CPRC Discussion Paper Series

Competition Policy Research Center

Japan Fair Trade Commission

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CPDP-77 -E June 2020

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Labor Market Concentration on Wage, Employment, and Exit of Plants: Empirical Evidence with Minimum Wage Hike

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Abstract

This study investigates the effects of labor market competition on wage stagnation using data from Japan's Census of Manufacture during 2001–2014. We find: (1) wage is suppressed in concentrated labor markets; (2) the effects of labor market concentration on wages are larger in fluid labor markets; (3) a hike in the minimum wage decreases employment; however, the reduction is smaller in concentrated markets than in competitive markets; and (4) firm exit rates are higher with a minimum wage hike; however, exit is less frequent in concentrated markets. Thus, wages are potentially below the competitive level in concentrated labor markets.

JEL Classification codes: D33, J23, J31, J42, K21, L49.

Keywords: concentrated labor market, labor share, market power, minimum wage, oligopsony labor market.

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1. Introduction

Many countries have witnessed a persistent decline in their labor income share (Karabarbounis and Neiman, 2014; IMF, 2017; Autor et al., 2020). Recently, an increase in the concentration of businesses among a few firms is being highlighted as a factor in the suppression of the labor income share. In the United States (US), Autor et al. (2020) argue that a fall in aggregate labor income share can be attributed to the concentration of output among a small number of "superstar" firms, who have a low labor share in value-added businesses. However, the hypothesis does not necessarily apply to other countries. An alternative hypothesis is that employment is getting more concentrated among a few firms. If employment is generated by a limited number of firms, employers would wield more power during wage negotiations, as workers would have fewer employment options.[4] Imagine a company town, where only one large firm hires most of the residents in the area. People are not easily able to relocate to take a better-paying job, so they accept the wage that the firm offers. As a consequence, firms pay less than the marginal product

[4] For example, Tokyo Electron built a new plant in Yamato-cho, Miyagi prefecture where Toyota has had an automobile plant since 2010. A newspaper article stated that the entry of a Tokyo Electron plant would intensify labor market competition in the area (Nihon Keizai Newspaper, July 24, 2010). This event illustrates how labor market competition is created in practice.

of labor to workers.[5] A decline in the number of firms due to the continuous exit of other firms, or a large number of merger and acquisitions (M&As) also enhances labor market concentration.

This study empirically examines the negative effects of labor market concentration on wages through potential changes in labor market power. Labor market concentration is captured by the Herfindahl-Hirschman Index (HHI) of employment following the Merger Guidelines and existing studies (Azar, 2018; Benmelech et al., 2018; Marinescu, 2019). Using the Japanese Manufacture Census data from 2001 through 2014, we estimate the causal effects of labor market concentration on wages. The first approach is to estimate standard wage regressions with employment HHI in corresponding labor markets defined with commuting zones and industry classifications, and apply instrumental variable (IV) regressions. In the next step, we investigate employment adjustment and plant exit behaviors exploiting minimum wage hikes as a natural experiment. Principles of microeconomic theory predict that firms cut employment or exit from the market when minimum wage rises, as long as the firms pay

[5] See Ashenfelter and Krueger (2018) and Ashenfelter et al. (2010) for more evidence on firms' incentive to avoid labor market competitions and mark down wages.

at the marginal labor products. We apply these mechanics to test the level of wages in concentrated labor markets.

Moreover, this study explores the roles of labor market rigidity in the relationship between labor market concentration and wages, utilizing the unique labor market structure in Japan. The impact of labor market concentration on wages is ambiguous in rigid labor markets where firms do not actively compete in acquiring middle-career workers. Japan has a dual labor market, a relatively permanent and a highly fluid market, in one country. Under the permanent employment system, most workers stay long in one firm (long-term employment) and wages go up steadily as tenure increases (seniority wage). The long-term employment is seen commonly across large firms, but in contrast, not as prevalent across small and medium businesses. Taking advantage of the polarized employment system between large plants and small to medium plants, we analyze the impact of labor market concentration on wages for different levels of labor market rigidity. This exercise helps to understand how different in roles of labor market concentration on a decline in wages across countries with different length of labor contracts. Intuitively, long labor contracts mitigate the effects of labor market competition on wages, and therefore, the impacts of labor market concentration on wages would be small.

We find that wages are lower by 3.5% with a one standard deviation increase in HHI in IV regressions. Decomposing this result into large plants and small to medium plants, a one standard deviation increase in HHI reduces wages by 2.6% for large plants and 3.8% for small to medium plants. The number of workers decreases by 0.05% with a 1% increase in minimum wage, and the rate of employment reduction shrinks as labor market HHI gets higher. Conducting the same analysis for small to medium plants and large plants separately, the number of total employees declines by -0.08% in small and medium plants, whereas, it increases by 0.04% at a mean of HHI in large plants. A gap in employment adjustment by minimum wage hikes reflects the difference in the employment system in small to medium plants and large plants. The rate of employment declines as HHI increases in a faster pace for small to medium plants than large plants. Alternatively, using the number of non-standard workers to evaluate employment effects, a 1 % increase in minimum wage lowers employment by -0.08% for both small to medium and large plants, and employment reduction disappears in more concentrated labor markets. Consistently, plant exit rate heightens by 0.1% with a 1% increase in minimum wage, and the exit rate drops as labor markets are more concentrated.

This paper contributes to literature in three folds. First, this paper shows that wages are suppressed in a concentrated labor market, using various models and

applications. We find consistent evidence from all the results, using a wage regression approach and evaluating the effects of minimum wage policy shocks on employment adjustment and plant exit behaviors. Second, we find that wages are suppressed in concentrated labor markets even under an environment with employment rigidity. This implies that labor market concentration is a common factor in wage deflation across any country, regardless of labor mobility. However, the effects of labor market competition are smaller with long-term employment practices. Third, we find firms' incentives to avoid paying high compensations under specific circumstances. The sensitivity of labor productivity and wages is higher in competitive labor markets than in concentrated labor markets. Also, plants pay less wages in competitive labor markets when they outsource relatively more tasks to other establishments.

Furthermore, this study has important policy implications. First, the findings have crucial proposals for the M&A review framework. Indeed, antitrust authorities showed an increased interest on competition issues in labor markets.[6] The current Merger Guidelines of agencies, including the US Department of Justice[7] and the Japan Fair Trade

[6] For example, the Department of Justice in the US had a workshop on competition in labor markets. https://www.justice.gov/atr/public-workshop-competition-labor-markets

[7] US Department of Justice "Horizontal Merger Guideline" (last revision: August 19, 2010), *available at https://www.justice.gov/atr/file/810276/download.*

Commission (JFTC)[8], focus more on the effects on prices in goods and service markets where merging firms sell their products, but not enough on the effects on labor markets where merging firms purchase their production inputs. Although in terms of firm profits where reducing input costs has the same effects as increasing prices, less attention paid to the impact on labor markets through merger reviews can suppress wages. This affects numerous economic agents.[9] Second, the minimum wage policy is controversial among economists because a minimum wage above equilibrium wage would increase the size of unemployment in competitive labor markets. Our results show that a minimum wage hike could increase employment in concentrated labor markets by shifting rents from firms to workers.

The rest of the manuscript is organized as follows. Section 2 provides the theoretical background, literature review and the description on minimum wage policy in Japan. Section 3 explains the definition of HHI and the acquired data. Sections 4 describes our empirical model. Section 5 discusses the results. Finally, Section 6 concludes the paper.

[8] JFTC "Guideline to application of the antimonopoly act concerning review of business combinations (last revision: December 17, 2019), available at *https://www.jftc.go.jp/en/legislation_gls/imonopoly_guidelines_files/191217GL.pdf*.

[9] Marinescu and HovenKamp (2019) argue applications of antitrust policy and merger review for labor market monopsony in the US.

2. Background

2.1. Theoretical background and literature review

Our paper is related to three strands of literature. First, it is linked to the growing literature that investigate employers' labor market power over workers. Recent studies (Azar et al., 2019, Azar et al., 2018, Benmelech et al., 2018, Naidu et al., 2018) explore a causal relationship between labor market structure and wages, and show that wages are uncompetitively low in concentrated labor markets. Prager and Schmitt (2019) study wage growth for various occupations in hospitals after hospital mergers in the US. They find that workers with industry-specific skills such as nurses experience a reduction in wages, but other occupations do not, when the mergers increase local market concentration. In contrast, Lu et al. (2019) find that the deregulation of foreign direct investment (FDI) in China, which potentially increases labor market competition for incumbent Chinese firms, widens wage markdown, which is opposes the monopsony theory. They conclude that their results are driven by search frictions.

An increase in online job postings enables researchers to gauge labor market power between employers and job seekers, utilizing rich data with relatively low cost. Azar et al. (2019) used online job posting data to study the effects of labor market concentrations on wages. They showed that posted wages are lower when job vacancies

for a particular occupation within a commuting zone are more concentrated to a small number of firms by running both OLS and IV regressions. The elasticity of the real wage on the HHI is -0.127 in the baseline IV regression. Dube et al. (2020) collected data from online job match platforms where search frictions are subtle and showed that labor supply elasticity is still low even in the frictionless world.

Second, there is a growing body of literature on employer labor market power to utilize minimum wage as an exogenous policy experiment. According to a standard microeconomics textbook, the minimum wage over equilibrium wage induces plants to reduce employment by firing employees, whose marginal productivity is below minimum wage, in competitive labor markets where wages are set at the marginal labor productivity. However, in concentrated labor markets where employers pay lower than the marginal product of labor, employment does not necessarily decrease with high minimum wages.[10] High minimum wages work as an external force to raise distortionary low wages in concentrated labor markets, and increase labor supply. Employers retain or expand employment as long as minimum wage is lower than the marginal productivity of labor. Concerning plant exits, under perfect labor market

[10] Azur et al. (2019), Naidu et al. (2018), and Card and Krueger (1994) discuss the effects of labor market monopsony on employment rigidity after minimum wage hikes.

assumptions, some plants cannot bear higher minimum wages when they surpass the marginal productivity of labor. With the imposition of minimum wage over equilibrium wage, exiting the market is the optimal decision for profit maximization. By contrast, if a labor market is imperfect, plants still earn profits when facing higher minimum wages that are lower than equilibrium wage.

This theoretical conclusion is supported by the empirical study by Card and Krueger (1994). They discuss that no reduction in employment after an increase in the minimum wage can be explained by monopsonic power in labor markets. They compare employment in fast food restaurants in New Jersey, where the minimum wage had increased, and Pennsylvania, where the minimum wage stayed the same, and show no reduction in employment after minimum wage hikes. Card and Krueger interprets that this indicates that while fast food restaurants might face an upward labor supply curve, they do not pay wages at marginal products of labor during the pre-hike period.

Many literatures debate that the impacts of minimum wage are heterogeneous by industrial attributes and worker characteristics. Cengiz et al. (2019) document that employment is reduced in the tradable sector. Harasztosi and Linder (2019) find that the rate of labor layoffs after a minimum wage hike is higher in industries where incremental labor costs cannot be passed on to consumers. Their results imply that labor force

adjustment in high minimum wage states is affected by downstream competition intensity. Neumark and Wascher (2004) present how minimum wage affects youth employment. Kawaguchi and Yamada (2007) find that employees who are paid below the new minimum wage are less likely to maintain employment status after minimum wage hikes than employees who are paid at low wages but above the new minimum wage. Kawaguchi and Mori (2019) highlight diverse effects of minimum wage hikes depending on the skills and educational levels of workers. Okudaira et al. (2019) describe that the effects are larger in plants where marginal product of labor is close to the wage rate. In contrast, there are literatures showing minimal effects on low-skilled, female low-skilled, or young workers (Sturn, 2017).

The final strand of literature of this study documents the effects on firm exits. To the best of our knowledge, there has been no study conducted that addresses the labor market concentration and exit directly, and this paper is the first one. A limited number of studies shed light on firm dynamics by minimum wage hikes potentially because of difficulties to track firm survival. Among these, Aaronson et al. (2018) show an increase in firm exits after a minimum wage hike, but do not find a change in employment. The study used restaurant industry data, where a substantial portion of workers are paid around minimum wage. Moreover, Acar et al. (2019) show a spike in firm exits after an enaction

of a minimum wage policy that caused a rapid and large upward shift of minimum wage in Turkey.

2.2. Minimum wage policy in Japan

The minimum wage system in Japan has two significant features: first, the minimum wages have variations in prefecture and industry[11]. Second, the minimum wage in Japan is revised every year. Minimum wage increased rapidly after 2007, reflecting the new Minimum Wage Act, to dissolve the reverse phenomenon between minimum wage and welfare benefit. After 2013, the Abe administration has been exploiting the minimum wage hikes as part of their economic growth strategy. The amount of prefectural minimum wage hikes is mainly determined by the targets proposed by the Central Minimum Wage Council, and political factors. Based on observation, the Regional

[11] The specific decision-making process is as follows: the central minimum wage council, representing workers, employers, and public interest, proposes the specific increase in the amount of regional minimum wage targets (meyasu) to prefectural minimum wage council annually. The increased amount of regional minimum wage targets has four ranks: A-rank, B-rank, C-rank, and D-rank. These reflect the regional economic conditions and increase in cost of living. In case of 2019, A-rank included six prefectures with relatively high wage levels, such as Tokyo, Kanagawa, and Osaka. D-rank consisted of 16 rural prefectures with relatively low wages, such as Okinawa, Aomori, and Kagoshima. A few industries in some prefectures have specific minimum wages because of historical regional industrial agreements. For example, plants in some industries have higher minimum wages than other plants in the same prefecture, which produces variations in the minimum wage in the dataset.

Minimum Wage Councils almost always follow the targets proposed by the Central Minimum Wage Council. Variation in yearly, regional, and industrial minimum wage allows us to capture more accurate impacts of minimum wage policies.

2.3. Labor market structure in Japan

The mobility of the labor force in Japan has been low, relative to the United States in general. Literature points out that a gap in labor mobility between Japan and the US stems from a difference in institutions including firm practices and labor law protection (Farber, 2007)[12].

One more major characteristic of the Japanese labor market is that it is a dual labor market; more specifically, employment practices and protections are different in large firms and small-medium firms. In large firms, workers are generally separated into two groups, standard ("seishain") and non-standard ("hi-seishain").[13] Standard workers are rarely fired under any circumstances, including minimum wage hikes, whereas non-standard workers are more vulnerable to business cycles or policy changes. US firms lay

[12] See Table S9.8 and Table S9.9 in Tomaskovic-Devey et al. (2020) for differences in employment protection between regular and temporary contracts by countries.
[13] For a more detailed description on segmented labor market, see Yokoyama et al. (2019) and Kambayashi and Kato (2017).

off workers, who are equivalent to Japanese standard workers, but in contrast, Japanese large firms keep standard workers, and reallocate them to other divisions or subsidiaries within the firm through labor force adjustment. The practice of long-term employment raises a question on whether firms compete to hire standard workers, besides first job matches for large firms. Whereas, in small and medium firms, employment is much more fluid and job-hopping is more common. We can exploit the variation in labor market in one country to examine the effects of labor market concentration on wages.

3. Definition of labor market concentration and data

3.1. Definition of labor market concentration

We primarily measure labor market concentration using the Herfindahl-Hirschman Index (HHI). Plant shares in a labor market are calculated using the ratio of the number of employees hired by a plant to the total number of employees in the corresponding labor market. A labor market is defined as a combination of 54 industrial classifications in the manufacturing sector based on the Japan Industrial Productivity (JIP) database and 203 economic areas determined by the Ministry of Internal Affairs and

Communications.[14] Figure 1 exhibits the average HHI of labor markets in each commuting zone. The HHI is low in Tokyo and surrounding suburbs, but in contrast, the HHI is high in countryside such as Shikoku and Kyushu which locate in the west of Japan.

Previous studies often use county or state to divide labor markets; however, address-based geographical areas are not likely to capture workers' commuting zones. Economic areas are determined based on geographic areas where economic and industrial activities are centered, and about 90% or more workers commute within an economic area. Using this, we measure more accurately the geographic splits between labor markets than previous studies.

We use industry classifications, instead of individual workers' occupation which is frequently used in previous studies, on the US labor market to define labor markets. Many workers in Japan, especially standard workers, have to accept unintended internal conversion of work positions, while occupation-based hiring is a standard practice in the US. In addition to this fact, wages are often decided by a collective bargaining agreement between management and a labor union that is organized by companies in Japan, whereas individual wage negotiation is more common in the US.

[14] Geographic labor market areas are based on the national survey of family income and expenditure in 2014, *available at* https://www.stat.go.jp/data/zensho/2014/furoku.html#c.

HHI is a market concentration measure widely used for merger reviews to evaluate market competition in various authorities, including JFTC. We use the HHI as a market concentration measure to evaluate the effects of labor market concentration on wages, along with the Merger Guidelines. The HHI in labor market *m* for year *t* is calculated as

$$HHI_{m,t} = \Sigma_i^n \left(\frac{Number\ of\ Employees_{i,m,t}}{\Sigma_i^n Numer\ of\ Employees_{i,m,t}} \right)^2 \quad (1)$$

where the squared labor shares of all plants in market *m* for year *t*. The HHI is widely used to measure market power based on the Cournot model. The HHI is a useful to assess market concentration since the Merger Guidelines provide criteria to evaluate it.

3.2. Data

Data on manufacturing plants is obtained from the Census of Manufacture (Kogyo Tokei) from 2001 to 2014, which is conducted by the Ministry of Economy, Trade, and Industry annually. The Census includes all manufacturing plants in Japan which have more than 3 employees, with response rates of around 95% or more in each

survey.[15] The Census primarily gathers information on plant identification, production, and shipment. Our analysis contains more than 380,000 distinct plants.

Variables used in our analysis are plant shipment values; production costs, including annual cash payments to employees; number of employees; location of plant; consignment payment, which is a payment to other plants for outsourcing any production process; and export ratio, which is the export amount in the total shipment amount. After 2001, detailed questions on employees, such as the number of male and female employees and non-fulltime employees, have been included in the questionnaires. More information on employees helps to control for factors that affect the average wages of plants from labor market concentration, and thus, the analysis period included the Census after 2001. In 2011, the Economic Census replaced the Census of Manufacture, and the surveyed plants are slightly different in the corresponding year. To calculate HHI consistently across years, the used datasets must employ the same rule to select plants. The data includes datasets from 2001–2014, and the dataset from 2011 is not included in this sample to avoid anomalies.

[15] Though only 59.4% of all plants have more than 3 employees (based on headcounts in 2008), coverage rates of our sample are higher in terms of the number of employees and shipment value; 95.9% and 99.3%, respectively.

The use of the Census data has several benefits. First, the Census provides a wide coverage of plants, which allows for an accurate grasp of the degree of labor market concentration. Furthermore, it is possible to control for plant productivity differences in wages by using production information. We calculate plant labor productivity as a productivity control, which is defined as the real value of plant production normalized by labor input hours. The Census data does not include labor input hours, but the number of workers in each plant. We get labor input hours in each plant by multiplying the surveyed number of workers and industry-average labor input hours from the JIP 2018 database.[16]

Furthermore, we are able to calculate the number of plants that exit the labor market in the dataset.[17] This benefit can be employed to examine whether plants pay less than the marginal product of labor in concentrated labor markets. If paid wages are around the marginal product of labor, plants that pay the minimum wage to its significant share of employees exit the market when faced with a high wage floor. By contrast, if plants pay less than the marginal products of labor for some reason, such as in an oligopsony, they can sustain their position in the market with high minimum wages because they can

[16] JIP 2018 database is available at https://www.rieti.go.jp/en/database/JIP2018/.
[17] To be more precise, we classify an exit of plants if a plant does not appear in dataset with the same labor market. Some plants classified as "exit" might be downsized to less than four employees, but not go through a formal shutdown.

offer competitive wages. The identification of plant exits is a tedious process because some plants have switched industries several times within the data sample period. Others have disappeared for a couple years and then returned. Plants that switched industries and have entered and remained in a new industry are counted as exits, whereas plants that had switched industries and later returned to the original industry are not considered.[18]

Table 1 summarizes the key variables in our analysis. The average HHI in the sample is 0.086 (or 860 in Merger Guidelines standards[19]). Labor market concentration seems low because the Merger Guidelines use a 1500 HHI threshold to consider concentration in markets. It is worth noting that the average HHI weighting each plant equally is much lower than the average HHI weighting each labor market equally because more plants are present in less concentrated labor markets.[20] The number of plants in a labor market has the same issue as the HHI measure. The average number of employers in a labor market is 206, which is higher than the number of employers averaged in labor markets. The ratio of export share to the total shipment of the plant is considerably low,

[18] One disadvantage of using the Census of Manufacture is that we cannot access disaggregated information on wage per employee. Also, we are not able to learn the distribution of employee occupations, education level, and job tenures, which are normally considered as important determinants of wages.

[19] The maximum value of HHI is 10000 in the Merger Guidelines. We normalize the maximum value to 1.

[20] Average HHI weighting each labor market equally is 0.34 or 3400.

with an average export percentage of 0.6%. The average consignment ratio, which is defined as the consignment amount divided by the total shipment amount, is 7.7%. Furthermore, the average non-standard and female worker percentages are 25.9% and 39%, respectively[21]. The average real wage normalized for the 2015 price level is approximately 3,300,000 yen.

Next, we separate sample plants into large and small plants to analyze the impact of labor market concentration on wages over labor market rigidity, using diverged employment practices across large and small-medium firms. In the data, we are able to distinguish plants that have other plants belonging to the same firm.[22] Those plants are considered as part of a large firm, and flagged as a large plant. In addition, we also consider single plants with 300 or more employees as a large plant. So, what we call a "large plant" is a plant with 300 or more employees or have multi-establishments, and a "small plant" is described otherwise. Table 1 also shows the key variables in large plants and small plants. The average real annual wage per employee is 3,060,000 yen for small plants and 3,870,000 yen for large plants. Average wages are higher for large plants, but they are comparable numbers across small and large plants. The female worker ratio is

[21] We refer part-time workers and temporary workers as non-standard workers.
[22] However, data does not allow to figure the firm that the plant belongs to.

lower for large plants, but the non-standard worker ratio is similar across two samples. The average number of total employees is 16.3 for small plants and 66.8 for large plants. Average HHI is 0.077 for small plants and 0.107 for large plants. Higher HHI for large plants possibly reflect that large plants themselves increase labor market concentration in the corresponding labor market.

4. Models

4.1. Base model

First, the effects of labor market concentration on the required outcome variables are estimated using the following equation:

$$Y_{i,m,t} = \alpha + \beta X_{i,m,t} + \gamma Labor\ Marktet\ Concentration_{m,t} + Plant\ Dummies + Year\ Dummies + \epsilon_{i,m,t}. \quad (2)$$

$Labor\ Marktet\ Concentration_{m,t}$ represents the degree of labor market concentration in labor market *m* for year *t.* As described in the previous chapter, the labor market is defined using 203 geographic markets (economic areas) and 54 industry classifications in manufacturing sectors, assuming that workers are not freely movable

beyond economic areas and across industries.[23] To ensure that our findings are not driven by the selected market concentration measure, the number of plants in a labor market is also used in the analysis, the results are reported in appendix Table 1.

Plant fixed effects are included to estimate equation (2). Interpretations of the estimated coefficients on labor market concentration measure provide the effects of annual variations in exposed labor market concentration on outcome variables after controlling for average plant outcomes. $Y_{i,m,t}$ is an outcome variable for plant *i* in labor market *m* for year *t*. The natural logarithm of the plant average wage and the number of employees are primarily used as outcomes of interest. Based on the monopsony/oligopsony theory in labor markets, the average wages would decline in highly concentrated labor markets.

$X_{i,m,t}$ is a vector of factors that potentially affect the outcome variables. We introduce the unemployment rate to control for labor demand, female employee ratio, and non-fulltime employee ratio as controls, following labor economic wage regressions. We then incorporate plant-specific elements, the average plant labor productivity, the

[23] We use 13 industry classifications based on the System of National Account, and also use 3 industry classifications, which are Machinery, Materials, and Others, instead of 54 industry classifications to relax an assumption that workers cannot move across narrowly defined industries. Overall implications from the results using broadly defined labor markets are the same as counterparts using 54 industry classifications.

consignment ratio, and the export ratio, which potentially affect the relation between labor market concentration and wages in wage regressions.

4.2. Interacted model

A paper by Benmelech et al. (2018) presents the effects of the labor market HHI on average wages of manufacturing plants by using data from the US, which shows that wages are suppressed in concentrated labor markets. Our baseline model is considerably similar to their models. We expand the wage and labor market concentration analysis by including interactions of labor market concentration with plant characteristics as follows:

$$\begin{aligned} Y_{i,m,t} = \alpha + \beta X_{i,m,t} + \phi Labor Market\ Concentration_{m,t} \times Z_{i,m,t} \\ + \gamma Labor\ Market\ Concentration_{m,t} + \delta Z_{i,m,t} \\ + Plant\ Dummies + Year\ Dummies + \epsilon_{i,m,t} \end{aligned} \quad (3)$$

$Z_{i,m,t}$ is a factor representing plant-specific elements, the plant-average labor productivity, the consignment ratio, and the export ratio. These variables are further used to interact with the degree of labor market concentration. First, we evaluate whether employers in a concentrated labor market pay wages related to worker productivity, compared with employers in a competitive labor market. To validate this hypothesis, an interaction term of labor productivity and labor market concentration is introduced in wage regressions. Second, plants with a high consignment ratio can avoid high wages in a competitive labor market by outsourcing some processes to other firms. Third, we

estimate the effects of downstream market competition on wages, measured by using the plant-level export ratio.[24]

4.3. Minimum wage model

A standard microeconomics theory predicts that a minimum wage hike reduces employment as companies fire employees whose marginal productivity is below minimum wage in competitive labor markets where wages are set at marginal labor productivity. However, in concentrated labor markets where employers pay lower than the marginal revenue of products, employment does not necessarily decrease with high minimum wages. To test the hypothesis, we estimate the following equation:

$$\begin{aligned} Y_{i,m,t} = {} & \alpha + \beta X_{i,m,t} + \rho W_{m,t} \\ & + \phi Labor\ Market\ Concentration_{m,t} \times \ln\left(inimum\ Wage_{m,t}\right) \\ & + \gamma Labor\ Marktet\ Concentration_{m,t} + \delta \ln(Minimum\ Wage_{m,t}) \\ & + Plant\ Dummies + Year\ Dummies + \epsilon_{i,m,t} \end{aligned} \tag{4}$$

Here, minimum wage is a key variable, which is used as an exogenous experiment to investigate whether plants pay competitive wages in this model. We then explore the effects of minimum wages on plant exits by employing the following model specifications:

[24] See Harasztosi and Lindner (2019).

$$
\begin{aligned}
Exit_{i,m,t} &= \alpha + \beta X_{i,m,t} + \gamma Labor\ Market\ Concentraiton_{m,t} \\
&+ \delta ln\left(Minimum\ Wage_{m,t}\right) \\
&+ \rho \ln\left(Minimum\ Wage_{m,t}\right) \times Labor\ Market\ Concentraiton_{m,t} \\
&+ Industry \times Year\ Dummies + \epsilon_{i,m,t}.
\end{aligned} \tag{5}
$$

$Exit_{i,m,t}$ is an indicator variable that is equal to 1 for the year that the plant exits from a given labor market. We observe 219,249 exits from 2001 to 2013. Labor market concentration is measured using the HHI, and the same control sets are used as an equation (2) for $X_{i,m,t}$. A logit model is employed to estimate the equation (5).

An interaction between minimum wage and labor market concentration is employed to test the proposed hypothesis: plant exits are less likely at high minimum wages in a concentrated labor market. Plants can allow high wages because of a difference between the actual wages and marginal product of labor arise from employer labor market power. Plant fixed effects cannot be controlled for in the plant exit study. Instead, the average exit rate in industry-year pair is eliminated during the estimation.

4.4. Regressions with instrument variable

A crucial issue for causal identification is to alleviate potential endogeneity issues. First, utilizing the panel structure of the dataset, we control for plant fixed effects on wages and employment. However, labor demand shocks or labor supply shocks simultaneously affect labor market concentration and plant-level wages, which generates bias in estimated coefficients in labor market concentration. To rule out those possibilities,

an average HHI of the same industry is employed in other geographic areas as an instrument variable. The use of information on other markets as an instrument is a common strategy. For example, Azar et al. (2017) used the average number of employers within the same industry in other geographic markets as an instrument for the labor market HHI. Nevo (2001) uses the price in other regions as an instrument for those in the city to study ready-to-eat cereal prices.

5. Results

5.1. Wage and labor market concentration

Table 2 reports the effects of labor market concentration on wages in plant fixed effects models. Model 1, which employs continuous HHI as labor market concentration, shows a one standard deviation increase in the HHI reduces wages by -0.69% (=-0.055×0.127). The concentrated labor markets with an HHI of higher than or equal to 1500 or higher than or equal to 2500 are flagged using *HHI≥0.15* dummy and *HHI≥0.25* dummy, respectively. An HHI larger than 1500 or 2500 defines concentrated markets following the Merger Guidelines in various authorities. For thresholds of 1500 or 2500, wages are lower by -1.1% in concentrated markets as shown in Model 2 and Model 3 of the same Table. Model 4 conducts the same analysis using only small plants, which have

more fluid workers, so labor market competition would significantly affect their wage level in order to keep their employees. The result indicates that a one standard deviation increase in the HHI reduces wages by -0.8% (=-0.073×0.114), which is larger than the counterpart using all plants. Model 5 includes only large plants, which have more permanent workers. Labor market competition presumably does not affect their wage level substantially since they are less threatened by losing their workers. Model 5 shows that a one standard deviation increase in the HHI reduces wages by -0.4% (=-0.025×0.150) for large plants. Wages are affected by labor market competition in large plants, but the size is smaller.

In the Model 1 and Model 4 of Table 3, we examine variations in sensitivity between labor productivity and wages given labor market concentration. Employers compete in hiring workers and should compensate productive workers based on their productivity to retain them if labor markets are competitive. Model 1 shows that, at a mean of the HHI, a 1% increase in labor productivity is associated with a 0.258% (=0.267-0.1×0.086) increase in real wages. At the 75th percentile of the HHI (highly concentrated labor markets), a 1% increase in labor productivity increases real wages by 0.257 % (=0.267-0.1×0.096), indicating less effects of labor productivity on wages. Similarly, Model 4, which employs an indicator variable for concentrated markets with an HHI

higher than 1500, shows wage and labor productivity sensitivity decreases by 2.8% in concentrated labor markets.

Moreover, we examine the extent that plants are able to mitigate the effects of labor market competition on wages in the Model 2, 3, 5, and 6 of Table 3. The export ratio and consignment ratio are employed as extended factors. The export ratio is considered as a proxy for downstream market competition intensity. The consignment ratio is used as a proxy for outside options in the labor input for production. Model 5 in Table 3 introduces an interaction between the export ratio and *HHI<0.15* dummy variable, which is equal to 1 for potentially competitive markets with an HHI of lower than 1500. The sign of coefficient of the interaction is negative, which suggests that the higher export ratio reduces wages in competitive labor markets but does not have statistical significance. The same implication is obtained using the continuous HHI for the interacted term with the export ratio in Model 2 of the same table. The positive sign of the coefficient on the interaction term implies that, for example, when both the labor market competition and the consignment ratio is high so the sign of HHI and consignment ratio interaction term is negative, the wages decline. Next, we use an interaction term between the consignment ratio and labor market concentration. The interaction term between the consignment ratio and *HHI<0.15* dummy is included in Model 6. The estimated coefficient of the interaction

term is negative, which supports our hypothesis that plants can avoid paying high wages in a competitive labor market by outsourcing their production processes. When the interaction with the continuous HHI is employed, a positive coefficient of the interaction between HHI and consignment ratio indicates similar results in Model 3.[25]

To address concerns that controlling for plant fixed effects does not solve the endogeneity problem, Table 4 presents the estimated results by using IV specifications.[26] The HHI and HHI-interaction terms are potentially endogenous. We employ the average HHI within the same industry in other geographic areas but exclude their own HHI as an instrument variable. An interaction term of the average HHI with an exogenous variable of the interaction term is also included as an instrumental variable for the models with potentially two endogenous variables. The impacts of labor market concentration on wages amplify in IV regressions. According to the results in Model 1 of Table 4, a one standard deviation increase in HHI suppresses wages by 3.5% (=0.127 × -0.277). The downward effects of labor market concentration on wages become more substantial in the IV regression results. Model 2 reveals that wages are more linked to labor productivity in

[25] Robustness checks using the natural logarithm of the number of plants as a labor market concentration measure are reported in the Appendix Table 1 Panel A. Implications from the results are consistent.

[26] First-stage regression results are reported in Appendix Table 2.

the competitive labor markets in the IV setting. The results in Model 3 and 4 show that wages are consistently suppressed with the higher export ratio and consignment ratio in competitive labor market (i.e. low HHI). Model 5 and Model 6 show the IV regression results using small plants and large plants, respectively. The direction is the same as using the panel fixed effects estimation: a one standard deviation increase in HHI lowers wages by 3.8% (=0.114 × -0.335) for small plants, and by 2.6 %(=0.150 × -0.171) for large plants. Wages are more affected by labor market concentration at small plants.

5.2. Wage, employment, minimum wage, and labor market concentration

Next, we investigate the effects of the minimum wage variable on plant employment and average wages. Table 5 presents the results. The results using plant wages as a dependent variable are reported in Panel A. Firm fixed effects are controlled for through estimations. In Model 1, we test a role of labor market concentration on a relation of minimum wage and plant average wage. At a mean of HHI, a 1% increase in minimum wage decreases the plant's average wage by -0.14% (=-0.152+0.145×0.086) and average wage growth increases with the higher HHI region. This result implies that minimum wage rises rapidly than actual wage growth for employer-unconcentrated areas, such as Tokyo. At a mean of minimum wage, a 1% increase in HHI causes the average

wage to decline by -0.05% (=-1.008+0.145×6.58); average wage growth increases with the higher minimum wage region. Interactions between minimum wages and a labor market concentration dummy variable (*HHI≥0.15)* are shown in Model 2. A 1% increase minimum wage is associated with a -0.148% decline in competitive labor markets, and with -0.11% (=-0.148+0.039) in concentrated labor markets. Model 3 uses an *HHI≥0.25* dummy variable to flag concentrated labor markets, and we obtain the analogous results to Model 2. Model 4 and Model 5 shows the results with restricted sample to small plants and large plants, respectively. A 1% increase in minimum wage decreases the plant's average wage by -0.13% (=-0.140+0.067×0.077) for small plants and by -0.11% (=-0.134+0.188×0.107) for large plants at a mean of HHI.

IV regression results are reported in Table 6. Panel A, Panel B, and Panel C, include all plants, small plants, and large plants, respectively. Model 1 in Panel A shows that a 1% increase in minimum wage results in a decrease in plant average wages by -0.29% (=-0.106-0.11×0.086) at a mean of HHI, and the size of decrease in annual wages enlarges with higher HHI. High minimum wage associated with low annual wage per employee is somehow counter-intuitive. It may be that the minimum wage hike in this period was larger than average wage growth in urban areas than in rural areas. The political intention was to raise minimum wage for areas where costs of living are high,

but wage growth in the manufacturing sector has been slowing down a last decade. The similar results are observed for analysis with restricted samples to small and large plants.

Considering our primary variable of interest in employment, Table 5 Panel B shows the effects of the minimum wage on the labor force. The interaction between the minimum wage and the HHI is employed to examine whether employers with labor market power retain employees with high minimum wage. Model 1 shows that a 1% increase in minimum wage decreases the number of employees by -0.04% (=-0.110+ 0.804×0.086) at a mean of HHI, and the size of labor force reduction shrinks as the HHI rises. Model 2 employs *HHI≥0.15* dummy variable, and exhibits that a 1% rise in minimum wage increases employment by 0.134% (=-0.072+0.206) in concentrated labor markets. In theory, employment expansion following a lifted wage floor can happen only when wages are distorted from a marginal product of labor with employer market power. Empirical evidence provides the same picture along with a theoretical argument. Model 3 uses *HHI≥0.25* dummy variable to capture concentrated labor markets. We find that results are similar to Model 2. Model 4 conducts the same exercise but using only small plants. We find that a 1% increase in minimum wage lowers the number of employees by -0.06% (=-0.117+ 0.784×0.077) at a mean of HHI, and labor force reduction vanishes as HHI increases. Model 5 uses only large plants, and shows a 1% increase in minimum

wage increases the number of total employees by 0.01% (=-0.067+ 0.701×0.107) at a mean of HHI. This finding is aligned with the fact that large Japanese firms mainly hold standard workers, whom the firms are not easily able to remove, and therefore, are not affected by the effects of minimum wage hikes.

IV regressions results are shown in Model 2 of Table 6 Panel A, Panel B and Panel C. The results on the effects of minimum wage and labor market concentration on employment consistently show that high minimum wages do not induce large layoffs in concentrated markets, thus suggesting that wages are not paid at a competitive level. Panel A shows the results using all plants. Model 2 indicates a 1% increase in minimum wage decreases the number of employees by -0.05% (=-0.229+ 2.032×0.086) at a mean of HHI, and the size of labor force reduction shrinks as the HHI rises. Panel B and Panel C report the estimation outcomes restricting sample to small plants and large plants, respectively. Model 2 of Panel B and Panel C show a 1% increase in minimum wage decreases the number of employees by -0.08% (=-0.246+ 2.206×0.077) for small plants, and increases the number of employees by 0.04% (=-0.145+ 1.392×0.107) for large plants at a mean of HHI.

In Table 5 Panel C, the number of non-standard workers is used as an outcome variable. Plant fixed effects estimations show that a 1% higher minimum wage is

associated with a -0.08% (=-0.161+0.924×0.086) decline in non-standard workers at a mean HHI (Model 1), which shows slightly larger effects of minimum wage hikes on labor force adjustment than the counterpart using the number of all employees. Model 2 and Model 3 applies *HHI≥0.15 and HHI≥0.25* dummy variables. The results show that non-standard employees increase with high minimum wages in concentrated labor markets. The effects of labor market concentration on employment adjustment are slightly larger using the number of non-standard workers than the number of all workers. Model 4 and Model 5 report the results using subsample of small plants and large plants, respectively. In large plants, the number of total employees is not decreased with minimum wage hikes at the mean HHI potentially because they cannot layoff standard workers. However, large plants might respond to minimum wage hikes by reducing non-standard workers. This exercise allows us to see their response. Model 4 shows a 1% higher minimum wage is associated with a -0.07% (=-0.104+0.503×0.077) decline in non-standard workers at a mean HHI for small plants. Model 5 exhibits a 1% higher minimum wage is associated with a -0.08% (=-0.218+1.311×0.107) decline in non-standard workers at a mean HHI for large plants. The result clearly shows that non-standard workers are affected by minimum wage even in large firms, and a reduction in non-standard workers by minimum wage hikes rapidly disappears as the HHI increases.

In IV specifications reported in Model 3 of Table 6 Panel A, Panel B and Panel C. Using all plants (Panel A), a 1% higher minimum wage is associated with a -0.05% (=-0.229+2.032×0.086) decrease in non-standard workers at a mean of HHI, and the downsizing effects of minimum wage on non-standard workers become negligible as the HHI increases. Decomposing sample into small plants (Panel B) and large plants (Panel C), a 1% higher minimum wage is associated with a -0.08% (=-0.169+1.191×0.077) decrease in non-standard workers for small plants, and with a -0.08% (=-0.356+2.607×0.107) decrease in non-standard workers for large plants at a mean of HHI. This finding is consistent with plant fixed effects regression results, and the magnitude of labor force adjustment no longer differs from all workers.

5.3. Minimum wage and plant exit in concentrated markets

Table 7 shows the marginal effects of minimum wage and other explanatory variables on plant exits estimated using the logit model. The plant exit is recorded in the year that the plant disappears from its labor market. Because the sample period of the dataset is from 2001 through 2014, plant exits were considered in 2013, but not in 2014. This restriction reduced the sample size as well as excluding suspicious exits as described in Section 3.

Model 1 shows that higher concentration in labor markets results reduces the plant exit rate. A one standard deviation increase in the HHI from the mean HHI is associated with a -0.1% (=-0.010*0.127) decrease in the plant exit rate. Models 2 through 4 estimate the effects of minimum wage on plant exits, implying that exit likelihood varies based on labor market concentration. The results show that, in Model 2, a 1% increase in the minimum wage is associated with a 0.10% (=0.111-0.135*0.086) increase in the likelihood of plant exit at a mean of HHI value, and the exit rate declines with a higher HHI. The results suggest that minimum wages have an impact on plant exit decisions in competitive labor markets, whereas their effects diminish in concentrated labor markets. These findings are consistent with the hypothesis that plant exits are due to increased minimum wages and are less responsive in concentrated labor markets since wages are below the marginal product of labor. Model 3 and Model 4 use *HHI≥0.15* and *HHI≥0.25* dummy variables to investigate plant exits with minimum wages in concentrated labor markets. We find that with a 1% increase in minimum wage, plant exit rate is lower by -0.037% in concentrated labor markets with HHI greater than or equal to 0.15, and by -0.043% in labor markets with HHI greater than or equal to 0.25.

Because the fraction of minimum-wage workers the plant in the dataset is unknown, plants may hire more productive workers in concentrated markets. To address

this possibility, we restrict the sample to plants with an average hourly wage of less than 500 yen (~ 5 USD) above minimum wage or lower.[27] Models 5 to 7 in Table 6 presents the results. The restriction of the sample to potentially affected plants does not alter implications from the baseline model. A 1% increase in minimum wage is associated with a 0.13% (=0.148-0.199*0.086) increase in the likelihood of plant exit at a mean of HHI, and an exit rate decreases with high HHI (Model 5).[28] Comparing the results across concentrated labor market dummy variable models, such as Model 3 and Model 6, we show that restricting the sample strengthens market concentration effects on plant survival by high minimum wages. In concentrated labor markets (HHI≥0.15), plant exit likelihood with a 1% increase in minimum wage is lower by -0.037% using all plants (Model 3), while exit rate is lower by -0.053% in restricted plants with average wage around minimum wage (Model 6).

Finally, we conduct robustness checks for all models in Section 5.1 through Section 5.3. weighting each observation by 1/N where N is the number of plants in corresponding labor market given year. Since more plants are in less concentrated labor markets, estimation results are more affected by plants in labor markets with low HHI.

[27] Recall that the average minimum wage is 726 yen at the 2015 price level.
[28] Results using the number of plants as a labor market concentration measure are available at the Appendix Table 1 Panel C.

To rule out this concern, we conduct weighted regressions and confirm that our results are not driven by sample distribution. Furthermore, we control for a possibility that the negative relationship between labor market concentration and wages are driven by exits of highly-paying plants. We re-estimate all models using balanced panel dataset and confirm that the results do not change.

6. Conclusion

This study analyzes the impacts of labor market concentration on wages by using the Census of Manufacture in Japan from 2001 through 2014. With the use of the HHI, which is a market concentration measure by Merger Guidelines, we show that wages are marked down in concentrated labor markets. Furthermore, we explore the roles of employment rigidity on a relationship of labor market concentration and wages. Japanese large plants conventionally hold more long-term workers, and they seem not affected by labor market competitions. However, the results show that labor market competition affects wages, even for large plants. We suggest the reason why the labor market concentration reduces wage even in less fluid labor market is that some employees switch jobs, and our sample includes some small and medium plants.[29] Another interpretation

[29] We define plants with 300 and more employees and having multi-establishments.

of this results is that, although large plants face less threats that their long-term workers are poached in a competitive labor market, they still respond to keep their workers by increasing wages. However, the size of the effects is less substantial than small plants, which is consist with economic theory. Furthermore, we find that plants with higher consignment and higher export ratios avoid paying high wages in a competitive labor market. This observation implies that plants that are able to outsource labor-intensive processes, or face more competitions in a downstream market, are able to lower wages. However, this is not statistically significant for downstream competition intensity. Moreover, this study shows that labor productivity and wage sensitivity are slightly lower in concentrated labor markets than in competitive markets.

Next, we investigate the effects of minimum wages on plant average wages, employment, and market exit decisions. If labor markets are a monopsony or an oligopsony, then the observed wages are lower than the marginal product of labor, and high minimum wages have limited effects on decreases in employment and plant exits. We show that employment does not decrease, and an exit rate does not increase with higher minimum wages in concentrated labor markets. All our findings suggest that wages are likely to be below the competitive level in concentrated labor markets.

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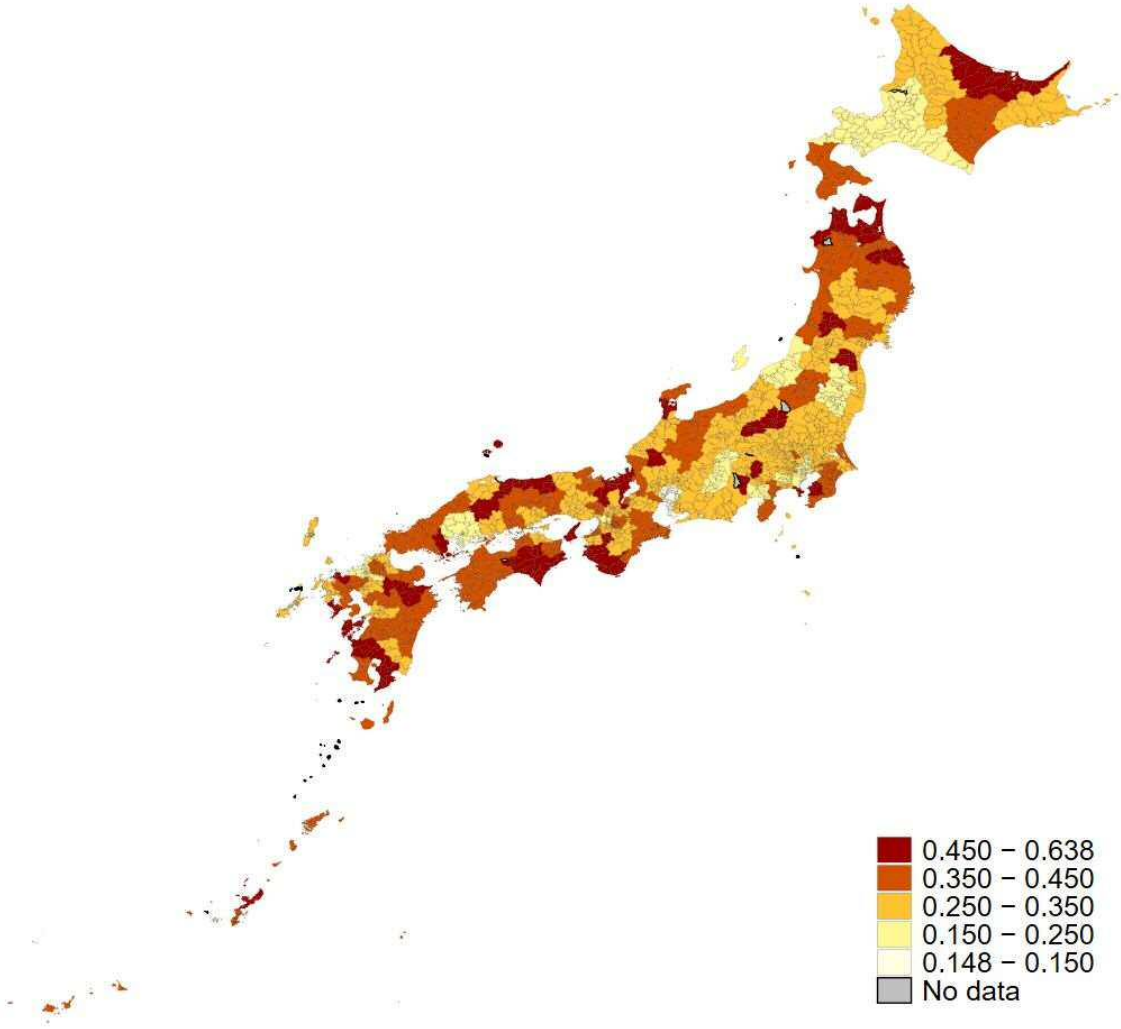
Figures

Figure 1. Employment HHI in Japan



Tables

Table 1. Summary statistics (All plants)

Variables	Mean	Std. Dev.	Min	25th percentile	50th percentile	75th percentile	Max	Obs.
Total real wage (million yen)	143.42	973.45	0.01	15.42	33.01	81.9	212,531.54	3,255,971
Annual real wage (1,000yen)	3,310.53	1,728.44	0.441	2,070.69	3,135.90	4,318.65	331,017.93	3,255,971
Log annual real wage	14.86	0.603	6.09	14.54	14.96	15.28	19.62	3,255,971
Hourly real wage	1,717.86	885.74	0.229	1,094.70	1,631.69	2,226.97	169,070.44	3,255,971
Real minimum wage	726.06	66.55	609.76	672.41	714.43	776.75	907.87	3,255,971
Log real minimum wage	6.58	0.090	6.41	6.51	6.57	6.66	6.81	3,255,971
Wage distance	1,013.42	856.94	-893.26	403.13	934.18	1,516.33	152,248.61	3,166,924
Total employees	31.81	132.41	4	6	10	23	22,343	3,255,971
Log employment	2.59	1.05	1.39	1.79	2.3	3.14	10.01	3,255,971
Non-standard employee ratio	0.259	0.266	0	0	0.188	0.43	1	3,255,971
Female employee ratio	0.39	0.251	0	0.19	0.333	0.571	1	3,255,971
Log labor productivity	-0.655	0.933	-12.48	-1.243	-0.657	-0.091	6.726	3,255,971
HHI	0.086	0.127	0.002	0.019	0.042	0.096	1	3,255,971
Plants per labor market	205.32	339.93	1	37	91	220	3,262	3,255,971
Rest HHI	0.2	0.135	0.052	0.098	0.156	0.25	1	3,255,971
Total value of shipment (million yen)	1,084.60	14,453.26	0	10	72.13	293.33	6,848,671	3,255,971
Consignment ratio	0.078	62.36	0	0	0	0	110,404	3,255,971
Export ratio	0.006	0.051	0	0	0	0	6.91	3,255,971

Summary statistics (Small plants)

Variables	Mean	Std. Dev.	Min	25th percentile	50th percentile	75th percentile	Max	Obs.
Total real wage (million yen)	56.74	114.59	0.01	12.38	24.87	54.2769	20,724.13	2,234,485
Annual real wage (1,000yen)	3,060.57	1,611.34	0.86	1,867.86	2,880.67	4,035.21	291,311.68	2,234,485
Log annual real wage	14.77	0.63	6.76	14.44	14.87	15.21	19.49	2,234,485
Hourly real wage	1,588.88	824.42	0.44	986.51	1,501.18	2,081.96	152,988.78	2,234,485
Real minimum wage	724.72	66.20	609.76	670.78	714.43	773.83	907.87	2,234,485
Log real minimum wage	6.58	0.09	6.41	6.51	6.57	6.65	6.81	2,234,485
Wage distance	889.06	811.22	-893.26	296.63	808.15	1,378.64	152,248.61	2,188,414
Total employees	16.25	24.94	4	5	8	16	299	2,234,485
Log employment	2.33	0.83	1.39	1.61	2.08	2.77	5.70	2,234,485
Non-standard employee ratio	0.262	0.267	0.000	0.000	0.200	0.447	1	2,234,485
Female employee ratio	0.414	0.248	0.000	0.200	0.389	0.600	1	2,234,485
Log labor productivity	-0.848	0.845	-12.481	-1.380	-0.819	-0.306	5.186	2,234,485
HHI	0.077	0.114	0.002	0.017	0.038	0.085	1	2,234,485
Plants per labor market	219.85	354.43	1	42	100	235	3,262	2,234,485
Rest HHI	0.189	0.127	0.052	0.094	0.152	0.231	0.995	2,234,485
Total value of shipment (million yen)	236.61	1204.97	0	1.74	48.28	158.62	542,026.30	2,234,485
Consignment ratio	0.029	6.276	0.000	0.000	0.000	0.000	7,197.17	2,234,485
Export ratio	0.003	0.034	0.000	0.000	0.000	0.000	6.91	2,234,485

Summary statistics (Large plants)

Variables	Mean	Std. Dev.	Min	25th percentile	50th percentile	75th percentile	Max	Obs.
Total real wage (million yen)	338.69	1,733.36	0.01	30.62	69.97	190.15	212,531.54	998,556
Annual real wage (1,000yen)	3,872.30	1,835.57	0.44	2,668.39	3,707.59	4,852.78	331,017.93	998,556
Log annual real wage	15.06	0.49	6.09	14.80	15.13	15.40	19.62	998,556
Hourly real wage	2,007.68	941.80	0.23	1,397.20	1,920.01	2,502.17	169,070.44	998,556
Real minimum wage	728.95	67.20	609.76	673.87	717.74	780.93	907.87	998,556
Log real minimum wage	6.59	0.09	6.41	6.51	6.58	6.66	6.81	998,556
Wage distance	1,294.13	891.44	-876.01	696.03	1,209.58	1,781.46	65,570.52	965,973
Total employees	66.83	232.32	4.00	9.00	20.00	50.00	22343.00	998,556
Log employment	3.18	1.23	1.39	2.20	3.00	3.91	10.01	998,556
Non-standard employee ratio	0.251	0.264	0.000	0.000	0.167	0.400	1.000	998,556
Female employee ratio	0.336	0.249	0.000	0.143	0.261	0.500	1.000	998,556
Log labor productivity	-0.222	0.975	-11.060	-0.820	-0.242	0.359	6.726	998,556
HHI	0.107	0.150	0.002	0.024	0.053	0.124	1	998,556
Plants per labor market	172.01	300.50	1	27	72	177	3,262	998,556
Rest HHI	0.222	0.149	0.052	0.105	0.169	0.289	1	998,556
Total value of shipment (million yen)	2,997.49	25,933.15	0	48.00	244.08	995.32	6,848,671	998,556
Consignment ratio	0.190	112.205	-0.008	0	0	0	110,404	998,556
Export ratio	0.012	0.075	0	0	0	0	1.02	998,556

Note: This table shows descriptive statistics on the plant-year observations being analyzed. Sample is restricted to plants that have multiple observations across years. Plant data is obtained from the Census of Manufacture from 2001 through 2014. 2011 is excluded due to inconsistency of surveyed plants. "Total real wage" is a sum of wages paid by a plant normalized at the 2015 price. "Annual real wage" is an employee's average annual wage, which is calculated as total real wage divided by the total number of employees. "Hourly real wage" is calculated using total real wage and total input hours by multiplying the total number of employees and industry-average labor input hours. "Real minimum wage" is minimum wage set by prefectures and industries normalized at the 2015 price. "Wage distance" is a difference between hourly real wage a year before and real minimum wage. "Total employees" is the total headcount of all employees at the plant. "Non-standard employee ratio" is a ratio of non-standard employees to the total number of employees. "Female employee ratio" is a ratio of female employees to the total number of employees. "Log labor productivity" is the natural logarithm of labor productivity, which is calculated as real output in 10,000 yen divided by total input hours. "HHI" indicates the Herhindahl-Hirschman Index, which is a sum of squared employment share for all plants in a labor market defined by 3-digit industry and economic areas. "Plants per labor market" is the number of plants in a given labor market. "Rest HHI" is an average HHI in the same industry but other geographic regions for a given labor market. "Import ratio" is a ratio of import value to total value of shipment by domestic plants within an industry. "Consignment ratio" is a ratio of consignment payments to total value of shipment within a plant. "Export ratio" is a ratio of export value to total value of shipment within a plant. Small plants are plants with single entity per firm with less than 300 employees. Large plants are plants with multiple entities per firm or single entity with 300 or more than 300 employees.

Table 2. Labor market concentration and wages: Plant fixed effects regressions

	(1)	(2)	(3)	(4)	(5)
	All Plants			Small Plants	Large Plants
Dep variable	log(annual real wages)				
HHI	-0.055***			-0.073***	-0.025***
	(0.003)			(0.004)	(0.005)
HHI≥0.15		-0.011***			
		(0.001)			
HHII≥0.25			-0.011***		
			(0.001)		
non-standard employee ratio	-0.276***	-0.276***	-0.276***	-0.255***	-0.317***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
female employee ratio	-0.161***	-0.161***	-0.161***	-0.142***	-0.201***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
log(unemployment rate)	-0.038***	-0.038***	-0.038***	-0.045***	-0.026***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
log(labor productivity)	0.256***	0.256***	0.256***	0.297***	0.190***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	-0.004	-0.004	-0.004	-0.008	-0.001
	(0.005)	(0.005)	(0.005)	(0.009)	(0.007)
consignment ratio	0.00001***	0.00001***	0.00001***	-0.000004	0.000009***
	(0.000002)	(0.000002)	(0.000002)	(0.00001)	(0.000002)
Constant	15.278***	15.276***	15.275***	15.282***	15.325***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)
Observations	3,255,971	3,255,971	3,255,971	2,234,485	998,556
R-squared	0.863	0.863	0.863	0.871	0.827
Plant FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table shows estimated effects of labor market concentration on wages using plant fixed effects regressions. A dependent variable is the natural logarithm of annual real wages. "HHI≥0.15" is an indicator variable, which equals to one if HHI is larger than 0.15. "HHI≥0.25" is defined as the similar fashion. Sample is restricted to plants that have multiple observations across years. White standard errors are reported in parentheses. Statistical significance maintains after clustering standard error by labor market. Small plants are plants with single entity per firm with less than 300 employees. Large plants are plants with multiple entities per firm or single entity with 300 or more than 300 employees. *** p<0.01, ** p<0.05 * p<0.1.

Table 3. Labor market concentration, wages, and plant characteristics (interacted models): Plant fixed effects regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Dep variable	log(annual real wages)					
HHI	-0.105***	-0.055***	-0.055***			
	(0.003)	(0.003)	(0.003)			
HHI≥0.15				-0.028***		
				(0.001)		
HHI<0.15					0.011***	0.011***
					(0.001)	(0.001)
non-standard employee ratio	-0.275***	-0.276***	-0.276***	-0.276***	-0.276***	-0.276***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
female employee ratio	-0.161***	-0.161***	-0.161***	-0.161***	-0.161***	-0.161***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(unemployment rate)	-0.038***	-0.038***	-0.038***	-0.038***	-0.038***	-0.038***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(labor productivity)	0.267***	0.256***	0.256***	0.262***	0.256***	0.256***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	-0.001	-0.005	-0.004	-0.003	-0.0003	-0.004
	(0.005)	(0.007)	(0.005)	(0.005)	(0.008)	(0.005)
consignment ratio	0.00001***	0.00001***	-0.00007***	0.00001***	0.00001***	0.0004***
	(0.000002)	(0.000002)	(0.00001)	(0.000002)	(0.000002)	(0.00003)
HHI×log(labor productivity)	-0.100***					
	(0.003)					
HHI×export ratio		0.007				
		(0.024)				
HHI×consignment ratio			0.001***			
			(0.000)			
HHI≥0.15× log(labor productivity)				-0.028***		
				(0.001)		
HH<0.15× export ratio					-0.005	
					(0.009)	
HHI<0.15× consignment ratio						-0.0004***
						(0.00003)
Constant	15.284***	15.278***	15.278***	15.279***	15.264***	15.264***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	3,255,971	3,255,971	3,255,971	3,255,971	3,255,971	3,255,971
R-squared	0.864	0.863	0.863	0.863	0.863	0.863
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows interacted effects of labor market concentration with plant specific factors on wages using plant fixed effects regressions. A dependent variable is the natural logarithm of annual real wages. "HHI≥0.15" is an indicator variable, which equals to one if HHI is larger than 0.15. "HHI<0.15" a defined as the similar fashion. Sample is restricted to plants that have multiple observations across years. White standard errors are reported in parentheses. Statistical significance maintains after clustering standard error by labor market. *** p<0.01, ** p<0.05 * p<0.1.

Table 4. Labor market concentration, wages, and plant characteristics: IV regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	All Plants				Small Plants	Large Plants
Dependent variable	log(annual real wage)					
HHI	-0.277***	-0.400***	-0.277***	-0.277***	-0.335***	-0.171***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.009)	(0.011)
non-standard employee ratio	-0.275***	-0.274***	-0.275***	-0.275***	-0.254***	-0.316***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
female employee ratio	-0.161***	-0.160***	-0.161***	-0.161***	-0.142***	-0.201***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
log(unemployment ratio)	-0.038***	-0.037***	-0.038***	-0.038***	-0.045***	-0.026***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
log(labor productivity)	0.257***	0.283***	0.257***	0.257***	0.299***	0.190***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	-0.004	0.002	-0.012	-0.004	-0.008	-0.001
	(0.005)	(0.005)	(0.008)	(0.005)	(0.009)	(0.007)
consignment ratio	0.00001***	.00001***	.00001***	-0.00004*	-0.000004	0.000009***
	(0.000002)	(0.000001)	(0.000002)	(0.00002)	(0.00001)	(0.000002)
HHI× log(labor productivity)		-0.246***				
		(0.007)				
HHI× export ratio			0.053			
			(0.043)			
HHI× consignment ratio				0.0005**		
				(0.0002)		
Observations	3,255,971	3,255,971	3,255,971	3,255,971	2,234,485	998,556
R-squared	0.167	0.167	0.167	0.167	0.184	0.140
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Endogenous Variable	HHI	HHI, HHI× log(labor productivity)	HHI, HHI×export ratio	HHI, HHI×consignment ratio	HHI	HHI

Note: This table shows effects of labor market concentration and plant specific factors on annual real wages using instrumental variable regressions. Our instrument variable is average employment HHI in the same industry but in other geographic areas. Small plants are plants with single entity per firm with less than 300 employees. Large plants are plants with multiple entities per firm or single entity with 300 or more than 300 employees. Sample is restricted to plants that have multiple observations across years. White standard errors are reported in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 5. Labor market concentration and minimum wage: Plant fixed effects regressions

Panel A: Annual real wage and minimum wage

	(1)	(2)	(3)	(4)	(5)
	All Plants			Small Plants	Large Plants
Dependent variable	log(annual real wage)				
HHI	-1.008***			0.373*	-1.264***
	(0.163)			(0.223)	(0.239)
HHI≥0.15		-0.269***			
		(0.048)			
HHII≥0.25			-0.155**		
			(0.062)		
non-standard employee ratio	-0.276***	-0.276***	-0.276***	-0.255***	-0.317***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
female employee ratio	-0.161***	-0.161***	-0.161***	-0.142***	-0.201***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
log(unemployment rate)	-0.037***	-0.037***	-0.037***	-0.044***	-0.025***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
log(labor productivity)	0.256***	0.256***	0.256***	0.297***	0.190***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	-0.004	-0.004	-0.004	-0.008	-0.002
	(0.005)	(0.005)	(0.005)	(0.009)	(0.007)
consignment ratio	0.00001***	0.00001***	0.00001***	-0.000004	0.000009***
	(0.000002)	(0.000002)	(0.000002)	(0.00001)	(0.000002)
log(minimum wage$_{-1}$)	-0.152***	-0.148***	-0.145***	-0.140***	-0.134***
	(0.008)	(0.008)	(0.008)	(0.010)	(0.014)
HHI× log(minimum wage$_{-1}$)	0.145***			-0.067**	0.188***
	(0.025)			(0.034)	(0.036)
HHI≥0.15× log(minimum wage$_{-1}$)		0.039***			
		(0.007)			
HHII≥0.25× log(minimum wage$_{-1}$)			0.022**		
			(0.009)		
Constant	16.273***	16.242***	16.223***	16.196***	16.198***
	(0.051)	(0.050)	(0.049)	(0.063)	(0.091)
Observations	3,255,971	3,255,971	3,255,971	2,234,485	998,556
R-squared	0.863	0.863	0.863	0.871	0.827
Plant FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Panel B: Number of total employees and minimum wage

	(1)	(2)	(3)	(4)	(5)
	All Plants			Small Plants	Large Plants
Dependent variable	log(number of employees)				
HHI	-5.289***			-5.173***	-4.564***
	(0.171)			(0.200)	(0.305)
HHI≥0.15		-1.352***			
		(0.049)			
HHII≥0.25			-1.264***		
			(0.064)		
non-standard employee ratio	0.261***	0.261***	0.261***	0.227***	0.351***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
female employee ratio	0.143***	0.143***	0.143***	0.121***	0.196***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)
log(unemployment rate)	-0.031***	-0.032***	-0.032***	-0.030***	-0.041***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
log(labor productivity)	-0.112***	-0.112***	-0.111***	-0.116***	-0.110***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	0.157***	0.158***	0.158***	0.125***	0.155***
	(0.007)	(0.007)	(0.007)	(0.010)	(0.009)
consignment ratio	-0.000004***	-0.000004***	-0.000004***	0.00004**	-0.000005***
	(0.000001)	(0.000001)	(0.000001)	(0.00002)	(0.000001)
log(minimum wage$_{-1}$)	-0.110***	-0.072***	-0.053***	-0.117***	-0.067***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.017)
HHI× log(minimum wage$_{-1}$)	0.804***			0.784***	0.701***
	(0.026)			(0.030)	(0.046)
HHI≥0.15× log(minimum wage$_{-1}$)		0.206***			
		(0.008)			
HHII≥0.25× log(minimum wage$_{-1}$)			0.193***		
			(0.010)		
Constant	3.229***	2.977***	2.852***	3.002***	3.556***
	(0.049)	(0.048)	(0.048)	(0.053)	(0.109)
Observations	3,255,971	3,255,971	3,255,971	2,234,485	998,556
R-squared	0.964	0.964	0.964	0.955	0.967
Plant FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Panel C: Number of non-standard employees and minimum wage

	(1)	(2)	(3)	(4)	(5)
		All Plants		Small Plants	Large Plants
Dependent variable		log(number of non-standard employees)			
HHI	-6.045***			-3.305***	-8.552***
	(0.277)			(0.262)	(0.558)
HHI≥0.15		-1.437***			
		(0.072)			
HHII≥0.25			-1.515***		
			(0.098)		
non-standard employee ratio	3.185***	3.185***	3.185***	2.925***	3.854***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)
female employee ratio	0.108***	0.108***	0.108***	0.080***	0.152***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)
log(unemployment rate)	-0.011***	-0.011***	-0.011***	-0.015***	-0.011
	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)
log(labor productivity)	-0.071***	-0.071***	-0.071***	-0.071***	-0.073***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
export ratio	0.198***	0.200***	0.200***	0.097***	0.232***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.020)
consignment ratio	0.000003***	0.000003***	0.000003***	0.00006**	0.000002
	(0.000001)	(0.000001)	(0.000001)	(0.00003)	(0.000001)
log(minimum wage$_{-1}$)	-0.161***	-0.111***	-0.093***	-0.104***	-0.218***
	(0.010)	(0.010)	(0.009)	(0.010)	(0.024)
HHI× log(minimum wage$_{-1}$)	0.924***			0.503***	1.311***
	(0.042)			(0.040)	(0.085)
HHI≥0.15× log(minimum wage$_{-1}$)		0.219***			
		(0.011)			
HHII≥0.25× log(minimum wage$_{-1}$)			0.231***		
			(0.015)		
Constant	1.391***	1.070***	0.948***	0.937***	1.971***
	(0.065)	(0.062)	(0.062)	(0.064)	(0.155)
Observations	3,255,971	3,255,971	3,255,971	2,234,485	998,556
R-squared	0.940	0.940	0.940	0.948	0.935
Plant FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table shows interacted effects of minimum wage with labor market concentration on outcome variables using plant fixed effects regressions. Panel A presents estimated results with natural logarithm of annual real wage as a dependent variable. Panel B presents estimated results with the natural logarithm of the total number of employees as a dependent variable. Panel C presents estimated results with the natural logarithm of the number of non-standard employees as a dependent variable. Small plants are plants with single entity per firm with less than 300 employees. Large plants are plants with multiple entities per firm or single entity with 300 or more than 300 employees. The sample is restricted to plants that have multiple observations across years. White standard errors are reported in parentheses. Statistical significance maintains after clustering standard error by labor market. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Labor market concentration and minimum wage: IV regressions

Panel A: All plants

Dependent variable	(1) log(annual real wage)	(2) log(number of employees)	(3) log(number of non-standard employees)
HHI	0.471	-13.339***	-13.233***
	(0.345)	(0.347)	(0.531)
non-standard employee ratio	-0.276***	0.261***	3.185***
	(0.002)	(0.001)	(0.002)
female employee ratio	-0.161***	0.143***	0.108***
	(0.002)	(0.003)	(0.003)
log(unemployment ratio)	-0.037***	-0.030***	-0.010***
	(0.002)	(0.002)	(0.003)
log(labor productivity)	0.257***	-0.113***	-0.072***
	(0.001)	(0.001)	(0.001)
export ratio	-0.003	0.154***	0.196***
	(0.005)	(0.007)	(0.013)
consignment ratio	0.00001***	-0.000004***	0.000003***
	(0.000002)	(0.000001)	(0.000001)
log(minimum wage$_{-1}$)	-0.106***	-0.229***	-0.263**
	(0.009)	(0.009)	(0.012)
HHI× log(minimum wage$_{-1}$)	-0.110**	2.032***	2.015***
	(0.052)	(0.053)	(0.081)
Observations	3,255,971	3,255,971	3,255,971
R-squared	0.168	0.082	0.641
Plant FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Endogenous Variable	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)

Panel B: Small plants

Dependent variable	(1) log(annual real wage)	(2) log(number of employees)	(3) log(number of non-standard employees)
HHI	4.176***	-14.507***	-7.803***
	(0.514)	(0.443)	(0.558)
non-standard employee ratio	-0.254***	0.227***	2.925***
	(0.002)	(0.002)	(0.002)
female employee ratio	-0.142***	0.121***	0.080***
	(0.003)	(0.003)	(0.003)
log(unemployment ratio)	-0.045***	-0.029***	-0.015***
	(0.003)	(0.002)	(0.003)
log(labor productivity)	0.299***	-0.117***	-0.071***
	(0.001)	(0.001)	(0.001)
export ratio	-0.008	0.124***	0.097***
	(0.009)	(0.010)	(0.013)
consignment ratio	-0.000004	0.00004**	0.00006**
	(0.00001)	(0.00002)	(0.00003)
log(minimum wage$_{-1}$)	-0.058***	-0.246***	-0.169***
	(0.011)	(0.010)	(0.012)
HHI× log(minimum wage$_{-1}$)	-0.681***	2.206***	1.191***
	(0.078)	(0.067)	(0.084)
Observations	2,234,485	2,234,485	2,234,485
R-squared	0.184	0.096	0.708
Plant FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Endogenous Variable	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)

Panel C: Large plants

Dependent variable	(1) log(annual real wage)	(2) log(number of employees)	(3) log(number of non-standard employees)
HHI	0.187	-9.074***	-17.108***
	(0.465)	(0.564)	(0.980)
non-standard employee ratio	-0.316***	0.351***	3.854***
	(0.003)	(0.003)	(0.007)
female employee ratio	-0.201***	0.196***	0.153***
	(0.005)	(0.006)	(0.007)
log(unemployment ratio)	-0.025***	-0.040***	-0.009
	(0.004)	(0.004)	(0.007)
log(labor productivity)	0.190***	-0.110***	-0.074***
	(0.001)	(0.001)	(0.002)
export ratio	-0.001	0.153***	0.229***
	(0.007)	(0.009)	(0.020)
consignment ratio	0.000009***	-0.000005***	0.000002
	(0.000002)	(0.000001)	(0.000001)
log(minimum wage$_{-1}$)	-0.097***	-0.145***	-0.356***
	(0.015)	(0.018)	(0.027)
HHI× log(minimum wage$_{-1}$)	-0.052	1.392***	2.607***
	(0.071)	(0.086)	(0.149)
Observations	998,556	998,556	998,556
R-squared	0.140	0.079	0.588
Plant FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Endogenous Variable	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)	HHI, HHI× log(minimum wage$_{-1}$)

Note: This table shows effects of labor market concentration, plant specific factors, and minimum wages on outcome variables using instrumental variable regressions. Our instrument variable is average employment HHI in the same industry but in other geographic areas. It presents interacted effects of labor market concentration with minimum wage with natural logarithm of annual real wages, the total number of employees, and the number of non-standard employees as a dependent variable. Panel A presents regression results using all plants Panel A presents regression results using all plants. Panel B presents regression results using plants with single entities per firm and less than 300 employees. Panel C regression results using plants with multiple entities per firm or single entity with 300 or more than 300 employees. Sample is restricted to plants that have multiple observations across years. White standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Minimum wage, labor market concentration, and plant exit

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All plants				Plants with less than 500 wage distance		
Dependent variable	Exit indicator variable						
HHI	-0.010***	0.887***			1.312***		
	(0.001)	(0.086)			(0.206)		
HHI≥0.15			0.244***			0.347***	
			(0.029)	-0.079***		(0.069)	
HHII≥0.25				(0.014)			0.519***
				(0.038)			(0.092)
log(minimum wage$_{-1}$)		0.111***	0.104***	0.102***	0.148***	0.137***	0.136***
		(0.003)	(0.002)	(0.002)	(0.006)	(0.005)	(0.005)
HHI× log(minimum wage$_{-1}$)		-0.135***			-0.199***		
		(0.013)			(0.031)		
HHI≥0.15× log(minimum wage$_{-1}$)			-0.037***			-0.053***	
			(0.004)			(0.010)	
HHII≥0.25× log(minimum wage$_{-1}$)				-0.043***			-0.079***
				(0.006)			(0.014)
non-standard employee ratio	0.011***	0.009***	0.009***	0.102***	0.148***	0.137***	0.136***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.006)	(0.005)	(0.005)
female employee ratio	-0.018***	-0.016***	-0.016***	0.009***	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(unemployment ratio)	0.017***	0.014***	0.014***	-0.016***	-0.055***	-0.055***	-0.055***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
log(labor productivity)	-0.029***	-0.029***	-0.029***	0.014***	0.008***	0.008***	0.008***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
export ratio	-0.014***	-0.014***	-0.014***	-0.029***	-0.040***	-0.040***	-0.040***
	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
consignment ratio	-0.00002**	-0.00002**	-0.00002**	-0.014***	-0.003	-0.002	-0.003
	(0.00001)	(0.00001)	(0.00001)	(0.003)	(0.014)	(0.014)	(0.014)
Observations	2,758,808	2,758,808	2,758,808	2,758,808	794,314	794,314	794,314
Pseudo R-squared	0.056	0.057	0.057	0.057	0.065	0.065	0.065
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows interacted effects of minimum wage with labor market concentration on plant exits using a logit model. Marginal effects at the mean value of independent variables are reported. Industry-Year fixed effects are controlled for. Dependent variable is an indicator variable, which equals one when plant does not appear in a given labor market the following year. Sample period is restricted to 2001 through 2013 due to an unobservability of plant exits in 2014. In "Plants with less than 500 wage distance" analysis (Model 5-Model 7), sample is restricted to plants with average hourly wage less than 500 yen above minimum wage or less. Robust standard errors are reported in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix

Appendix Table 1. Robustness check with alternative concentration measure

Panel A: Labor market concentration, wage, and plant characteristics

	(1)	(2)	(3)	(4)
Dependent variable	log(annual real wage)			
log(# of plants)	0.018***	0.027***	0.018***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
non-standard employee ratio	-0.276***	-0.275***	-0.276***	-0.276***
	(0.002)	(0.002)	(0.002)	(0.002)
female employee ratio	-0.161***	-0.160***	-0.161***	-0.161***
	(0.002)	(0.002)	(0.002)	(0.002)
log(unemployment ratio)	-0.038***	-0.037***	-0.038***	-0.038***
	(0.002)	(0.002)	(0.002)	(0.002)
log(labor productivity)	0.256***	0.190***	0.256***	0.256***
	(0.001)	(0.002)	(0.001)	(0.001)
export ratio	-0.005	-0.002	0.008	-0.005
	(0.005)	(0.005)	(0.014)	(0.005)
consignment ratio	0. 00001***	0. 00001***	0. 00001***	-0.00002*
	(0.000002)	(0.000002)	(0.000002)	(0.00001)
log(# of plants)× log(labor productivity)		0.016***		
		(0.000)		
log(# of plants)×export ratio			-0.003	
			(0.003)	
log(# of plants)× consignment ratio				-0.000
				(0.000)
Constant	15.192***	15.152***	15.192***	15.192***
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	3,255,971	3,255,971	3,255,971	3,255,971
R-squared	0.863	0.864	0.863	0.863
Plant FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Panel B: Labor market concentration and minimum wage: Effects on wages and employment

	(1)	(2)	(3)
	log(annual real wage)	log(number of employees)	log(number of non-standard employees)
log(# of plants)	0.319***	0.713***	0.794***
	(0.019)	(0.018)	(0.026)
non-standard employee ratio	-0.276***	0.261***	3.185***
	(0.002)	(0.001)	(0.002)
female employee ratio	-0.160***	0.143***	0.108***
	(0.002)	(0.003)	(0.003)
log(unemployment ratio)	-0.037***	-0.031***	-0.010***
	(0.002)	(0.002)	(0.003)
log(labor productivity)	0.256***	-0.112***	-0.071***
	(0.001)	(0.001)	(0.001)
export ratio	-0.005	0.156***	0.198***
	(0.005)	(0.007)	(0.013)
consignment ratio	0.00001***	-0.000004***	0.000003***
	(0.000002)	(0.000001)	(0.000001)
log(minimum wage$_{-1}$)	0.089***	0.469***	0.486***
	(0.015)	(0.015)	(0.021)
log(# of plants) ×log(minimum wage$_{-1}$)	-0.046***	-0.106***	-0.119***
	(0.003)	(0.003)	(0.004)
Constant	14.602***	-0.640***	-2.907***
	(0.098)	(0.099)	(0.139)
Observations	3,255,971	3,255,971	3,255,971
R-squared	0.863	0.964	0.940
Plant FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Panel C: Minimum wage, labor market concentration, and plant exit

	(1)	(2)	(3)
	All Plants		Plants with less than 500 wage distance
Dependent Variable	Exit indicator variable		
log(# of plants)	0.003***	-0.056***	-0.091***
	(0.0001)	(0.009)	(0.021)
log(# of plants)×log(minimum wage$_{-1}$)		0.009***	0.014***
		(0.001)	(0.003)
log(minimum wage$_{-1}$)		0.051***	0.060***
		(0.006)	(0.015)
non-standard employee ratio	0.011***	0.009***	-0.006***
	(0.001)	(0.001)	(0.001)
female employee ratio	-0.018***	-0.016***	-0.055***
	(0.001)	(0.001)	(0.002)
log(unemployment ratio)	0.016***	0.014***	0.008***
	(0.001)	(0.001)	(0.001)
log(labor productivity)	-0.029***	-0.029***	-0.040***
	(0.000)	(0.000)	(0.000)
export ratio	-0.014***	-0.014***	-0.002
	(0.003)	(0.003)	(0.014)
consignment ratio	-0.00002**	-0.00002**	-0.002
	(0.00001)	(0.00001)	(0.002)
Observations	2,758,808	2,758,808	794,314
Pseudo R-squared	0.057	0.057	0.065
Industry-Year FE	Yes	Yes	Yes

Note: This table shows the estimated effects of labor market concentration and interacted effects of labor market concentrations with plant specific factors and minimum wages on outcome variables using plant fixed effects regressions and a logit model. Panel A presents estimated results with the natural logarithm of annual real wage as a dependent variable using natural logarithm of the number of plants as a labor market concentration measure. Panel B presents estimated results with the natural logarithm of annual real wages, the total number of employees, and the number of non-standard employees as a dependent variable using natural logarithm of the number of plants as a labor market concentration measure. Panel C presents estimated results with exit indicator variable as a dependent variable using natural logarithm of number of plants as a labor market concentration measure using logit model. Marginal effects at the mean value of independent variables are reported. Industry-Year fixed effects are controlled for. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 2. First-stage regressions in IV regressions

	(1)	(2)	(3)	(4)
Dependent variable	HHI	HHI≥0.15	HHI	HHI× log(labor productivity)
rest HHI	0.588***	1.418***	0.593***	0.013***
	(0.002)	(0.005)	(0.002)	(0.003)
non-standard employee ratio	0.001***	0.002**	0.001***	0.001***
	(0.0002)	(0.001)	(0.0002)	(0.0004)
female employee ratio	-0.001***	-0.002	-0.001***	0.002***
	(0.0004)	(0.001)	(0.0004)	(0.001)
log(unemployment ratio)	0.001	-0.003**	0.001	-0.001**
	(0.0004)	(0.002)	(0.0004)	(0.001)
log(labor productivity)	0.0004***	0.002***	-0.002***	-0.025***
	(0.0001)	(0.0004)	(0.0002)	(0.001)
export ratio	0.003**	-0.005	0.003**	0.007***
	(0.001)	(0.005)	(0.001)	(0.002)
consignment ratio	0.0000002	0.00000001	0.0000002	0.000001
	(0.0000002)	(0.0000001)	(0.0000002)	(0.000003)
rest HHI×log(labor productivity)			0.009***	0.579***
			(0.001)	(0.003)
Constant	-0.030***	-0.119***	-0.031***	0.0001
	(0.0008)	(0.003)	(0.001)	(0.001)
Observations	3,255,971	3,255,971	3,255,971	3,255,971
R-squared	0.887	0.801	0.887	0.887
Plant FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
F statistics on IVs	77,000.13	82,802.94	38,506.81	19,649.23

	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable	HHI	HHI×export ratio	HHI	HHI×consignment ratio	HHI	HHI×log(minimum wage$_{-1}$)
rest HHI	0.587***	0.0001	0.588***	0.075	2.345***	12.017***
	(0.002)	(0.0002)	(0.002)	(0.060)	(0.076)	(0.499)
non-standard employee	0.001***	0.00003	0.001***	-0.030	0.001**	0.004**
ratio	(0.0002)	(0.00002)	(0.0002)	(0.026)	(0.0002)	(0.002)
female employee ratio	-0.001***	-0.00003	-0.001***	-0.016	-0.001**	-0.005**
	(0.0004)	(0.00003)	(0.0004)	(0.014)	(0.0004)	(0.003)
log(unemployment ratio)	0.001	-0.00009*	0.001	-0.016	0.001***	0.006**
	(0.0004)	(0.00005)	(0.0004)	(0.016)	(0.0004)	(0.003)
ln(labor productivity)	0.0004***	-0.0000005	0.0004***	-0.091	0.001***	0.005***
	(0.0001)	(0.00002)	(0.0001)	(0.084)	(0.0001)	(0.001)
export ratio	-0.022***	-0.053***	0.003**	-0.003	0.004***	0.027***
	(0.004)	(0.003)	(0.001)	(0.015)	(0.001)	(0.010)
consignment ratio	0.0000001	-0.0000003**	-0.000005	-0.088	0.0000002	0.000001
	(0.0000002)	(0.0000001)	(0.000006)	(0.067)	(0.0000002)	(0.000001)
rest HHI×export ratio	0.085***	0.704***				
	(0.014)	(0.013)				
rest HHI×consignment ratio			0.00001	0.497***		
			(0.00002)	(0.180)		
rest HHI×					-0.264***	-1.221***
log(minimum wage$_{-1}$)					(0.011)	(0.075)
log(minimum wage$_{-1}$)					-0.049***	-0.349***
					(0.003)	(0.021)
Constant	-0.030***	0.0002*	-0.030***	-0.026	0.281***	2.044***
	(0.001)	(0.0001)	(0.001)	(0.025)	(0.020)	(0.135)
Observations	3,255,971	3,255,971	3,255,971	3,255,971	3,255,971	3,255,971
R-squared	0.887	0.866	0.887	0.940	0.888	0.888
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
F statistics on IVs	38,514.95	1,444.54	38,500.12	4.05	38,473.81	38,519.35

Note: This table shows first-stage regression results with an endogenous variable as a dependent variable in IV regressions using all plants. “Rest HHI” is average HHI of labor markets in the same industry classification and in the different geographic area. White standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.