. While we find returns to firm's technology and other characteristics contributed substantially, we do not know what particular characteristic is particularly important. Another issue is how entry and exit of firms influence the between-firm logwage variance. How new entrants are different from exiting and incumbent firms? Do any policies and regulations affect the characteristics of new entrants? At this juncture, our initial findings suggest that multiple factors may simultaneously influence the fluctuation in between-firm logwage variance, rendering a singular policy inadequately equipped to mitigate this escalating trajectory. We will address these issues in the next version of this paper.

References

ACEMOGLU, D., AND D. AUTOR (2011): "Skills, tasks and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*. Elsevier, vol. 4, pp. 1043–1171.

ALVAREZ, J., F. BENGURIA, N. ENGBOM, AND C. MOSER (2018): "Firms and the Decline in Earnings Inequality in Brazil," *American Economic Journal: Macroeconomics*, 10(1), 149–189.

BARTH, E., A. BRYSON, J. C. DAVIS, AND R. FREEMAN (2016): "It's Where You Work: Increases in the Dispersion of Earnings across Establishments and Individuals in the United States," *Journal of Labor Economics*, 34(S2), S67–S97.

CARD, D., J. HEINING, AND P. KLINE (2013): "Workplace Heterogeneity and the Rise of West German Wage Inequality," *Quarterly Journal of Economics*, 128(3), 967–1015.

FAGGIO, G., K. G. SALVANES, AND J. VAN REENEN (2010): "The evolution of inequality in productivity and wages: Panel data evidence," *Industrial and Corporate Change*, 19(6), 1919–1951.

HÅKANSON, C., E. LINDQVIST, AND J. VLACHOS (2021): "Firms and skills the evolution of worker sorting," *Journal of Human Resources*, 56(2), 512–538.

HELPMAN, E., O. ITSKHOKI, M. A. MUENDLER, AND S. J. REDDING (2017): "Trade and inequality: From theory to estimation," *Review of Economic Studies*, 84(1), 357–405.

KATZ, L. F., AND D. H. AUTOR (1999): "Changes in the wage structure and earnings inequality," *Handbook of Labor Economics*, 3, 1463–1555.

MUELLER, H. M., P. P. OUIMET, AND E. SIMINTZI (2017): "Wage Inequality and Firm Growth," *The American Economic Review*, 107(5), 379.

SONG, J., D. J. PRICE, F. GUVENEN, N. BLOOM, AND T. VON WACHTER (2019): "Firming up inequality," *The Quarterly journal of economics*, 134(1), 1–50.

A Details of Data

A.1 Data Sources

We use the Basic Survey on Wage Structure (BSWS) and the Basic Survey of Japanese Business Structure and Activities (BSJBSA) to create the matched-employer-employee data for our analysis. The BSWS is an establishment survey, which includes information on establishment characteristics and compensations for employees. The BSJBSA is a firm survey, which includes information on various firm's activities. The details of the two surveys are explained below.

A.1.1 Basic Survey on Wage Structure

The BSWS is an annual establishment survey conducted by the Ministry of Health, Labour and Welfare (MHLW) of Japan. The survey started in 1948. The BSWS is designed for the purpose of collecting the information on worker's wages and salaries in various work environment. The survey covers all the industries but agriculture and fishery, and includes a sample of private establishments with more than or equal to five employees, and public establishments with more than or equal to 10 employees. The Labor Standard Act Article 108 in Japan mandates all employers to maintain payroll records, and thus guarantees the accuracy of wages and salaries information. The BSWS's survey response rate is about 80%.

Every year in July, the sampled establishments are surveyed, and answer questions on establishment characteristics, worker characteristics, compensations paid, and hours worked by the workers. The BSWS collects employees' information only on *regular* workers: those whose employment contract is either permanent or longer than one month, or those who are actually worked more than 18 days in April or May in the survey year. The survey asks establishments with less than 30 regular workers to report information on all of their regular workers, while those with more than or equal to 30 regular workers need to report information on a sample of the regular workers they have only. The sample size is determined by its industrial classification and the number of the regular workers in the establishment.

The BSWS reports information on compensations and hours worked in details. The information on compensation covers monthly base salaries, monthly overtime payments, and annual bonus payments annual bonus payments (usually twice a year). For working hours, it reports the numbers of days worked, hours worked per day, and overtime hours. For establishment characteristics, the BSWS reports the numbers of employees in the establishment and the firm that the establishment belongs to, industry classification, and its location. For worker characteristics, it reports age, gender, experience, and job tenure for all workers and educational attainment only for fulltime workers. The information on worker characteristics are aggregated within a firm.

We calculate hourly wages for workers in the BSWS using its compensation record and hours worked. We calculate the total earnings on monthly basis by summing the three types of compensation, and divide it by total hours worked in a month including overtime hours to obtain hourly wage rate.

A.1.2 Basic Survey of Japanese Business Structure and Activities

The BSJBSA is an annual firm survey administrated by the Ministry of Economy, Trade and Industry (METI) of Japan. The survey started in 1992 for the purpose of guiding the government's policies The BSJBSA collects information on various firm activities. The survey includes all the firms with more than 50 employees or with their share capital equal to or more than 30 million yens (roughly 270 thousands in U.S. dollars). The BSJBSA covers all the industries but agriculture, fishery, construction, transportation service, health, and public service industries. The BSJBSA's response rate is about 85%.

Every year in July, the firms that meet the above criteria receive and answer to the questionnaires of the survey. The BSJBSA asks firms on their basic characteristics such as name, address, the amount of share capital, and starting year, as well as its organization structure, parent/subsidiary relationship, assets and debts, and sales and profits. The survey also include information on international trade, outsourcing, R&D, patient holding, and usage of information and communication technology (ICT).

A.2 Merging Two Data Sets

We merge the BSWS (establishment survey) and the BSJBSA (firm survey) to create the matched-employer-employee data for our analysis. As the two data sets don't have a common firm identifier, we use the information on firm's name, and the telephone number and the postcode of the firm's headquarter to merge the two data sets. The details of the merging procedure are explained bellow.Step 1. Creating Panels of the BSWS and the BSJBSA

In the first step, we make each of the BSWS and the BSJBSA to have a panel structure. The years at which we can connect the two data sets are only 2001, 2006, and 2009. Therefore, the two data sets cannot be connected outside of those years, unless we make them to have a panel structure. For the BSJBSA, it is straight forward to create panels as the sample are only changing little across years. For the BSWS, while we see more changes in the sample across years, we are still able to create decent panels as the original sample size of establishment is quite large. Since, the BSWS doesn't track establishment identification number (EIN) before 1995, we cannot extend the panels of the BSWS before 1995. Therefore, we set 1995 as the starting year.

Step 2. Connecting the BSWS to the BSJBSA through the Census

We connect the BSWS to the BSJBSA through the Census for Business Frame. The Census for Business Frame is a establishment survey administrated by the Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC). The survey is conducted every five years. This Census survey covers all the establishments in Japan, and most importantly, shares the same establishment identification number (EIN) with that of the BSWS.

For the years, 2001, 2006, and 2009, the Census survey includes the name and telephone number of the headquarter of the firm, to which each establishments belongs to. Therefore, for those years, by using the information, we are able to identify a firm in the BSJBSA and the establishment(s) in the Census survey, which belongs to that firm. Once the connection of the firms in the BSJBSA and the establishments in the Census is created, we can also link establishments in the Census to those in the BSWS by using the common EIN.

Step 3. Merging Algorithm

To connect firms in the BSJBSA and establishments in the Census, we use the following algorithm.

- First, we pick up the establishments in the Census, which themselves are headquarters of firms. For those establishments, we can use their name, postcode, and telephone number to match them to those of firms in the BSJBSA. In the first round of the match, we create a set of establishments, which are uniquely identified by their name in Chinese character (kanji), postcode, and telephone number. In the second round of the match, we create a set of establishments, which are left in the first round, and are uniquely identified by their name in Japanese original character (kana), postcode, and telephone number. In the third round of the match, we create a set of establishments, which are left in the second round, and are uniquely identified by their postcode, and telephone number. In the fourth round of the match, we create a set of establishments, which are left in the third round, and are uniquely identified by telephone number.

- Second, we pick up the establishments in the Census, which are branches of firms. For those establishments, we can use the name, and telephone number of their headquarter, to match them to those of firms in the BSJBSA. In the first round of the match, we create a set of establishments, which are uniquely identified by their name in Chinese character (kanji) and telephone number. In the second round of the match, we create a set of establishments, which are left in the first round, and are uniquely identified by their name in Japanese original character (kana) and telephone number. In the third round of the match, we create a set of establishments, which are left in the second round, and are uniquely identified by their telephone number.

Among the firms in the BSJBSA, 85% of them are matched to the Census establishments in 2001, 88% in 2006, and 79% in 2009.

A.3 Variable Definitions

Table 3: Definitions of Variables Used in the Regressions

	Variable name	Definition
(1)	Log of total factor productivity	The measured total factor productivity calculated by the following formula. $\ln(\text{TFP}) = \ln(\text{value added}) - (\text{labor cost share}) \times \ln(\text{total hours worked}) - (\text{capital cost share}) \times \ln(\text{fixed capital})$
	Log of hourly labor productivity	The total sales per hours worked.
(2)	Share of female	The share of female employees within the firm.
	Average age	The average age of employees within the firm.
	Average tenure	The average length of employee's tenure within the firm.
	Share of junior high	The share of high school graduates within the firm.
	Share of 2-year-college	The share of two-year college graduates within the firm.
	Share of 4-year-univeristy	The share of four-year university graduates within the firm.
(3)	Log of firm size	The logarithm of the number of employees listed in the BSJBSA.
	Log of firm asset	The logarithm of the value of firm's asset.
	Foreign ownership ratio	The share of foreign-owned capital in the total value.
	Share of ICT cost in intermediates	The share of ICT cost in the total intermediate expenditure.
	Share of exports in sales	The share of firm's exports in the total sales.
	Share of import in intermediates	The share of firm's imports in the total intermediate expenditure.

B Wage Growth By Percentile

Variance is a useful summary measure of wage inequality between firms, but it may mask more nuanced changes in the distribution of average wages at the firm level. To understand how top and bottom halves of the distribution changed over time, we present the growth of logwage for the 10th, 50th, and 90th percentile of the wage distribution in Figure 4. Note that the unit of observation is firm and the base year is 2000.

The top panel shows the wage growth by percentile using a sample of male fulltime workers. We find that between-firm wage inequality increased for both the top and bottom halves of the wage distribution by the similar extent. The bottom panel shows the evolution of between-firm wage inequality for female fulltime workers. Between-firm wage inequality rose for both the top and bottom halves of the distribution, but the difference between the 90th and 50th percentiles grows faster than that between the 50th and 10th percentiles.

Figure 5 presents changes of between-firm wage inequality by industry, using a sample of male fulltime workers. The between-firm wage inequality changed little for agriculture, mining, and construction industries (top),[1] but grew substantially for manufacturing (middle) and service (bottom) industries. For the manufacturing industry, between-firm wage inequality increased for the bottom and top halves of the distribution by the similar extent. Interestingly, for the service industry, the between-firm wage inequality in the bottom-half of the distribution increased more than that in the top-half.

Figure 6 shows changes of between-firm wage inequality by firm size, using a sample of male fulltime workers. Within each subgroup, the between-firm wage inequality for the bottom half grew faster than that for the top half.

[1] As shown in Figure 2, between-firm variance increased, which may seem contradict with Figure 5. A possible explanation is that between-firm logwage variance is driven by firms at the top and bottom 10% of the distribution. We will examine if this hypothesis is true.

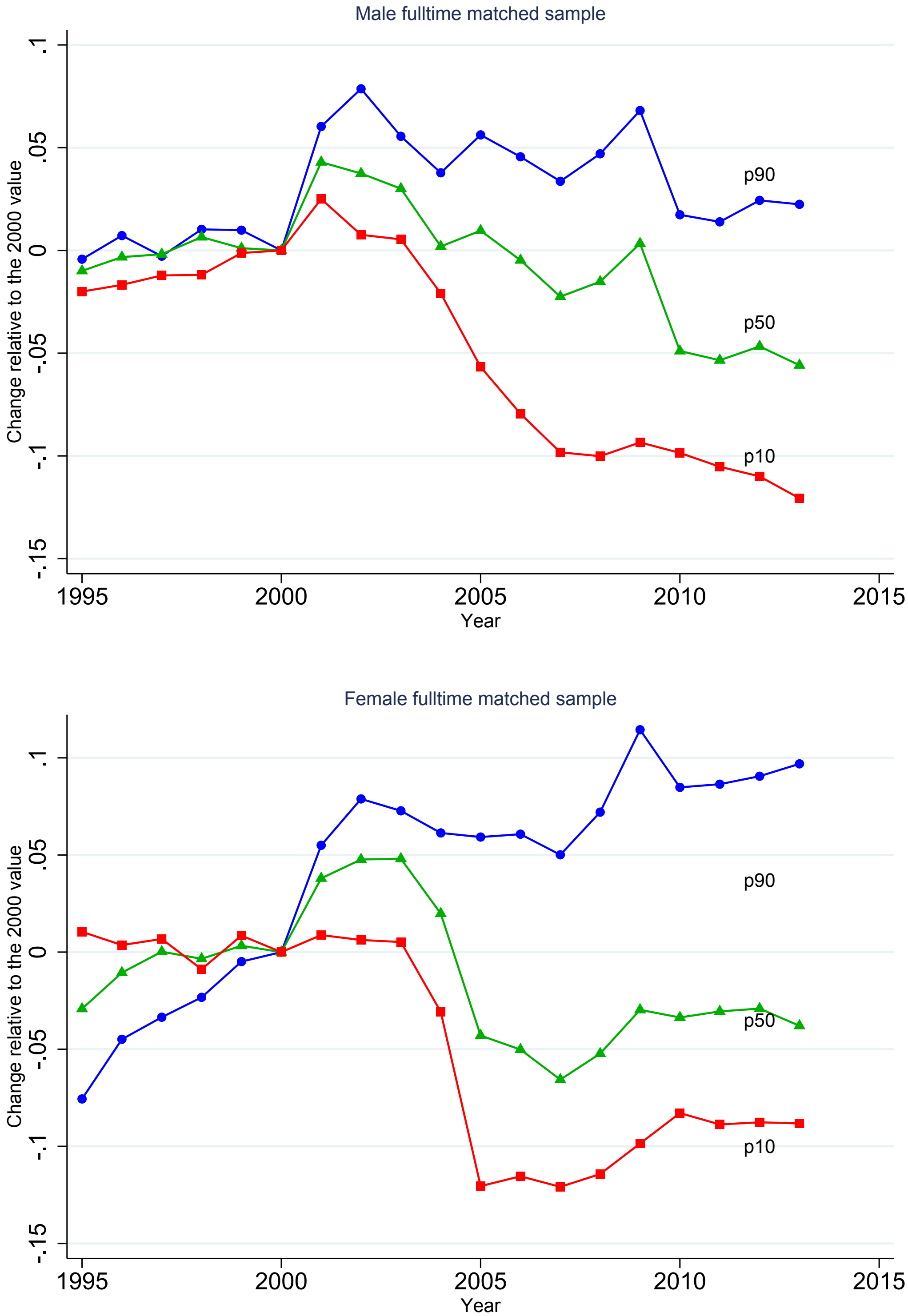

Figure 4: Wage Growth by Percentile

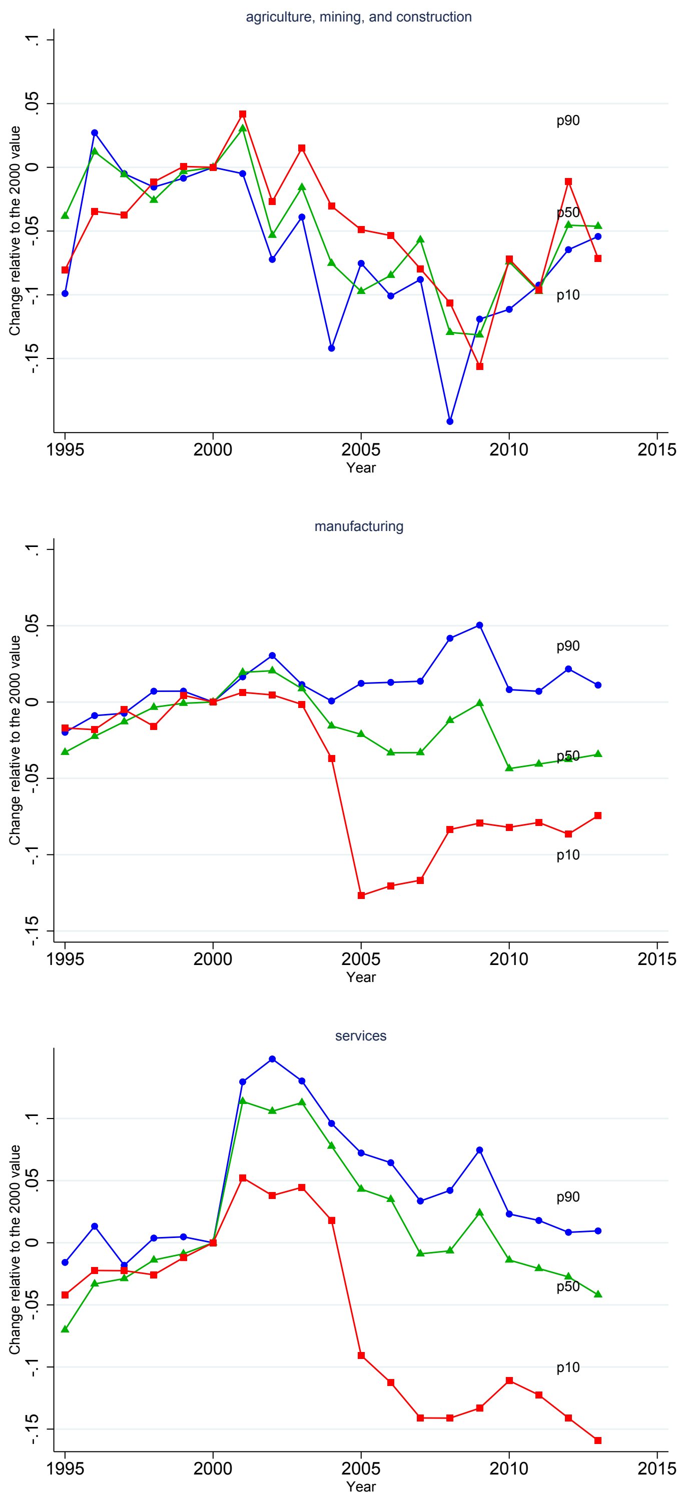

Figure 5: Growth of Mean Firm Wage by Percentile and Industry

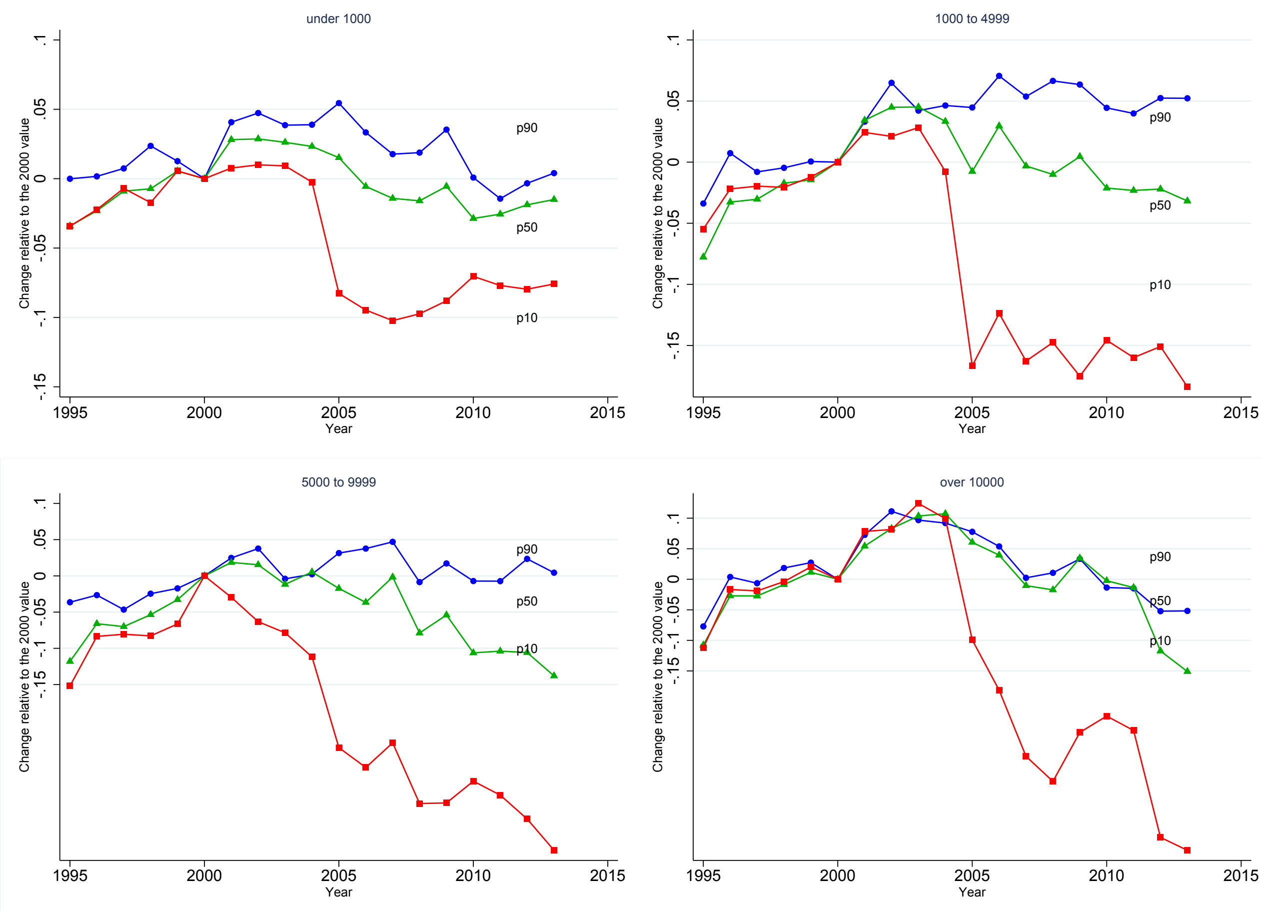

Figure 6: Growth of Mean Firm Wage by Percentile and Firm Size

C Additional Tables

Table 4: Wage Variances in 1995-2013

	Male parttime, Matched sample, firmid			Female parttime, Matched sample, firmid			Male fulltime, Matched sample, firmid			Female fulltime, Matched sample, firmid		
	total variance	within-variance	between-variance	total variance	within-variance	between-variance	total variance	within-variance	between-variance	total variance	within-variance	between-variance
1995	0.1030	0.0231	0.0800	0.0491	0.0207	0.0284	0.1934	0.1255	0.0679	0.1128	0.0489	0.0638
1996	0.1124	0.0182	0.0943	0.0512	0.0183	0.0329	0.1967	0.1210	0.0757	0.1220	0.0478	0.0742
1997	0.1037	0.0183	0.0854	0.0478	0.0181	0.0298	0.1921	0.1220	0.0701	0.1215	0.0513	0.0702
1998	0.0974	0.0238	0.0736	0.0486	0.0190	0.0297	0.1968	0.1232	0.0736	0.1287	0.0524	0.0762
1999	0.0904	0.0234	0.0670	0.0459	0.0181	0.0278	0.1914	0.1159	0.0755	0.1304	0.0509	0.0795
2000	0.0913	0.0215	0.0697	0.0422	0.0155	0.0267	0.1876	0.1094	0.0782	0.1342	0.0474	0.0868
2001	0.0965	0.0229	0.0736	0.0471	0.0169	0.0302	0.1979	0.1141	0.0837	0.1479	0.0525	0.0954
2002	0.0874	0.0254	0.0620	0.0465	0.0173	0.0291	0.2086	0.1144	0.0942	0.1583	0.0550	0.1034
2003	0.0802	0.0233	0.0569	0.0431	0.0166	0.0265	0.2026	0.1074	0.0951	0.1556	0.0527	0.1029
2004	0.0759	0.0244	0.0516	0.0415	0.0173	0.0241	0.2055	0.1068	0.0986	0.1609	0.0535	0.1074
2005	0.0874	0.0206	0.0668	0.0448	0.0164	0.0284	0.2252	0.1157	0.1095	0.1866	0.0653	0.1213
2006	0.0819	0.0214	0.0605	0.0456	0.0157	0.0299	0.2295	0.1183	0.1112	0.1861	0.0679	0.1181
2007	0.0865	0.0211	0.0654	0.0484	0.0173	0.0311	0.2309	0.1191	0.1118	0.1856	0.0686	0.1169
2008	0.0827	0.0244	0.0584	0.0474	0.0189	0.0286	0.2360	0.1238	0.1122	0.1871	0.0688	0.1183
2009	0.0839	0.0222	0.0617	0.0490	0.0177	0.0313	0.2421	0.1259	0.1162	0.1986	0.0723	0.1263
2010	0.0849	0.0235	0.0614	0.0534	0.0192	0.0342	0.2260	0.1175	0.1085	0.1848	0.0680	0.1168
2011	0.0926	0.0267	0.0658	0.0501	0.0187	0.0314	0.2265	0.1183	0.1082	0.1861	0.0690	0.1171
2012	0.0840	0.0218	0.0623	0.0533	0.0189	0.0344	0.2307	0.1211	0.1096	0.1874	0.0718	0.1156
2013	0.0716	0.0234	0.0482	0.0541	0.0197	0.0344	0.2337	0.1211	0.1126	0.1904	0.0733	0.1171

Table 5: Mean of Firm Characteristics in 1995-2013

year	all	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
max. of # of observation	101,758	3,892	4,793	4,884	4,862	4,944	4,910	5,407	5,873	5,853	6,708	5,538	5,809	5,605	5,462	5,282	5,453	5,271	5,603	5,609
mean of average hourly wage	3.099	3.119	3.124	3.124	3.126	3.127	3.122	3.140	3.125	3.118	3.115	3.102	3.091	3.075	3.070	3.080	3.061	3.059	3.059	3.063
hourly labor productivity	-5.779	-5.776	-5.774	-5.763	-5.781	-5.804	-5.791	-5.730	-5.779	-5.761	-5.751	-5.754	-5.769	-5.761	-5.769	-5.823	-5.845	-5.792	-5.796	-5.796
total factor productivity	-4.542	-4.745	-4.660	-4.628	-4.619	-4.620	-4.626	-4.548	-4.560	-4.529	-4.544	-4.497	-4.531	-4.480	-4.426	-4.460	-4.472	-4.456	-4.465	-4.526
share of female	0.247	0.255	0.248	0.245	0.244	0.238	0.233	0.237	0.235	0.232	0.234	0.261	0.257	0.262	0.255	0.257	0.250	0.251	0.254	0.252
average age	38.857	37.211	37.385	37.713	37.774	38.044	38.474	38.586	38.353	38.646	38.791	38.840	39.009	39.285	39.377	39.584	39.774	39.939	40.162	40.356
average age2/100	15.370	14.101	14.249	14.488	14.534	14.731	15.047	15.140	14.976	15.200	15.289	15.374	15.492	15.713	15.797	15.958	16.077	16.204	16.383	16.541
average tenure	12.623	12.381	12.238	12.490	12.503	12.908	13.330	13.298	12.778	13.032	13.010	12.414	12.374	12.327	12.213	12.131	12.466	12.643	12.463	12.684
average tenure2/100	1.866	1.760	1.737	1.805	1.812	1.918	2.028	2.025	1.895	1.961	1.968	1.840	1.827	1.814	1.800	1.769	1.825	1.873	1.831	1.894
share of junior high	0.068	0.141	0.129	0.122	0.112	0.103	0.097	0.083	0.072	0.066	0.059	0.051	0.049	0.047	0.043	0.039	0.035	0.032	0.030	0.029
share of hish school	0.126	0.093	0.099	0.102	0.105	0.109	0.110	0.121	0.126	0.128	0.128	0.129	0.133	0.134	0.134	0.139	0.144	0.147	0.145	0.150
share of 2-yr-college	0.278	0.197	0.211	0.214	0.223	0.230	0.237	0.255	0.267	0.278	0.291	0.308	0.303	0.295	0.306	0.311	0.315	0.319	0.328	0.329
share of 4-yr-university	5.899	6.058	5.936	5.911	5.910	5.884	5.886	5.836	5.802	5.796	5.734	5.877	5.824	5.854	5.960	6.003	5.969	5.978	5.992	5.989
log of firm size	9.080	9.235	9.138	9.147	9.138	9.127	9.149	9.143	9.064	9.049	8.949	9.041	9.051	9.030	9.090	9.093	9.051	9.042	9.050	9.057
log of firm asset	7.198	26.837	10.153	9.589	8.882	17.314	19.727	1.942	1.880	1.883	21.548	2.451	2.740	2.617	2.465	2.642	2.727	2.452	2.526	2.903
foreign owenership ratio	0.009	0.008	0.006	0.007	0.006	0.007	0.007	0.011	0.011	0.012	0.011	0.012	0.010	0.009	0.008	0.009	0.009	0.008	0.008	0.008
share of ICT cost in intermediates	0.030	0.032	0.000	0.000	0.033	0.032	0.033	0.031	0.031	0.031	0.033	0.029	0.030	0.030	0.034	0.035	0.037	0.037	0.038	0.041
share of export in sales	0.022	0.016	0.000	0.000	0.020	0.020	0.021	0.022	0.021	0.022	0.025	0.026	0.025	0.025	0.027	0.026	0.026	0.028	0.028	0.030
share of import in intermediates	0.528	0.569	0.561	0.562	0.560	0.557	0.556	0.541	0.535	0.528	0.522	0.511	0.515	0.524	0.518	0.511	0.506	0.501	0.496	0.492

Table 6: Standard Deviation of Firm Characteristics in 1995-2013

year	all	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
max. of # of observation	101,758	3,892	4,793	4,884	4,862	4,944	4,910	5,407	5,873	5,853	6,708	5,538	5,809	5,605	5,462	5,282	5,453	5,271	5,603	5,609
average hourly wage	0.298	0.260	0.268	0.258	0.264	0.266	0.268	0.279	0.292	0.292	0.295	0.320	0.316	0.315	0.315	0.329	0.313	0.311	0.314	0.317
hourly labor productivity	0.555	0.462	0.458	0.453	0.480	0.472	0.481	0.524	0.549	0.560	0.556	0.618	0.596	0.631	0.631	0.594	0.599	0.582	0.583	0.579
total factor productivity	0.982	0.938	0.849	0.839	0.864	0.883	0.872	0.913	0.954	0.968	0.971	1.053	1.010	1.065	1.075	1.038	1.057	1.047	1.053	1.027
share of female	0.188	0.186	0.177	0.173	0.179	0.176	0.175	0.181	0.181	0.179	0.184	0.199	0.193	0.200	0.196	0.194	0.194	0.194	0.194	0.194
average age	5.217	5.046	5.222	5.147	5.147	5.073	4.945	5.011	5.168	5.149	4.918	5.373	5.243	5.292	5.405	5.379	5.067	5.027	5.036	5.043
average age2/100	4.114	3.820	3.982	3.972	3.968	3.908	3.848	3.929	4.040	4.058	3.860	4.210	4.128	4.187	4.297	4.329	4.079	4.072	4.131	4.141
average tenure	5.219	4.768	4.898	4.953	4.986	5.023	5.012	5.065	5.124	5.127	5.250	5.469	5.440	5.429	5.551	5.451	5.207	5.238	5.271	5.340
average tenure2/100	1.449	1.318	1.353	1.394	1.384	1.430	1.466	1.481	1.439	1.469	1.503	1.507	1.485	1.478	1.489	1.449	1.399	1.435	1.432	1.488
share of junior high	0.111	0.160	0.152	0.146	0.141	0.134	0.128	0.119	0.110	0.105	0.096	0.090	0.087	0.084	0.079	0.077	0.068	0.067	0.064	0.064
share of hish school	0.142	0.116	0.120	0.122	0.125	0.129	0.131	0.137	0.144	0.149	0.142	0.142	0.146	0.147	0.146	0.145	0.153	0.153	0.151	0.156
share of 2-yr-college	0.233	0.174	0.188	0.189	0.194	0.198	0.203	0.215	0.227	0.232	0.241	0.253	0.249	0.243	0.245	0.246	0.248	0.247	0.255	0.254
share of 4-yr-university	1.262	1.218	1.211	1.211	1.226	1.232	1.240	1.261	1.240	1.239	1.220	1.277	1.256	1.279	1.295	1.296	1.294	1.302	1.296	1.302
log of firm size	1.659	1.600	1.576	1.571	1.589	1.588	1.601	1.682	1.662	1.660	1.649	1.715	1.707	1.723	1.689	1.667	1.678	1.669	1.691	1.705
log of firm asset	54.370	134.804	67.355	63.878	59.296	91.172	97.729	9.676	9.516	9.829	101.912	11.007	11.560	10.847	11.134	11.327	11.626	10.771	11.193	12.170
foreign owenership ratio	0.039	0.124	0.012	0.026	0.010	0.011	0.009	0.038	0.038	0.033	0.034	0.042	0.033	0.033	0.032	0.051	0.032	0.022	0.025	0.023
share of ICT cost in intermediates	0.104	0.098	0.000	0.000	0.105	0.102	0.102	0.102	0.101	0.101	0.105	0.100	0.102	0.104	0.111	0.111	0.121	0.119	0.123	0.129
share of export in sales	0.083	0.069	0.000	0.000	0.078	0.075	0.078	0.078	0.077	0.078	0.084	0.090	0.090	0.090	0.097	0.091	0.095	0.096	0.096	0.102
share of import in intermediates	0.252	0.204	0.212	0.214	0.216	0.221	0.226	0.240	0.248	0.254	0.261	0.272	0.266	0.262	0.263	0.266	0.267	0.269	0.272	0.273

Table 7: Wage Regression (TFP is controlled)

Sample		matched sample																			
Unit of observation		firm by year																			
period		1995〜1999					2000〜2004					2005〜2009					2010〜2013				
Estimation method		FE					FE					FE					FE				
		(20)					(21)					(22)					(23)				
dependent variable					mean	s.d.				mean	s.d.				mean	s.d.				mean	s.d.
mean of log hourly wage[(1)]					3.12	0.26				3.13	0.29				3.09	0.32				3.06	0.31
Explanatory variables		coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.	coeff.	s.r.	p-value	mean	s.d.
[productivity]	total factor productivity	0.028	0.002	0.00	-4.65	0.87	0.042	0.003	0.00	-4.56	0.94	0.037	0.003	0.00	-4.49	1.04	0.038	0.004	0.00	-4.48	1.03
	hourly labor productivity																				
[human capital][(2)]	share of female	0.170	0.022	0.00	0.25	0.18	0.139	0.019	0.00	0.23	0.18	0.090	0.019	0.00	0.26	0.19	0.046	0.022	0.04	0.25	0.19
	average age	0.057	0.005	0.00	37.64	5.13	0.045	0.006	0.00	38.54	5.01	0.039	0.005	0.00	39.19	5.30	0.030	0.006	0.00	40.03	4.99
	average $age^2/100$	-0.065	0.007	0.00	14.43	3.93	-0.048	0.008	0.00	15.11	3.92	-0.042	0.006	0.00	15.64	4.19	-0.031	0.008	0.00	16.28	4.05
	average tenure	0.022	0.002	0.00	12.51	4.93	0.026	0.002	0.00	13.09	5.11	0.028	0.002	0.00	12.34	5.45	0.028	0.003	0.00	12.61	5.24
	average $tenure^2/100$	-0.007	0.007	0.27	1.81	1.38	-0.028	0.008	0.00	1.97	1.47	-0.032	0.007	0.00	1.82	1.48	-0.040	0.008	0.00	1.86	1.43
	share of junior high	-0.120	0.015	0.00	0.12	0.15	-0.157	0.017	0.00	0.07	0.11	-0.116	0.028	0.00	0.05	0.08	-0.141	0.037	0.00	0.03	0.06
	share of 2-yr-college	0.089	0.013	0.00	0.10	0.12	0.063	0.011	0.00	0.12	0.14	0.130	0.016	0.00	0.13	0.14	0.097	0.017	0.00	0.15	0.15
	share of 4-yr-university	0.259	0.011	0.00	0.22	0.19	0.239	0.011	0.00	0.27	0.23	0.305	0.012	0.00	0.31	0.25	0.291	0.014	0.00	0.32	0.25
[firm tech]	log of firm size	0.017	0.008	0.04	5.94	1.22	0.022	0.007	0.00	5.82	1.23	0.002	0.008	0.77	5.90	1.26	0.005	0.010	0.62	5.98	1.28
	log of firm asset	0.005	0.009	0.54	9.15	1.58	0.023	0.007	0.00	9.09	1.63	0.015	0.008	0.06	9.08	1.66	0.031	0.011	0.01	9.06	1.64
	foreign owenership ratio	0.000	0.000	0.15	14.05	85.53	0.000	0.000	0.31	9.49	64.69	0.000	0.000	0.72	2.51	11.02	0.001	0.000	0.09	2.60	11.36
	share of ICT cost in intermediates	0.002	0.027	0.94	0.01	0.05	-0.024	0.064	0.71	0.01	0.03	0.019	0.022	0.37	0.01	0.04	-0.073	0.125	0.56	0.01	0.03
	share of export in sales	0.022	0.011	0.05	0.02	0.08	0.040	0.020	0.05	0.03	0.10	0.052	0.028	0.07	0.03	0.11	-0.053	0.028	0.06	0.04	0.12
	share of import in intermediates	-0.014	0.014	0.32	0.01	0.06	-0.008	0.025	0.76	0.02	0.08	-0.006	0.036	0.86	0.03	0.09	0.021	0.030	0.49	0.03	0.10
# of observation		23314					27628					25282					19526				
# of firm		9936					12395					12442					10855				
s.d. of predicted fixed effects		0.184					0.200					0.220					0.215				
s.d. of predicted error		0.081					0.086					0.106					0.108				

Note: Fixed-effect models.