RIETI Discussion Paper Series 22-E-022

Spatial Gaps in Minimum Wages and Job Search of Young Workers

HAMAGUCHI, Nobuaki
RIETI

KONDO, Keisuke
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 22-E-022
March 2022

Spatial gaps in minimum wages and job search of young workers*

Nobuaki Hamaguchi†
RIETI & RIEB, Kobe University

Keisuke Kondo‡
RIETI & RIEB, Kobe University

Abstract

This study examines the extent to which spatial gaps in real minimum wages affect the location choice in job search of new high school graduates in Japan. We exploit the exogenous shock related to the 2007 amendment of the Minimum Wage Act which expanded variations in real minimum wage between urban and rural prefectures. We propose Bartik-like instruments for differential exposure to these shocks to perform a causal inference of the impact of spatial gaps in real minimum wages on the location choice in job search of unskilled young workers. Our estimation results show that the real minimum wage gaps partially motivate job search outside resident prefectures. Our counterfactual evaluation for the uniform minimum wage across prefectures shows that approximately 10-25% of new high school graduates in rural prefectures seek jobs outside their resident prefectures even under the uniform minimum wage setting. This result suggests that the simple correlation overestimates the impact of minimum wage on outmigration because other factors than wages such as urban amenity may explain spatial behavior in job search.

JEL classification: J61, J65, R23

Keywords: Minimum wage, Spatial job search, Bartik-like instrument, Shift-share design, Spatial weight matrix

* This study is conducted as a part of the Project "Economic Policy for Post Covid-19 Japanese Regional Economies" undertaken at the Research Institute of Economy, Trade and Industry (RIETI).

† Research Institute for Economics and Business Administration (RIEB), Kobe University. 2-1 Rokkodai-cho, Nada-ku, Kobe-shi, Hyogo, 657-8501, Japan. (e-mail: hamaguchi@rieb.kobe-u.ac.jp).

‡ *Corresponding author*. Research Institute of Economy, Trade and Industry (RIETI). 1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo, 100-8901, Japan. (e-mail: kondo-keisuke@rieti.go.jp).

1. Introduction

Minimum wage policy affects a wide range of economic activities. Numerous relevant studies have discussed how minimum wage hikes affect labor market outcomes, such as employment, labor force participation, job search, and wage/income distribution (Brown 1999; Card and Krueger 1994; Dube, Lester, and Reich 2010; Flinn 2006; Manning 2021; Neumark, Salas, and Wascher 2014; Neumark and Wascher 2007, 2008). This study focuses on how regional minimum wages affect the location choice of workers because regional labor markets are not independent but interact with each other through labor mobility (Cadena 2014; Manning and Petrongolo 2017; Monras 2019). Regional differences in real minimum wages can affect young, low-skilled, and low-wage workers' preferred location (Martin and Termos 2015; McKinnish 2017). Consequently, the central or local governments' equivocal setting of regional minimum wage may lead to distortion in spatial distribution of economic activities. Thus, setting the optimal minimum wages is an important policy agenda (Boeri 2012; Fehr, Goette, and Zehnder 2009; Simon and Wilson 2021).

We highlight job seekers' decision on migration when the regional minimum wage structure was changed. We restrict our focus on new high school graduates looking for jobs. According to Falk et al. (2006), minimum wages affect subjective reservation wages of workers. Hence, any worker is potentially signaled by a minimum wage setting. However, we follow previous studies, such as Gorry (2013), Hyslop and Stillman (2007), Kawaguchi and Mori (2009, 2021), and examine the data of young low-skilled workers, who are more sensitive to minimum wage differences. Additionally, unlike these previous studies, we focus on the labor supply side and analyze the spatial job search behavior in response to regional differences in minimum wages.

Our identification strategy follows a shift-share design, often related to the Bartik-like instrument (Adão, Kolesár, and Morales 2019; Bartik 1991; Borusyak, Hull, and Jaravel 2022; Goldsmith-Pinkham, Sorkin, and Swift 2020; Jaeger, Ruist, and Stuhler 2018). The original Bartik instrument is the inner product of the industry-location shares and the industry component of the growth rates (Bartik 1991; Goldsmith-Pinkham, Sorkin, and Swift 2020). In the original situation, the Bartik instrument's core idea is an exposure design, meaning that the weights express differential exposure to shocks. The sufficient condition for consistency is the strict exogeneity of shares (Goldsmith-Pinkham, Sorkin, and Swift 2020). Borusyak, Hull, and Jaravel (2022) further extend the idea for the Bartik-like instruments when shocks are exogeneous and shares are endogenous.

This study's proposed Bartik-like instruments exploit between-unit exposure based on location components, whereas existing studies generally exploit within-unit exposure based on industry-location components (Autor, Dorn, and Hanson 2013; Diamond 2016). This study's proposed shift-share components depend only on the locational unit because the minimum wage setting is based on a prefectural unit in Japan.[1] Unlike a within-unit exposure design in the standard situation for the Bartik-like instrument, our between-unit exposure design implies that the shift-share design based on the geographical weights coincides with a core idea of the spatial econometrics in situations where a spatial weight matrix is endogenous (Qu and Lee 2015; Qu, Lee, and Yang 2021). The shift is assumed to be exogeneous for job seekers in our setting; however, the share remains endogenous because the share components depend on the location choice of job seekers. Since this study's row-standardized spatial weight matrix expresses the share of interregional connection by previously observed matched job flows, our shift-share design using the Bartik-like instrument coincides with the endogenous spatial weight matrix case.

Another empirical challenge in our identification is how real wage equalization controls for unobserved locational fixed effects. In general, fixed-effect estimation should be used to control for unobserved locational factors (Allegretto, Dube, and Reich 2011). For example, when regions with high nominal minimum wages contain high amenities and other factors attractive for workers, cross-sectional correlation overestimates the impact of spatial gaps in minimum wages on their location choice. However, controlling for locational fixed effects simultaneously annihilates the spatial variations in minimum wages across regions under real minimum wage equalization. Therefore, this study identifies the causal impact of spatial gaps in real minimum wages by exploiting the exogenous variations in nominal minimum wages arising from the institutional change, which we will explain in next section.

Our estimation results through the instrumental variable (IV) method show that the gaps in real minimum wages between urban and rural prefectures motivate rural high school graduates in areas with low minimum wages to seek jobs outside their prefectures of residence. We also find that the simple correlation analysis using the ordinary least squares (OLS) method overestimates the migration incentive for spatial gaps in the minimum wage. In line with an increasing debate for uniform minimum wage policy (Nagatsuma 2016; National Confederation of Trade Unions 2021), we conduct a counterfactual analysis for the setting, where nominal minimum wages are uniform across prefectures. Our counterfactual evaluation shows that approximately 10–25% of new graduates seeking jobs in rural prefectures still seek jobs outside their prefectures, even if real minimum wages are higher in their prefectures. This suggests that urban amenities and non-wage factors, such as history, culture, diversity in consumption of goods and services, and diversified jobs, also play a key role in explaining new high school graduates' spatial job search behavior (Glaeser, Kolko, and Saiz 2001).

This study makes twofold contributions to the literature. The first contribution of this study is

[1] Although the minimum wage is also stipulated for some specific industries in Japan, this minimum wage level must be higher than the minimum wage level stipulated at the prefecture level.

uncovering subjective aspects of young workers' spatial job searches in terms of unobservable preferences in the labor supply side. Our data in Japan cover location choice of all new high school graduates in the job application process. The second contribution is proposing shift-share instruments for geographical weights. Importantly, our concept based on between-unit exposure coincides with the endogenous spatial weight matrix in spatial econometrics literature (Qu and Lee 2015; Qu, Lee, and Yang 2021). In our case, the origin–destination (OD) matrix of matched job flows comprises the geographical weights, which describes the strength of the interregional interaction. The shares in the Bartik-like instruments correspond to the weights constructed from the long-lagged OD matrix.

The rest of this paper is organized as follows. Section 2 provides the literature review on minimum wage policies in Japan. Section 3 outlines the empirical strategy, Section 4 describes data, Section 5 presents estimation results, and Section 6 concludes with policy implications.

2. Minimum Wage in Japan

2.1. Overview

This section provides an overview of the historical development of the minimum wage system in Japan (see also Nakakubo 2009). The Labor Standard Act was enacted in 1947 as a part of the legal system reform in the post-World War II democratization process. Although the law envisaged the introduction of the minimum wage, it did not take effect immediately. In 1959, the Minimum Wage Act was enacted, and the minimum wage system was formally established. In the initial setting, representatives of industrial sectors set the minimum wage without the representation of workers. A 1968 amendment stipulated the council method, in which employers and employees' representatives formed committees. Regional minimum wages were instituted in the 1968 amendment. A 1978 amendment introduced the current system of the two-stage determination process of a prefecture-level minimum wage. In the first stage, the Central Minimum Wage Council sets the referential minimum wage increase for each rank of prefectures.[2]. In the second stage, the Regional Minimum Wage Council, organized at the prefectural level, determines the minimum wage increase in each prefecture while considering the Central Committee's deliberation. This system reflects local specificity while moderating minimum wage variations among prefectures. The sector-wise minimum wage

[2] The 47 prefectures are classified into four ranks based on the compounded index. The prefectural level compounded index is built on sub-indices of *income and consumption* (regional economic account-based per-capita income and consumption expenditure), *wage* (hourly wage of low-paid salary workers in small establishments), *business conditions* (labor productivity measured by the value-added per employee of various sectors). The 47 prefectures are grouped into four classes ranked as A (6), B (11), C (14), and D (16).

continues to be valid for some specific sectors, provided they are above the prefectural minimum wages.[3]

Low minimum wages, reflecting employers' rejection of higher labor costs, created the critical situation where minimum wages in several prefectures were under the income transfer of social welfare benefits. The minimum wage system received harsh criticism for creating the "working poor" phenomenon where wages do not assure workers' constitutional right to maintain minimum standards of wholesome and cultured living, discouraging willingness to work. The 2007 amendment to the Minimum Wage Act made it mandatory that the monthly earnings of a full-time minimum-wage worker should not be less than the social welfare benefit in each prefecture.[4] The 2007 amendment also increased penalties on employers paying less than the minimum wage (the maximum fine was raised from 20,000 JPY to 500,000 JPY) because the legal enforcement of the minimum wage was weak in Japan, as the fines for non-compliance were negligible.[5]

Figure 1 shows the geographical distribution of the prefectural minimum wages and population density in October 2019. As shown in Panel (a) of Figure 1, the minimum wages in urban prefectures are higher than in rural prefectures. As of October 2019, the group with the highest hourly minimum wages includes Tokyo (1,013 JPY), Kanagawa (1,012 JPY), and Osaka (964 JPY). The group with the lowest hourly minimum wages includes Aomori (793 JPY), Iwate (793 JPY), Akita (792 JPY), Yamagata (793 JPY), Tottori (792 JPY), Shimane (792 JPY), Tokushima (796 JPY), Ehime (793 JPY), Kochi (792 JPY), Saga (792 JPY), Nagasaki (793 JPY), Kumamoto (793 JPY), Oita (792 JPY), Miyazaki (793 JPY), Kagoshima (793 JPY), and Okinawa (793 JPY). As shown in Panel (b) of Figure 1, the geographical distribution of minimum wages is highly correlated with population density since the cost of living, particularly rent and housing, is generally connected with the city size. Therefore, whereas nominal wages are different between prefectures, the current minimum wage setting, based on the 2007 amendment of the Minimum Wage Act, aims to achieve real wage equalization at the prefectural level.

[Figure 1]

Figure 2 shows the Gini coefficient's time-series trend of the prefectural minimum wages. Panel (a) of Figure 2 shows that the Gini coefficients of prefectural minimum wages increased around the 2007 amendment; however, a sharp rise in the Gini coefficient occurred two years before the Minimum Wage Act's 2007 amendment. This increasing trend is not observed after the moratorium period of five years. Panel

[3] Regional minimum wages are stipulated on a daily and hourly basis. However, they were integrated only into hourly minimum wages in 2002.

[4] Social welfare benefit is set at the municipality level to assure essential consumption and living needs based on the National Survey of Family Income and Expenditure.

[5] Abe (2011) points out that minimum wages were not binding for wage settings in Japan until the mid-2000s, but they have gradually become more binding since the 2007 amendment of the Minimum Wage Act (Abe 2011). Kawaguchi and Mori (2021) also found that the minimum wages have formed the wage floor of low-wage workers only after the amendment.

(b) of Figure 2 shows the percentage changes in the Gini coefficient of prefectural minimum wages. Drastic changes occurred between 2007 and 2009, resulting from steeper minimum wages hikes in urban prefectures than rural ones.[6] We will use such exogenous sources of variations in minimum wages for identifying its causal effect on the location choice of job seekers.

[Figure 2]

Kambayashi, Kawaguchi, and Yamada (2013) analyzed the data between 1994 and 2003 before the 2007 amendment. They observed that the fraction of workers paid less than or equal to the minimum wage rose more significantly among female workers in low-wage prefectures than in high-wage prefectures. They concluded that the increase in the minimum wage had adverse effects on new hires, hours worked, and women's employment.

As same as our study, recent studies consider the 2007 amendment to the Minimum Wage Act as a treatment event that generated exogeneous sources of variations in minimum wages. Testing for the local labor market monopsony, Okudaira, Takizawa, and Yamanouchi (2019) found that increasing the minimum wage affected employment in the manufacturing sector heterogeneously. They focused on the surplus between the marginal product of labor and the wage rate in each manufacturing plant as a measure of local labor market competition. The higher surplus expresses that firms have market power and less labor market competition. They found that minimum wage hikes had minor employment effects in plants with a higher surplus, whereas they significantly and negatively impacted employment in plants with a lower surplus. Kawaguchi and Mori (2021) consider changes in gaps between minimum wages and living costs in Japan. The 2007 amendment of the Minimum Wage Act of Japan (in force from July 1, 2008) aimed to adjust regional minimum wages to compensate different costs of living between prefectures because minimum wages in urban prefectures were too low in the light of local cost of living. This adjustment temporarily extended spatial gaps in real minimum wages between urban and rural prefectures. Kawaguchi and Mori (2021) found that minimum wage hikes had significantly negative impacts on the employment of young, less-educated male workers aged 19–24, while they did not affect other demographic groups.

Existing studies point out that minimum wage hikes affect the choice of new high school graduates' future paths. For example, Hojo (2017) found that the minimum wage hikes gave more incentives to enter the labor market than pursue further education. This effect was stronger for male graduates than for female graduates. However, we do not explicitly consider this nest structure in the job search process.

[6] The data in Figure 2 show that the spatial gaps in minimum wages started to increase as of 2005.

2.2. Starting Wages for New High School Graduates

This study considers that minimum wages are relevant for new high school graduates' job searches. This section discusses starting wages for new high school graduates in Japan to support this assumption.

Figure 3 shows the distribution of average starting wages for new high school graduates and minimum wages at the prefecture level. If this ratio approaches one, the starting wages become the minimum wages. Figure 3 provides several stylized facts for setting wages for new high school graduates. First, we can see that average starting wages for new high school graduates are within 1.1–1.5 times as high as minimum wages in the 2000s. Accounting for the skewed wage distribution with a long right tail, spatial gaps in minimum wages are relevant for the job search behavior of most new high school graduates. Second, the distribution shifts to the left over the years. Significantly, the ratio is distributed near one in the 2010s, implying that starting wages for new high school graduates are indexed to the minimum wages. Abe and Tamada (2007) show that wages for part-time workers are also near the minimum wages, although there was regional heterogeneity regarding the ratio's decline.

[Figure 3]

Our assumption that new high school graduates refer to regional minimum wages in searching for jobs is reasonable in the context of the Japanese labor market. The following sections introduce the spatial gaps in minimum wages into the location choice of new high school graduates.

3. Empirical Strategy

3.1. Theoretical Model

This study considers the additive random utility model to describe the location choice of new high school graduates, as used in existing studies (Diamond 2016). Suppose that each new graduate faces two options when searching for a job: search for jobs inside their region of residence, or search for jobs outside their region of residence. Each new graduate who resides in region i decides region j for working. Note that region j includes only two options $j \in \{i, o(i)\}$: index i indicates working in the same region i, and index $o(i)$ indicates working outside the region i. That is, the location choice is a binary problem at this step.[7]

The total utility of each new graduate, U_{ij}, is defined as follows:

[7] Each new graduate must choose one of the multiple candidate regions after finding a job. Therefore, inter-regional matched job flows are uniquely determined for each new graduate. Because our analysis focuses on the job application process, the matching in the spatial job search is beyond the scope of this paper.

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \tag{1}$$

where V_{ij} is the deterministic utility of new graduate who resides in region i and plans to work in region j, and $\varepsilon_{ij} > 1$ is a stochastic factor of amenities related to region j.

It is assumed that the stochastic factor ε_{ij} is independently and identically distributed across new graduates according to the Type I extreme value distribution (i.e., Gumbel distribution). The probability density function $f(\varepsilon, \beta)$ and cumulative distribution function $F(\varepsilon, \beta)$ are expressed as follows:

$$f(\varepsilon, \beta) = \frac{1}{\beta} \exp\left[-\frac{\varepsilon}{\beta} - \exp\left(-\frac{\varepsilon}{\beta}\right)\right] \quad \text{and} \quad F(\varepsilon, \beta) = \exp\left[-\exp\left(-\frac{\varepsilon}{\beta}\right)\right], \tag{2}$$

where $\beta > 0$ is a scale parameter that represents the heterogeneity.

The deterministic utility V_{ij} includes the real wage ω_j in region j, meaning the ratio of nominal wage W_j and cost of living P_j. Considering other factors $\boldsymbol{X}_j$ that affect location choice, the deterministic utility is specified as follows:

$$V_{ij} = \alpha \log(\omega_j) + \boldsymbol{X}_j \boldsymbol{\gamma}, \tag{3}$$

where $\alpha > 0$ is the parameter that defines the strength of the migration incentive for the spatial difference in real wages, and $\boldsymbol{\gamma}$ is the vector of parameters related with other factors $\boldsymbol{X}_j$. Note that migration costs are assumed to be free.

Each new graduate makes an optimal choice to maximize their utility. The probability of location choice is expressed in a logit form as follows:

$$\pi_{ii} = \frac{\exp(V_{ii}/\beta)}{\exp(V_{ii}/\beta) + \exp(V_{io(i)}/\beta)} \quad \text{and} \quad \pi_{io(i)} = \frac{\exp(V_{io(i)}/\beta)}{\exp(V_{ii}/\beta) + \exp(V_{io(i)}/\beta)}. \tag{4}$$

The expected numbers of graduates who search for jobs inside and outside region i are expressed using the choice probability of location as follows:

$$S_{ii} = \pi_{ii} S_i \quad \text{and} \quad S_{io(i)} = \pi_{io(i)} S_i, \tag{5}$$

where S_i is the total number of new graduates that search for jobs in region i.

Using Equations (4) and (5), the ratio of new graduates who search for jobs outside and inside region i is expressed as follows:

$$\frac{S_{io(i)}}{S_{ii}} = \exp\left(\frac{V_{io(i)}}{V_{ii}}\right). \tag{6}$$

Taking the logarithm of both sides and inserting Equation (3) into this, the ratio of job seekers is expressed as follows:

$$\log\left(\frac{S_{io(i)}}{S_{ii}}\right) = \alpha \log\left(\frac{\omega_{o(i)}}{\omega_i}\right) + \boldsymbol{X}_{o(i)i}\boldsymbol{\gamma}, \tag{7}$$

where $\omega_{o(i)}/\omega_i$ is the ratio of real wages between regions o and i, and $\boldsymbol{X}_{o(i)i}$ is the vector of other factors between regions o and i. The first term in this equation says that higher real wage in region o than in region i attracts more job seekers for a positive parameter α.

Using the log differences, this equation can be rewritten in percentage change form as follows:

$$g_i^S = \alpha g_i^\omega + \boldsymbol{g}_i^X \boldsymbol{\gamma} \tag{8}$$

where $g_i^S = \log(S_{io(i)}) - \log(S_{ii})$ is the approximation of the percentage change in new graduates seeking jobs outside and inside prefecture i, $g_i^\omega = \log(\omega_{o(i)}) - \log(\omega_i)$ is the approximation of the spatial percentage change in real wages, and $\boldsymbol{g}_i^X$ is the spatial change in control variables. In this study, the parameter of our interest is α, which measures the strength of migration incentives for the spatial percentage change in real wages.

3.2. Empirical Specification

This study aims to examine how spatial gaps in real minimum wages affect the location choice of new high school students. Based on Equation (8), we estimate time-varying parameters α_y of the following regression model:

$$g_{it}^S = \sum_{y=2003}^{2019} \alpha_y \, g_{iy}^{MW} \cdot 1(\text{Year} = y) + \boldsymbol{g}_{it}^X \boldsymbol{\gamma} + \eta_i + \phi_{rt} + g_{it}^e, \qquad t = 2003, \dots, 2019 \tag{9}$$

where α_y is the parameter of our interest in year y, $g_{it}^{MW} = \log(\widetilde{MW}_{o(i),t}) - \log(MW_{i,t})$ is the spatial percentage change in nominal minimum wages (tilde represents the weighted average), $1(\text{Year} = y)$ is the indicator function that takes 1 if $\text{Year} = y$ and 0 otherwise, η_i is the fixed effect of prefecture i, ϕ_{rt} is the region-year dummy (47 prefectures are classified into 7 regions), and $g_{it}^e = \tilde{e}_{io(i),t} - e_{ii,t}$ is the spatial difference in the error term e.[8]

This regression assumes that new graduates consider minimum wages to reference the wage rate available in the local labor markets. This assumption is reasonable because the starting salary for new high school graduates adheres to the minimum wage rate.

Unlike Equation (8), our empirical specification does not directly rely on the spatial percentage changes in real wages. An empirical issue is that real wages are not directly observed because living costs are not easily calculated. For example, existing studies point out the conventional cost-of-living index's bias (Handbury and Weinstein 2015). Therefore, in the regression, the real wage is divided into the nominal wage and cost of living as follows:

$$g_{it}^{\omega} = g_{it}^{MW} - g_{it}^{P}, \tag{10}$$

where $g_{it}^{P} = \log(\widetilde{P}_{o(i),t}) - \log(P_{it})$ is the spatial percentage change in cost of living. We intend to control for the spatial percentage change in cost of living by the prefectural fixed effect η_i and the region-year dummy ϕ_{rt}. Even if the cost-of-living variable is available, the simultaneous inclusion of nominal wages and cost of living may suffer from multicollinearity under the real wage equalization because the cost of living is proportional to nominal wages.

An empirical challenge is that there are multiple candidate regions for jobs seekers outside the regions of residence during their job search process. Conversely, bilateral job flows between prefectures are uniquely identified after the jobs are matched. When calculating the nominal wages outside the prefecture, we aggregate the nominal minimum wages of outside prefectures with the weights of the choice probability of location. Because each new graduate has information on job matches in the previous year, the weighted averages are based on previous matches. The matched job flows across 47 prefectures in the previous year are obtained as an OD matrix,

$$\boldsymbol{M}_{t-1} = \begin{pmatrix} m_{1,1,t-1} & m_{1,2,t-1} & m_{1,3,t-1} & \cdots & m_{1,47,t-1} \\ m_{2,1,t-1} & m_{2,2,t-1} & m_{2,3,t-1} & \cdots & m_{2,47,t-1} \\ m_{3,1,t-1} & m_{3,2,t-1} & m_{3,3,t-1} & \cdots & m_{3,47,t-1} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ m_{47,1,t-1} & m_{47,2,t-1} & m_{47,3,t-1} & \cdots & m_{47,47,t-1} \end{pmatrix}, \tag{11}$$

where $m_{ij,t-1}$ indicates the number of matched job flows from prefecture i to prefecture j in year $t-1$

[8] This study uses the regional classification of the 47 prefectures. Region 1 includes 1. Hokkaido, 2. Aomori, 3. Iwate, 4. Miyagi, 5. Akita, 6. Yamagata, and 7. Fukushima. Region 2 includes 8. Ibaraki, 9. Tochigi, 10. Gunma, 11. Saitama, 12. Chiba, 13. Tokyo, and 14. Kanagawa. Region3 includes 15. Niigata, 16. Toyama, 17. Ishikawa, 18. Fukui, 19. Yamanashi, 20. Nagano, 21. Gifu, 22. Shizuoka, 23. Aichi, and 24. Mie. Region 4 includes 25. Shiga, 26. Kyoto, 27. Osaka, 28. Hyogo, 29. Nara, and 30. Wakayama. Region 5 includes 31. Tottori, 32. Shimane, 33. Okayama, 34. Hiroshima, and 35. Yamaguchi. Region 6 includes 36. Tokushima, 37. Kagawa, 38. Ehime, and 39. Kochi. Region 7 includes 40. Fukuoka, 41. Saga, 42. Nagasaki, 43. Kumamoto, 44. Oita, 45. Miyazaki, 46. Kagoshima, and 47. Okinawa.

$(i, j \in \{1, 2, \dots, 47\})$.

We assume that the nominal wages outside the residential regions are the weighted average of the prefecture minimum wage with the choice probability in each prefecture. The weight is constructed as follows:

$$z_{ij}(m_{ij,t-1}) = \begin{cases} 0 & \text{for } i = j, \\ \dfrac{m_{ij,t-1}}{\sum_{k=1} m_{ik,t-1} - m_{ii,t-1}} & \text{for } i \neq j. \end{cases} \tag{12}$$

Note that diagonal elements of the weight matrix take the value of 0. Therefore, the spatial percentage change in nominal minimum wages is mathematically expressed as

$$\begin{aligned} g_{it}^{MW} &= \sum_{k=1} z_{ik}\left(m_{ik,t-1}\right) \cdot (\log MW_{kt} - \log MW_{it}) \\ &= \sum_{k=1} z_{ik}\left(m_{ik,t-1}\right) \log MW_{kt} - \log MW_{it} \\ &= \log \widetilde{MW}_{o(i),t}\left(m_{ik,t-1}\right) - \log MW_{it}, \end{aligned} \tag{13}$$

where MW_{it} is the minimum wage in prefecture i in year t, and $\widetilde{MW}_{o(i),t}\left(m_{ik,t-1}\right)$ is the weighted geometric average of the minimum wage outside the prefecture i in year t. The second line holds because the sum of weights is equal to one.

The spatial percentage change in minimum wages becomes zero if the nominal wage outside the residential prefecture is equal to that inside. Generally, this variable takes positive values in rural prefectures; only Tokyo, Kanagawa, Aichi, and Osaka show negative values in our data. Therefore, this study limits the sample to prefectures with positive values of spatial percentage change in minimum wages.

It is important to include the control variables to control for other regional labor market shocks. This study includes three variables: the outside-inside ratios of unemployment rates, labor market tightness, and the ratio of outmigration-immigration flows, excluding new high school graduates. The unemployment rates and labor market tightness control for the different employment conditions between regional labor markets. These two variables outside the residential prefecture are constructed as an average with the weights based on matched job flows in 1984, consistent with the Bartik-like instrument in Section 3.3. The ratio of outmigration-immigration flow is expected to control for other shocks that determine inter-prefectural migration flows.

The baseline regressions are based on the OLS and fixed-effect estimation methods. Still, an endogeneity issue in the regression should be solved. For example, labor demand factors affect an incentive to migrate to regions with increasing minimum wage, included in the error term. Unobserved labor demand shocks arising from minimum wage hikes also affect matched job flows in the OD matrix. Therefore, correlated factors exist in the error term and the explanatory variable of interest; thus, this study proposes IV methods using the Bartik-like instruments.

3.3. Bartik-like Instruments

Our identification strategy is based on the Bartik-like instruments, originally the inner product of the industry-location shares and the industry component of the growth rates (Bartik 1991; Borusyak, Hull, and Jaravel 2022; Goldsmith-Pinkham, Sorkin, and Swift 2020). The core idea of the Bartik instruments is an exposure design, meaning that the weights express differential exposure to common shock. Importantly, the sufficient condition for consistency is the strict exogeneity of the shares (Goldsmith-Pinkham, Sorkin, and Swift 2020).

This study exploits differential exposure to the minimum wage hikes in locations to identify the causal effect on a spatial job search. We assume that, whereas minimum wage hikes are exogenous shocks for job seekers, the shares of the matched job flows are endogenous because the matched job flows are determined at the labor market equilibrium. The endogeneity of the shares indicates that the following equation does not hold:

$$\mathrm{E}\left[g_{it}^{e}\, z_{ij}(m_{ij,t-1}) \mid \boldsymbol{g}_{it}^{X}, \boldsymbol{K}_{it}\right] = 0 \ \text{ for all } j \text{ where } g_{it}^{MW} \neq 0, \tag{14}$$

where $\boldsymbol{K}_{it}$ is the vector of the prefecture fixed effects and the region-year dummies.

Minimum wage hikes simultaneously affect labor demand and supply sides over time. Systematic shocks arising from labor market equilibrium affect the location choice decision of job seekers, and the error terms g_{it}^{e} include unobserved shocks. The matched job flows $m_{ij,t-1}$ in year $t-1$ also affect the decision making of new graduates in year t, and the error terms g_{it}^{e} possibly correlate with the matched job flows. The error components and the lagged migration flows may be correlated in the short run. Therefore, the orthogonality in Equation (14) is not necessarily guaranteed.

This study proposes Bartik-like instruments based on the between-unit exposure, constructed as follows:

$$\begin{aligned} B_{it}\left(m_{ij,\tau}\right) &= \sum_{k=1} z_{ik}\left(m_{ik,\tau}\right) \cdot \left(\log MW_{kt} - \log MW_{it}\right) \\ &= \sum_{k=1} z_{ik}\left(m_{ik,\tau}\right) \log MW_{kt} - \log MW_{it} \\ &= \log \widetilde{MW}_{o(i),t}\left(m_{ij,\tau}\right) - \log MW_{it}, \end{aligned} \tag{15}$$

where the share $z_{ik}\left(m_{ik,\tau}\right)$ is fixed by the matched job flows in time τ and $\widetilde{MW}_{o(i),t}\left(m_{ij,\tau}\right)$ is the weighted geometric average of minimum wages outside prefecture i. This study sets $\tau \in \{1984, 1992\}$, 10 and 18 years before the initial year of the study period. Using lagged variables is reasonable because the shocks in 1984 or 1992 are absorbed in the long run, while the structure of inter-prefectural migration flows is persistent in the long run. This study considers the simultaneous inclusion of the two Bartik-like instruments, enabling us to implement an overidentification test.

Since the shares of the Bartik-like instruments are fixed in the panel regression, the Bartik-like instruments' time-variations arise from the exogeneous shifts (i.e., the spatial changes in minimum wages). Borusyak, Hull, and Jaravel (2022) investigate the situation of endogenous shares. The relevance of our Bartik-like instruments is the high correlation between the ratio of minimum wages and the Bartik-like instruments. The strict exogeneity of the instruments is required for consistency as follows:

$$\mathrm{E}\left[g_{it}^{e}\, z_{ij}(m_{ij,\tau}) | \boldsymbol{g}_{it}^{X}, \boldsymbol{K}_{it}\right] = 0 \quad \text{for all } j \text{ where } g_{it}^{W} \neq 0, \tag{16}$$

where the migration flows in time τ is not correlated with the shocks in spatial job search in year t.

Our Bartik-like instruments partly relate to the identification strategy by Card (2009), who proposed an exposure design in the literature on immigrants because the exposure is based on geographical units. Card (2009) proposes shift-share instruments for immigration in terms of their origin country to the US to solve an endogeneity problem. The instruments are constructed by decomposing the aggregate immigrants into "shift" and "share" components. Shift indicates the changes in immigrants from each country to the US, while share indicates the initial distribution of the immigrants. The shift-share design's identification assumption is based on the relevance and exclusion restriction. Changes in immigrants are correlated with the levels of immigrants and less correlated with the levels of shocks. The initial distribution of immigrants is correlated with the contemporaneous distribution of immigrants because the immigration trend is persistent. However, the initial distribution of immigrants is not correlated with the contemporaneous shocks. Therefore, the shift-share instruments proposed by Card (2009) can be interpreted as exogeneous predictors of immigrants that extend forward from the initial period. The correlation between realized and predicted values corresponds to the relevance and exclusion restriction for the shift-share instruments.

Another idea of our Bartik-like instruments corresponds to endogenous spatial weight matrix in the literature on spatial econometrics (Qu and Lee 2015; Qu, Lee, and Yang 2021). Although the spatial weight matrix is constructed from the exogeneous conditions, such as contiguity or geographical distance, the interdependence between regions can be expressed using economic distance, such as trade and migration. However, interregional trade and migration are endogenous variables, leading to a bias in the parameter estimates. Therefore, our Bartik-like instruments can solve the endogenous spatial weight matrix problems.

3.4. Counterfactual Evaluation for Uniform Minimum Wage Policy

We evaluate the uniform minimum wage policy as a counterfactual analysis. Currently, the minimum wage setting in Japan is based on different costs of living across prefectures. However, there are recent policy debates for a uniform national minimum wage system because the higher minimum wage in urban prefectures attracts more young people, leading to rapid population decline in rural prefectures (Nagatsuma 2016; National Confederation of Trade Unions 2021).

Under the uniform minimum wage setting, the ratio of nominal minimum wages $\widetilde{MW}_{o(i)}/MW_i$ is equal to one. Ceteris paribus, our counterfactual analysis estimates the shares of new high school graduates searching for jobs inside their prefecture of residence. Let $\hat{S}_{io(i)}/\hat{S}_{ii}$ denote the ratio of new high school graduates searching for jobs outside and inside their prefecture of residence under the nominal minimum wage equalization. Taking the difference between the log ratio under the nominal minimum wage equalization and that observed in 2019 in Equation (7), we have the following equation:

$$\log\left(\frac{\hat{S}_{io(i)}}{\hat{S}_{ii}}\right) - \log\left(\frac{S_{io(i),2019}}{S_{ii,2019}}\right) = \hat{\alpha}\log(1) - \hat{\alpha}\log\left(\frac{\widetilde{MW}_{o(i),2019}}{MW_{i,2019}}\right), \tag{17}$$

where $\hat{\boldsymbol{\alpha}}$ is the averaged time-varying estimate between 2007 and 2009. Manipulating this equation provides the estimated share of graduates who search for jobs inside their prefecture of residence, as follows:

$$\frac{\hat{S}_{ii}}{\hat{S}_{ii} + \hat{S}_{io(i)}} = \frac{1}{1 + \exp\left(-\left\{\hat{\alpha}\log\left(\frac{\widetilde{MW}_{o(i),2019}}{MW_{i,2019}}\right) - \log\left(\frac{S_{io(i),2019}}{S_{ii,2019}}\right)\right\}\right)}, \tag{18}$$

which can be interpreted as a function of parameter $\boldsymbol{\alpha}$, given the data on spatial job search and regional minimum wages. These shares are calculated for male and female graduates.

Equation (21) takes the form of the inverse logit, also called the logistic function or the sigmoid function. Therefore, the estimated share of new high school graduates searching for jobs inside their prefecture of residence lies within 0 and 1 for any value of the difference term on the right-hand side. The estimated share approaches one as the parameter estimate $\hat{\alpha}$ increases.

Although uniform minimum wage policy considers that nominal minimum wages are uniform across prefectures, real minimum wages in rural prefectures are higher than those in urban prefectures because the cost of living is generally low in rural prefectures. This minimum wage setting rule motivates workers to search for jobs inside their prefectures. Our counterfactual analysis quantifies the extent to which the uniform minimum wage setting increases the shares of new high school graduates seeking jobs inside their prefectures.[9]

4. Data

This study uses data from the Survey on Job Search (Offer) of New High School Graduates, conducted every year by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The survey covers all students in public and private high schools, and high schools conduct the survey three times during the academic year (from April to March): October, December, and March. This study uses the survey data at the end of March and covers 2003–2019.[10]

High schools ask students about their future paths after graduation. Students seeking jobs are asked for details concerning career location and occupation, and teachers support job placement based on their preferences. The aggregate data on job search behaviors are published at the prefecture level, and this study uses data on the location choice of the job search process.

Figure 4 shows the ratio of new high school graduates seeking jobs outside and inside their prefectures of residence in 2019. In general, rural prefectures, such as Aomori, Iwate, Akita, Saga, Nagasaki, Kumamoto, Miyazaki, and Kagoshima prefectures, show higher values than one. Around 30–50% of new graduates search for jobs outside these prefectures. Conversely, rural prefectures in Hokuriku and Tokai regions, such as Toyama, Ishikawa, Fukui, Shizuoka, and Mie, show that 80–90% of new graduates seek jobs inside their prefectures.

[Figure 4]

The minimum wages outside the prefecture of residence are constructed as a weighted average based on the choice probability. The weights are constructed from the matched job flows of new high school graduates. The School Basic Survey (MEXT) is conducted every year in Japan, including kindergartens, elementary schools, junior high schools, high schools, junior colleges, and universities. This survey provides the basic statistical data on the numbers of students and teachers, the future path after graduation, and job searches. This study uses the matched job flows of new high school graduates between prefectures, provided as an OD

---

[9] Yamagishi (2021) shows that minimum wage hikes lead to higher rents. Although the cost-of-living is fixed in our counterfactual evaluation, the uniform minimum wage policy could affect the cost-of-living. However, our evaluation is based on the subjective aspect in terms of whether new high school graduates can predict the increase in cost-of-living by the minimum wage hikes.

[10] There is an employment practice for new high school graduates seeking jobs in Japan, under which the schedule is controlled for some authorities concerned, such as the Ministry of Health, Labour, and Welfare, the Ministry of Education, Culture, Sports, Science and Technology, the National Association of Upper Secondary School Principals, and major business associations. Generally, the recruiting process between new high school graduates and firms starts in September of the academic year. According to the Survey on Job Search (Offer) of New High School Graduates, more than half of them get job offers until the end of October.

matrix each year. The OD matrix between prefectures is used to construct the matrix of the choice probability.

Figure 5 shows the OD matrix of matched job flows for male and female graduates in 2007. Note that the diagonal elements are set to zero. First, new high school graduates seeking jobs in rural prefectures tend to find employment in urban prefectures like Tokyo, Aichi, and Osaka. New graduates are likely to search for jobs in urban prefectures near their prefectures of residence. For example, new graduates in the Tohoku region are mainly employed in Tokyo, not in Osaka. Conversely, new graduates in the Kansai, Chugoku, and Shikoku regions typically find employment in Osaka. Therefore, the migration distance also affects the location choice of new high school graduates.

[Figure 5]

This study uses minimum wage data from 47 prefectures publicly available from the Ministry of Health, Labour, and Welfare (MHLW). The minimum wages of 47 prefectures are published around October in each year. The minimum wage unit has been hourly since 2002, whereas the unit was mainly daily before 2002. Therefore, the study period is from 2002 until 2019.

Figure 6 shows the spatial distribution of the relative minimum wage. Based on Equation (13), the nominal wages outside the residential prefectures are calculated as weighted averages of the minimum wage gap, with the weights of matched job flows between prefectures observed in the previous year. Since four prefectures (Tokyo, Kanagawa, Aichi, and Osaka) include the largest cities in Japan and show higher minimum wages than other prefectures, the ratio of the minimum wages outside and inside prefectures is less than one. Conversely, Aomori, Iwate, Akita, Yamagata, Fukushima, Miyazaki, Kagoshima, and Okinawa prefecture show higher relative minimum wages than one. Okinawa shows the highest value, 1.20, for male graduates, and Aomori shows the highest value, 1.22, for female graduates.

[Figure 6]

The regression analysis also includes some control variables. Unemployment rates at the prefectural level are taken from the open data of the Labor Force Survey (Ministry of Internal Affairs and Communications, MIC). Labor market tightness for new high school graduates is publicly available from the Situation on Job Offers for New Junior High School and High School Graduates (MHLW). The migration data of all residents in Japan is taken from the Annual Report on Internal Migration in Japan Derived from the Basic Resident Registration (MIC).

Table 1 presents the descriptive statistics of variables used in the empirical analysis. This study limits the sample to rural prefectures and focuses on rural-to-urban migration in job search behavior. Therefore, Tokyo, Kanagawa, Aichi, and Osaka are excluded from the sample. This study considers gender differences in job search behavior by dividing the sample into male and female graduates. Compared to female graduates, male graduates tend to seek jobs outside their prefectures of residence.

[Table 1]

Figure 7 shows the correlation between the ratio of new high school graduates seeking jobs outside and inside their prefectures of residence and the ratio of minimum wages in each year of the study period. There is a positive relationship between these two variables, suggesting that relatively low minimum wages in rural prefectures push individuals to seek jobs outside the prefectures. However, the prefectures with higher minimum wages include large cities, which provide high amenities and diversified career options for young workers. These factors are sources of bias in the regression analysis. This study includes prefecture fixed effects to control for unobserved attractive factors of urban areas. Furthermore, we use the Bartik-like instruments to control for the endogeneity of the location choice problem.

[Figure 7]

5. Estimation Results

5.1. Migration Incentive for Minimum Wage Hikes

Table 2 presents the baseline estimation results by OLS with and without control variables. Because our interests are in the time-varying coefficients of the ratio of minimum wages, we present them graphically. Figure 8 shows the OLS coefficient estimates for male and female graduates, which are significantly positive at the 5% level throughout the period (except 2003 and 2004 for males) when the control variables are excluded. Increasing the real minimum wage by 1 percentage point increases the migration incentive by around 10 percentage points, and the magnitude is larger for female graduates than male graduates. However, these OLS estimates can be biased because we do not control for the unobserved labor market and fixed locational factors.

In Panel (b) of Figure 8, the OLS coefficient estimates' magnitudes decrease for males and females when the control variables are included. This drop results from the labor market tightness because job shortages in rural prefectures mainly motivate new high school graduates to seek jobs outside their prefectures of residence. Moreover, the coefficient estimates for males become insignificant, suggesting that labor market factors other than wages influence migration incentives in seeking jobs.

Table 3 presents estimation results of fixed-effect methods with and without the control variables, and Figure 9 shows the time-varying coefficient estimates graphically. Unlike the OLS estimation results in Panel (b) of Figure 8, the fixed-effect coefficient estimates for male graduates are significant at the 5% level and positive in 2006, 2008, 2009, 2010, 2012, 2013, and 2016, shown in Panel (b) of Figure 9. Conversely, the fixed-effect coefficient estimates for female graduates are insignificant at the 5% level across the entire period. There is a suggested association between lower fixed-effect estimates and the within transformation because the spatial gaps in minimum wages did not vary over the years, except the moratorium period following the 2007 amendment of the Minimum Wage Act. Although the fixed-effect estimation can control for unobserved prefecture effects, the within transformation simultaneously annihilates informative variations in this variable.

[Table 2, Table 3, Figure 8, and Figure 9]

Table 4 presents the IV estimation results using our Bartik-like instruments, from which Figure 10 visually depicts the time-varying coefficients of spatial percentage changes in minimum wages. The overidentification tests are passed at the 10% level.

The coefficient estimates for male and female graduates are significantly positive at the 5% level between 2007 and 2009. In Columns (2) and (4) of Table 4**,** the averaged estimates between 2007 and 2009 are 5.53 for male graduates and 5.04 for female graduates, suggesting that male graduates are more sensitive than female graduates to the spatial gaps in minimum wages.

According to the estimation results, our findings suggest that spatial gaps in minimum wages motivate new high school graduates to seek jobs outside their regions of residence. Additionally, increasing gaps by 1 percentage point in real minimum wages between outside and inside the prefecture of residence changes the ratio of new high school graduates searching for jobs outside and inside their region by approximately 6–7 percentage points.

[Table 4 and Figure 10]

5.2. Counterfactual Results

Figure 11 shows the counterfactual evaluation of the uniform minimum wage policy. A recent policy debate in Japan indicates that the minimum wage should be uniform between prefectures (Nagatsuma 2016; National Confederation of Trade Unions 2021). This study's counterfactual evaluation quantifies the extent to which new high school graduates switch their job location choices from outside to inside their prefectures in response to the uniform minimum wage setting, based on Equation (21). In the counterfactual evaluation, we use the averaged coefficient estimates of the logarithm of relative minimum wages between 2007 and 2009 in Columns (2) and (4) of Table 4.

Rural prefectures (e.g., 2. Aomori, 3. Iwate, 5. Akita, 39. Kochi, 41. Saga, 42. Nagasaki, 43. Kumamoto, 45. Miyazaki, and 46. Kagoshima) show that 30–40% of new male graduates seeking jobs preferred to work outside their prefectures in 2019 (hollow circle markers). However, uniform minimum wage changes their preferred location to inside their prefectures (solid circle markers). According to counterfactual evaluation, 75–90% of new male graduates in these prefectures seek jobs inside, which means approximately 10–25% of new graduates switch job locations from outside to inside their prefectures.

New female graduates prefer to work inside their prefectures more than new male graduates. In 2019, 20–30% of new female graduates in rural prefectures sought jobs outside their prefectures of residence (hollow circle markers). The counterfactual evaluation of the universal minimum wage policy shows that around 90% of new female graduates searched for jobs inside their prefectures (solid circle markers).

Our IV point estimates are almost half of the OLS point estimates without controls. The simple OLS correlation analysis overestimates the shares of new graduates who prefer jobs inside their prefecture under the uniform minimum wage setting (solid triangle markers). Importantly, our counterfactual evaluation shows that approximately 10–25% of new graduates seeking jobs still look outside their prefectures under the uniform minimum wage setting, suggesting that urban amenity and non-wage factors also help explain spatial job search behavior of new high school graduates.

[Figure 11]

6. Concluding Remarks

This study investigated how spatial gaps in real minimum wages affect the spatial job search of new high school graduates in Japan. One novelty of this study is exploiting differential exposure to exogenous shocks to identify the causal effect of spatial gaps in minimum wages. This study discussed that the IV method for the endogenous spatial weight matrix correspond to the Bartik-like instruments.

The findings indicate that spatial gaps in real minimum wages partially motivate new high school graduates to seek jobs outside their regions of residence. Using the IV estimates, we conducted a counterfactual analysis for uniform minimum wage policy. This evaluation showed that approximately 10–25% of new graduates in rural prefectures with low minimum wages still seek jobs outside their prefectures, even if rural prefectures offer higher real minimum wages than urban prefectures. These findings suggest that great labor demand, local amenity, and non-wage factors in major metropolitan areas are also crucial in explaining new high school graduates' spatial job search behavior.

This study includes important policy implications for minimum wage setting. There is an increasing policy debate that higher minimum wages in urban prefectures lead to excess outflows of young workers from rural prefectures. However, the simple correlation analysis between outmigration and minimum wages overestimates the impact of interregional differences in minimum wages because urban prefectures include high amenities and diversified jobs for young workers, which are not available in rural prefectures. Therefore, there is room for discussion regarding the uniform minimum wage policy and its impact on local labor markets. Moreover, the spatial job search within prefectures should be considered. In Japan, minimum wages are determined at the prefecture level to compensate for different living costs. However, it is difficult to measure the cost of living at the prefecture level because there is significant heterogeneity within each prefecture, making it difficult to set the optimal minimum wages in terms of real wage equalization. Underestimating or overestimating spatial gaps in real minimum wages can distort local economic activities.

Finally, this study has some limitations. This study focused only on the labor supply side of young workers and did not consider the long-run equilibrium outcome in each local labor market regarding the minimum wage policy. For example, a uniform minimum wage policy would also affect the labor demand side. Even if young workers seek jobs inside their prefectures, they may face fierce competition in local labor markets with decreasing labor demand. A spatial job search model based on the general equilibrium framework is also needed to evaluate a uniform minimum wage policy. Additionally, this study did not consider how spatial gaps in the real minimum wage affect other age groups' migration decisions, such as new university graduates and married people. For example, married people's migration decisions become more complicated, and the magnitude of spatial gaps in real minimum wages may be small because their migration costs are relatively high. Understanding their migration incentives for minimum wage hikes requires further investigation.

References

Abe, Yukiko. 2011. "Minimum Wage and Employment in Japan." *Japan Labor Review* 8(2): 42–54.

Abe, Yukiko and Keiko Tamada. 2007. "On the Regional Differences in Minimum Wages and Welfare Benefits in Japan." *Japanese Journal of Labour Studies* 563: 31–47.

Adão, Rodrigo, Michal Kolesár, and Eduardo Morales. 2019. "Shift-Share Designs: Theory and Inference." *Quarterly Journal of Economics* 134(4): 1949–2010. https://doi.org/10.1093/qje/qjz025

Allegretto, Sylvia A., Arindrajit Dube, and Michael Reich. 2011. "Do Minimum Wages Really Reduce Teen Employment? Accounting for Heterogeneity and Selectivity in State Panel Data." *Industrial Relations* 50(2): 205–240. https://doi.org/10.1111/j.1468-232X.2011.00634.x

Autor, David H., David Dorn, and Gordon H. Hanson. 2013. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." *American Economic Review* 103(6): 2121–2168. https://doi.org/10.1257/aer.103.6.2121

Bartik, Timothy J. 1991. *Who Benefits from State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research. https://www.jstor.org/stable/j.ctvh4zh1q

Boeri, Tito. 2012. "Setting the Minimum Wage." *Labour Economics* 19(3): 281–290.

http://dx.doi.org/10.1016/j.labeco.2012.01.001

Borusyak, Kirill, Peter Hull, and Xavier Jaravel. 2022. "Quasi-Experimental Shift-Share Research Designs." *Review of Economic Studies* 89(1): 181–213. https://doi.org/10.1093/restud/rdab030

Brown, Charles. 1999. "Minimum Wages, Employment, and the Distribution of Income." In Orley C. Ashenfelter and David Card, eds. *Handbook of Labor Economics* 3(B). Amsterdam: Elsevier, 2101–2163. https://doi.org/10.1016/S1573-4463(99)30018-3

Cadena, Brian C. 2014. "Recent Immigrants as Labor Market Arbitrageurs: Evidence from the Minimum Wage." *Journal of Urban Economics* 80: 1–12. http://dx.doi.org/10.1016/j.jue.2013.10.002

Card, David. 2009. "Immigration and Inequality." *American Economic Review* 99(2): 1–21. https://doi.org/10.1257/aer.99.2.1

Card, David, and Alan Krueger. 1994. "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania." *American Economic Review* 84(4): 772–793. https://www.jstor.org/stable/2118030

Diamond, Rebecca. 2016. "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000." *American Economic Review* 106(3): 479–524. https://doi.org/10.1257/aer.20131706

Dube, Arindrajit, T. William Lester, and Michael Reich. 2010. "Minimum Wage Effects across State Borders: Estimates Using Contiguous Counties." *Review of Economics and Statistics* 92(4): 945–964.

Falk, Armin, Ernst Fehr, and Christian Zehnder. 2006. "Fairness Perceptions and Reservation Wages: The Behavioral Effects of Minimum Wage Laws." *Quarterly Journal of Economics* 121(4): 1347–1381. https://doi.org/10.1093/qje/121.4.1347

Fehr, Ernst, Lorenz Goette, and Christian Zehnder. 2009. "A Behavioral Account of the Labor Market: The Role of Fairness Concerns." *Annual Review of Economics* 1(1): 355–384. https://doi.org/10.1146/annurev.economics.050708.143217

Flinn, Christopher J. 2006. "Minimum Wage Effects on Labor Market Outcomes under Search, Matching, and Endogenous Contact Rates." *Econometrica* 74(4): 1013–1062. https://doi.org/10.1111/j.1468-0262.2006.00693.x

Fujita, Masahisa, Paul Krugman, and Anthony J. Venables. 1999. *The Spatial Economy: Cities, Regions, and International Trade*. Cambridge, MA: MIT Press. https://doi.org/10.7551/mitpress/6389.001.0001

Glaeser, Edward L., Jed Kolko, and Albert Saiz. 2001. "Consumer City." *Journal of Economic Geography* 1(1): 27–50. https://doi.org/10.1093/jeg/1.1.27

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift. 2020. "Bartik Instruments: What, When, Why, and How." *American Economic Review* 110(8): 2586–2624. https://doi.org/10.1257/aer.20181047

Gorry, Aspen. 2013. “Minimum Wages and Youth Unemployment.” *European Economic Review* 64: 57–75. http://dx.doi.org/10.1016/j.euroecorev.2013.08.004

Handbury, Jessie, and David E. Weinstein. 2015. “Goods Prices and Availability in Cities.” *Review of Economic Studies* 82(1): 258–296. https://doi.org/10.1093/restud/rdu033

Harris, John R, and Michael P Todaro. 1970. “Migration, Unemployment and Development: A Two-Sector Analysis.” *American Economic Review* 60(1): 126–142. https://www.jstor.org/stable/1807860.

Higashi, Yudai. 2018. “Spatial Spillovers in Job Matching: Evidence from the Japanese Local Labor Markets.” *Journal of the Japanese and International Economies* 50: 1–15. https://doi.org/10.1016/j.jjie.2018.06.001

Hojo, Masakazu. 2017. “College Enrollment Decision of New High School Graduates and Minimum Wage.” *Journal of Japan Economic Research* 75: 1–20. https://www.jcer.or.jp/jcer_download_log.php?post_id=53805&file_post_id=53796 (accessed on August 31, 2021)

Hyslop, Dean, and Steven Stillman. 2007. “Youth Minimum Wage Reform and the Labour Market in New Zealand.” *Labour Economics* 14(2): 201–230. https://doi.org/10.1016/j.labeco.2005.10.001

Jaeger, David, Joakim Ruist, and Jan Stuhler. 2018. “Shift-Share Instruments and the Impact of Immigration.” NBER Working Paper No. 24285. https://doi.org/10.3386/w24285

Kambayashi, Ryo, Daiji Kawaguchi, and Ken Yamada. 2013. “Minimum Wage in a Deflationary Economy: The Japanese Experience, 1994-2003.” *Labour Economics* 24: 264–76. http://dx.doi.org/10.1016/j.labeco.2013.09.005

Kawaguchi, Daiji, and Yuko Mori. 2009. “Is Minimum Wage an Effective Anti-Poverty Policy in Japan?” *Pacific Economic Review* 14(4): 532–54. https://doi.org/10.1111/j.1468-0106.2009.00467.x

Kawaguchi, Daiji, and Yuko Mori. 2021. “Estimating the Effects of the Minimum Wage Using the Introduction of Indexation.” *Journal of Economic Behavior and Organization* 184: 388–408. https://doi.org/10.1016/j.jebo.2021.01.032

Kawata, Keisuke, Kentaro Nakajima, and Yasuhiro Sato. 2016. “Multi-region Job Search with Moving Costs.” *Regional Science and Urban Economics* 61: 114–129. https://doi.org/10.1016/j.regsciurbeco.2016.10.002

Kondo, Keisuke. 2019. “Monopolar Concentration in Tokyo and Promotion of Urban-to-Rural Migration.” RIETI Policy Discussion Papers (Japanese) No. 19-P-006.

Manning, Alan. 2021. “The Elusive Employment Effect of the Minimum Wage.” *Journal of Economic Perspectives* 35(1): 3–26. https://doi.org/10.1257/jep.35.1.3

Manning, Alan, and Barbara Petrongolo. 2017. “How Local Are Labor Markets? Evidence from a Spatial

Job Search Model." *American Economic Review* 107(10): 2877–2907. https://doi.org/10.1257/aer.20131026

Martin, D., and A. Termos. 2015. "Does a High Minimum Wage Spur Low-Skilled Emigration?" *Economics Letters* 137: 200–202. https://doi.org/10.1016/j.econlet.2015.10.027

McKinnish, Terra. 2017. "Cross-State Differences in the Minimum Wage and out-of-State Commuting by Low-Wage Workers." *Regional Science and Urban Economics* 64: 137–147. http://dx.doi.org/10.1016/j.regsciurbeco.2017.02.006

Monras, Joan. 2019. "Minimum Wages and Spatial Equilibrium: Theory and Evidence." *Journal of Labor Economics* 37(3): 853–904. https://doi.org/10.1086/702650

Nakakubo, Hiroya, "A New Departure in the Japanese Minimum Wage Legislation." *Japan Labor Review* 6(2): 22–38. https://www.jil.go.jp/english/JLR/documents/2009/JLR22_nakakubo.pdf (accessed September 20, 2021).

Nagatsuma, Akira. 2016. "Question about Why the Minimum Wage Is Not Uniform." *The House of Representatives, Japan*, February 26, 2016. https://www.shugiin.go.jp/internet/itdb_shitsumon.nsf/html/shitsumon/190137.htm (accessed on September 18, 2021).

National Confederation of Trade Unions. 2021. "Three Points of View for Minimum Wage Increase." http://www.zenroren.gr.jp/jp/english/2021/06/english210621_01.html (accessed on September 18, 2021).

Neumark, David, J. M. Ian Salas, and William Wascher. 2014. "Revisiting the Minimum Wage-Employment Debate: Throwing Out the Baby with the Bathwater?" *ILR Review* 67(3): 608–648. https://doi.org/10.1177%2F00197939140670S307

Neumark, David, and William L. Wascher. 2007. "Minimum Wages and Employment." *Foundations and Trends in Microeconomics* 3(1–2): 1–182. http://dx.doi.org/10.1561/0700000015

Neumark, David, and William L. Wascher. 2008. *Minimum Wages*. Cambridge, MA: MIT Press.

Okudaira, Hiroko, Miho Takizawa, and Kenta Yamanouchi. 2019. "Minimum Wage Effects across Heterogeneous Markets." *Labour Economics* 59: 110–122. https://doi.org/10.1016/j.labeco.2019.03.004

Patacchini, Eleonora, and Yves Zenou. 2007. "Spatial Dependence in Local Unemployment Rates." *Journal of Economic Geography* 7(2): 169–191. https://doi.org/10.1093/jeg/lbm001

Qu, Xi, and Lung-Fei Lee. 2015. "Estimating a Spatial Autoregressive Model with an Endogenous Spatial Weight Matrix." *Journal of Econometrics* 184(2): 209–232. https://doi.org/10.1016/j.jeconom.2014.08.008

Qu, Xi, Lung-Fei Lee, and Chao Yang. 2021. "Estimation of a SAR model with endogenous spatial weights constructed by bilateral variables." *Journal of Econometrics* 221(1): 180–197.

Simon, Andrew, and Matthew Wilson. 2021. "Optimal Minimum Wage Setting in a Federal System." *Journal of Urban Economics* 123: 103336. https://doi.org/10.1016/j.jue.2021.103336

Yamagishi, Atsushi. 2021. "Minimum Wages and Housing Rents: Theory and Evidence." *Regional Science and Urban Economics* 87: 103649. https://doi.org/10.1016/j.regsciurbeco.2021.103649

Acknowledgments

We thank Sato Yasuhiro, Masahito Ambashi, Yuki Hashimoto, Yudai Higashi, Nobuyoshi Kikuchi, Sagiri Kitao, Tomoharu Mori, Masayuki Morikawa, Hiroyuki Motegi, Shinpei Sano, Masaru Sasaki, Takaaki Takahashi, Liu Yang, Atsushi Yamagishi, and participants at the 2021 annual conference of the ARSC, RIETI Discussion Paper Seminar, and Kansai Labor Seminar for their valuable comments and suggestions. Naturally, all remaining errors are our own.

Author contributions

K.K. conceived and planned this study. K.K. designed the mathematical model. K.K. collected and analyzed the data. K.K. produced the figures. N.H. and K.K. interpreted findings and drafted the work.

Funding

This work was supported by JSPS KAKENHI Grant Number 21K01497.

Conflicts of interest

The authors declare no competing interests.

Table 1. Descriptive Statistics

Variables	Mean	S.D.	Min	Max
Dependent variable				
Percentage changes in new high school graduates seeking jobs outside and inside their prefectures (male)	-1.247	0.766	-2.991	0.567
Percentage changes in new high school graduates seeking jobs outside and inside their prefectures (female)	-1.788	0.782	-3.800	0.237
Explanatory variables				
Spatial percentage changes in minimum wages (male)	0.100	0.043	0.008	0.202
Spatial percentage changes in minimum wages (female)	0.100	0.045	0.004	0.212
Spatial percentage changes in unemployment rates (male)	0.121	0.207	-0.758	0.933
Spatial percentage changes in unemployment rates (female)	0.110	0.193	-0.671	0.902
Spatial percentage changes in labor market tightness (male)	0.795	0.471	-0.131	2.554
Spatial percentage changes in labor market tightness (female)	0.780	0.435	-0.136	2.575
Log ratio of out- and in-migration	0.100	0.098	-0.159	0.869
Instrumental variables				
Spatial percentage changes in minimum wage predicted by matched job flows across prefectures in 1984 (male)	0.118	0.054	0.016	0.243
Spatial percentage changes in minimum wage predicted by matched job flows across prefectures in 1984 (female)	0.119	0.050	0.018	0.234
Spatial percentage changes in minimum wage predicted by matched job flows across prefectures in 1992 (male)	0.110	0.044	0.012	0.212
Spatial percentage changes in minimum wage predicted by matched job flows across prefectures in 1992 (female)	0.112	0.048	0.013	0.223

Notes: The number of observations is 733 (= 43 prefectures × 17 years). The variables are expressed in a logarithm. Tokyo, Kanagawa, Aichi, and Osaka are excluded from the sample.

Table 2. Estimation Results by OLS

	Dependent Variable: Log ratio of new high school graduates seeking jobs outside and inside their prefecture of residence			
	Male		Female	
Explanatory Variables	(1)	(2)	(3)	(4)
Spatial percentage changes in minimum wages × 2003	6.379	-2.957	10.384**	6.279
	(4.587)	(3.740)	(4.766)	(4.738)
Spatial percentage changes in minimum wages × 2004	8.043*	-0.808	10.116***	7.542*
	(4.226)	(3.595)	(3.901)	(4.107)
Spatial percentage changes in minimum wages × 2005	10.478**	1.014	11.208***	8.340**
	(4.132)	(3.523)	(4.092)	(3.961)
Spatial percentage changes in minimum wages × 2006	13.269***	1.258	12.354***	6.469**
	(4.406)	(3.755)	(3.515)	(2.997)
Spatial percentage changes in minimum wages × 2007	12.576***	1.114	14.652***	8.168**
	(3.668)	(3.302)	(3.352)	(3.741)
Spatial percentage changes in minimum wages × 2008	11.390***	0.133	15.383***	8.703***
	(3.539)	(3.146)	(2.995)	(2.976)
Spatial percentage changes in minimum wages × 2009	9.940***	1.139	12.844***	7.043***
	(3.245)	(2.641)	(2.616)	(2.691)
Spatial percentage changes in minimum wages × 2010	7.672***	0.731	9.965***	6.003***
	(2.754)	(2.365)	(2.474)	(2.299)
Spatial percentage changes in minimum wages × 2011	7.493**	1.962	8.018**	5.129*
	(3.219)	(2.545)	(3.220)	(2.813)
Spatial percentage changes in minimum wages × 2012	7.040**	1.967	8.833***	6.446**
	(3.060)	(2.561)	(3.018)	(2.717)
Spatial percentage changes in minimum wages × 2013	8.072***	3.274	8.514***	5.785**
	(3.039)	(2.657)	(2.819)	(2.870)
Spatial percentage changes in minimum wages × 2014	7.253**	2.044	9.528***	6.864**
	(3.110)	(2.809)	(2.597)	(2.762)
Spatial percentage changes in minimum wages × 2015	7.736***	2.102	9.783***	7.496**
	(2.991)	(2.604)	(3.009)	(2.951)
Spatial percentage changes in minimum wages × 2016	7.328**	2.172	9.834***	7.660***
	(2.892)	(2.425)	(2.901)	(2.804)
Spatial percentage changes in minimum wages × 2017	7.013**	1.693	8.343***	6.647**
	(3.147)	(2.585)	(3.206)	(2.998)
Spatial percentage changes in minimum wages × 2018	6.450**	1.490	6.992**	5.612*
	(2.965)	(2.362)	(3.452)	(3.082)
Spatial percentage changes in minimum wages × 2019	7.337**	2.605	10.375***	8.138***
	(3.334)	(2.498)	(3.361)	(2.975)
Spatial percentage changes in unemployment rates		0.206		-0.220
		(0.371)		(0.452)
Spatial percentage change in labor market tightness		1.031***		1.118***
		(0.156)		(0.214)
Log(Out- and in-migration ratio)		1.305*		0.619
		(0.759)		(0.621)
Log(Multi-distance)		0.516***		0.910***
		(0.199)		(0.254)
Prefecture Fixed Effect	No	No	No	No
Region × Year Effects	Yes	Yes	Yes	Yes
Number of Observations	731	731	731	731
Number of Prefectures	43	43	43	43
Adjusted R^2	0.517	0.699	0.477	0.686

Note: Heteroskedasticity-robust standard errors clustered at the prefecture level are in parentheses. Tokyo, Kanagawa, Aichi, and Osaka are excluded from the sample. Log(Multi-Distance) is the closeness centrality of the distance matrix.

Table 3. Estimation Results by Fixed Effect

	Dependent Variable: Log ratio of new high school graduates seeking jobs outside and inside their prefecture of residence			
	Male		Female	
Explanatory Variables	(1)	(2)	(3)	(4)
Spatial percentage changes in minimum wages × 2003	1.828	1.759	-1.199	-1.202
	(3.018)	(2.835)	(2.742)	(2.458)
Spatial percentage changes in minimum wages × 2004	2.933	2.919	-0.208	0.062
	(2.996)	(2.779)	(2.153)	(1.992)
Spatial percentage changes in minimum wages × 2005	4.691*	4.258*	1.173	1.115
	(2.550)	(2.344)	(2.064)	(1.860)
Spatial percentage changes in minimum wages × 2006	6.207**	4.985**	-0.319	-1.500
	(2.736)	(2.421)	(2.906)	(2.550)
Spatial percentage changes in minimum wages × 2007	5.155**	3.624*	2.828	1.179
	(2.397)	(2.092)	(1.960)	(1.644)
Spatial percentage changes in minimum wages × 2008	5.629***	4.091**	4.117**	2.388*
	(2.020)	(1.838)	(1.826)	(1.436)
Spatial percentage changes in minimum wages × 2009	4.660***	3.813**	2.777*	1.653
	(1.762)	(1.623)	(1.485)	(1.209)
Spatial percentage changes in minimum wages × 2010	3.363**	2.990**	1.755	1.286
	(1.431)	(1.353)	(1.231)	(1.046)
Spatial percentage changes in minimum wages × 2011	3.055*	3.077*	-0.143	-0.074
	(1.728)	(1.580)	(1.544)	(1.469)
Spatial percentage changes in minimum wages × 2012	3.001**	3.261**	-0.370	-0.115
	(1.489)	(1.482)	(1.151)	(1.253)
Spatial percentage changes in minimum wages × 2013	3.698**	4.069**	-0.192	0.243
	(1.616)	(1.707)	(1.473)	(1.513)
Spatial percentage changes in minimum wages × 2014	2.753*	3.040*	0.662	1.081
	(1.477)	(1.685)	(1.457)	(1.609)
Spatial percentage changes in minimum wages × 2015	2.635*	2.805*	0.310	0.632
	(1.465)	(1.523)	(1.352)	(1.422)
Spatial percentage changes in minimum wages × 2016	2.945*	3.350**	0.030	0.707
	(1.519)	(1.616)	(1.561)	(1.574)
Spatial percentage changes in minimum wages × 2017	2.840	3.392*	0.036	0.646
	(1.752)	(1.909)	(1.418)	(1.450)
Spatial percentage changes in minimum wages × 2018	2.060	2.523	-1.509	-0.780
	(1.737)	(1.848)	(1.459)	(1.559)
Spatial percentage changes in minimum wages × 2019	3.037	3.381*	-0.098	0.549
	(1.962)	(1.976)	(1.683)	(1.623)
Spatial percentage changes in unemployment rates		-0.276**		-0.276*
		(0.138)		(0.151)
Spatial percentage change in labor market tightness		0.295***		0.524***
		(0.110)		(0.129)
Log(Out- and in-migration ratio)		0.287		0.308
		(0.217)		(0.247)
Prefecture Fixed Effect	Yes	Yes	Yes	Yes
Region × Year Effects	Yes	Yes	Yes	Yes
Number of Observations	731	731	731	731
Number of Prefectures	43	43	43	43
Within R^2	0.410	0.462	0.585	0.635

Note: Heteroskedasticity-robust standard errors clustered at the prefecture level are in parentheses. Tokyo, Kanagawa, Aichi, and Osaka are excluded from the sample.

Table 4. IV Fixed-Effect Estimation Results by the Bartik-like Instruments

	Dependent Variable: Log ratio of new high school graduates seeking jobs outside and inside their prefecture of residence			
	Male		Female	
Explanatory Variables	(1)	(2)	(3)	(4)
Spatial percentage changes in minimum wages × 2003	3.227	3.540	2.685	2.363
	(3.669)	(3.421)	(3.670)	(3.460)
Spatial percentage changes in minimum wages × 2004	4.527	4.960	3.594	3.535
	(3.755)	(3.482)	(3.359)	(3.142)
Spatial percentage changes in minimum wages × 2005	6.185*	6.108*	5.170	4.620
	(3.335)	(3.144)	(3.374)	(3.039)
Spatial percentage changes in minimum wages × 2006	7.719**	6.762**	4.214	2.507
	(3.548)	(3.297)	(3.533)	(3.070)
Spatial percentage changes in minimum wages × 2007	6.781**	5.471*	6.530**	4.534*
	(3.270)	(3.040)	(2.980)	(2.564)
Spatial percentage changes in minimum wages × 2008	7.382**	5.945**	7.030***	5.093**
	(2.879)	(2.744)	(2.623)	(2.193)
Spatial percentage changes in minimum wages × 2009	5.888**	5.172**	5.911**	4.595**
	(2.453)	(2.287)	(2.426)	(2.114)
Spatial percentage changes in minimum wages × 2010	4.671**	4.441**	4.887**	4.107**
	(2.240)	(2.110)	(2.210)	(1.964)
Spatial percentage changes in minimum wages × 2011	4.218*	4.375*	3.506	3.193
	(2.480)	(2.335)	(2.371)	(2.274)
Spatial percentage changes in minimum wages × 2012	4.107*	4.573*	2.552	2.535
	(2.427)	(2.403)	(2.186)	(2.239)
Spatial percentage changes in minimum wages × 2013	4.891**	5.582**	2.398	2.699
	(2.301)	(2.320)	(2.189)	(2.265)
Spatial percentage changes in minimum wages × 2014	4.127*	4.795*	3.590	3.843
	(2.349)	(2.486)	(2.373)	(2.469)
Spatial percentage changes in minimum wages × 2015	3.810	4.315*	3.016	3.067
	(2.484)	(2.519)	(2.593)	(2.747)
Spatial percentage changes in minimum wages × 2016	4.012*	4.780**	2.610	2.952
	(2.336)	(2.379)	(2.453)	(2.550)
Spatial percentage changes in minimum wages × 2017	4.509	5.420*	3.151	3.518
	(2.886)	(2.937)	(2.284)	(2.430)
Spatial percentage changes in minimum wages × 2018	3.932	4.792	1.745	2.183
	(2.945)	(3.006)	(2.438)	(2.619)
Spatial percentage changes in minimum wages × 2019	4.850	5.421*	3.178	3.374
	(3.198)	(3.218)	(2.588)	(2.613)
Spatial percentage changes in unemployment rates		-0.298**		-0.278*
		(0.136)		(0.162)
Spatial percentage change in labor market tightness		0.315***		0.528***
		(0.109)		(0.118)
Log(Out- and in-migration ratio)		0.233		0.300
		(0.229)		(0.243)
Prefecture Fixed Effect	Yes	Yes	Yes	Yes
Region × Year Effects	Yes	Yes	Yes	Yes
Number of Observations	731	731	731	731
Number of Prefectures	43	43	43	43
Overidentification Test (p-value)	0.881	0.908	0.184	0.272
First-Stage F-value	13.584	13.164	11.102	11.047

Note: Heteroskedasticity-robust standard errors clustered at the prefecture level are in parentheses. Tokyo, Kanagawa, Aichi, and Osaka are excluded from the sample. Instruments for spatial changes in minimum wages include the two variables of $B_{it}(m_{ij,1984})$ and $B_{it}(m_{ij,1992})$ interacted with year dummies. Tests for overidentification and weak instruments are conducted under the assumption of homoskedasticity in error terms.

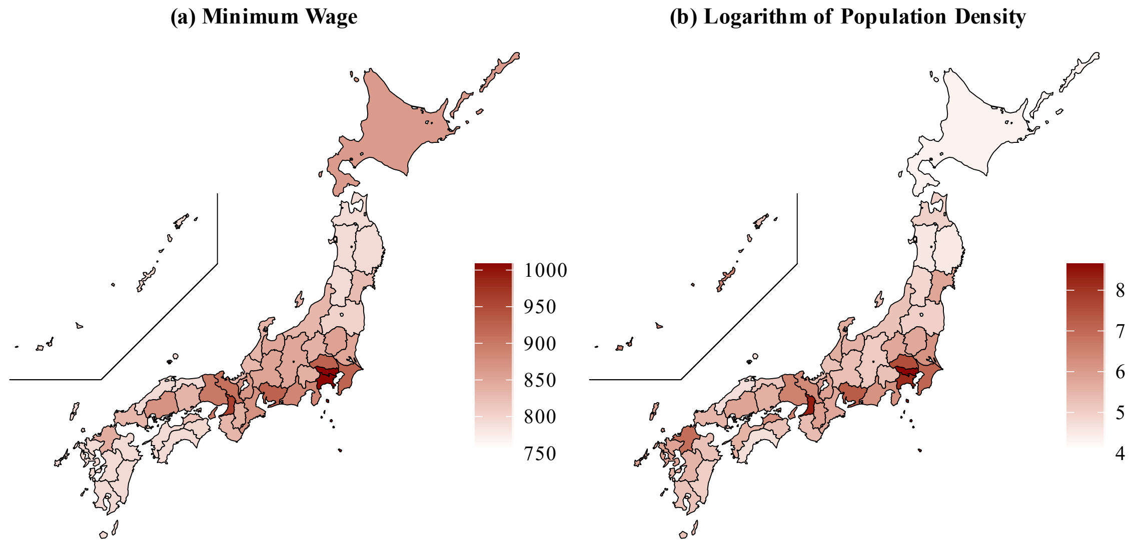


Figure 1. Minimum Wages and Population Density by Prefecture

Note: Authors' creation based on the minimum wages of 47 prefectures (Ministry of Health, Labour and Welfare). The minimum wage in October 2019 is shown in Panel (a). The population density is calculated as the total population and area ratio, which is provided in the 2015 population census.

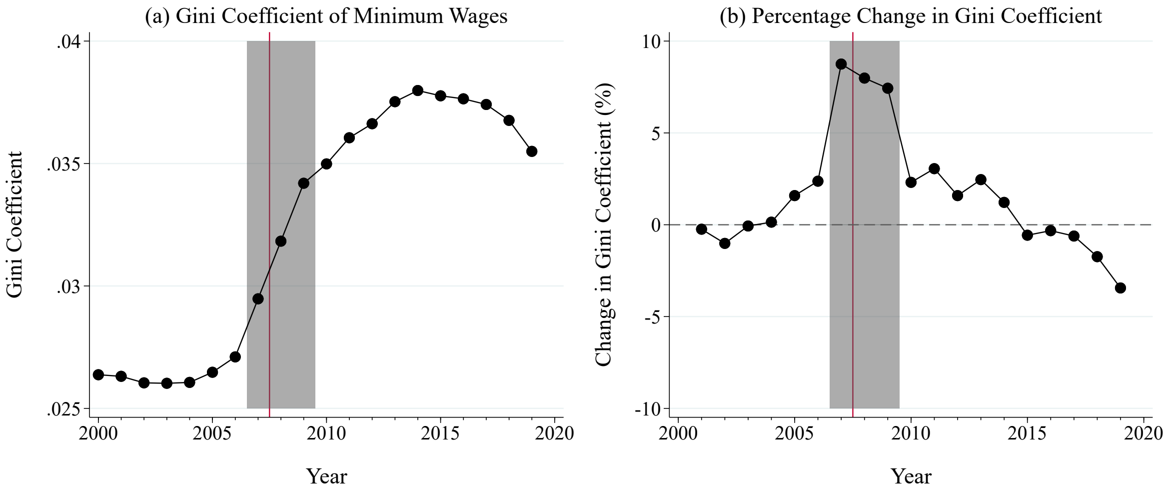


Figure 2. The Trend of Gini Coefficient of Minimum Wages between Prefectures

Note: The authors' calculation is based on the minimum wages of 47 prefectures (MHLW). The vertical line indicates the 2007 amendment of the Minimum Wage Act, which came into effect on July 1, 2008. Note that the Gini coefficient of prefectural minimum wages shows a sharp rise before the 2007 amendment. This study focuses on spatial variation in minimum wages from 2007 to 2009.

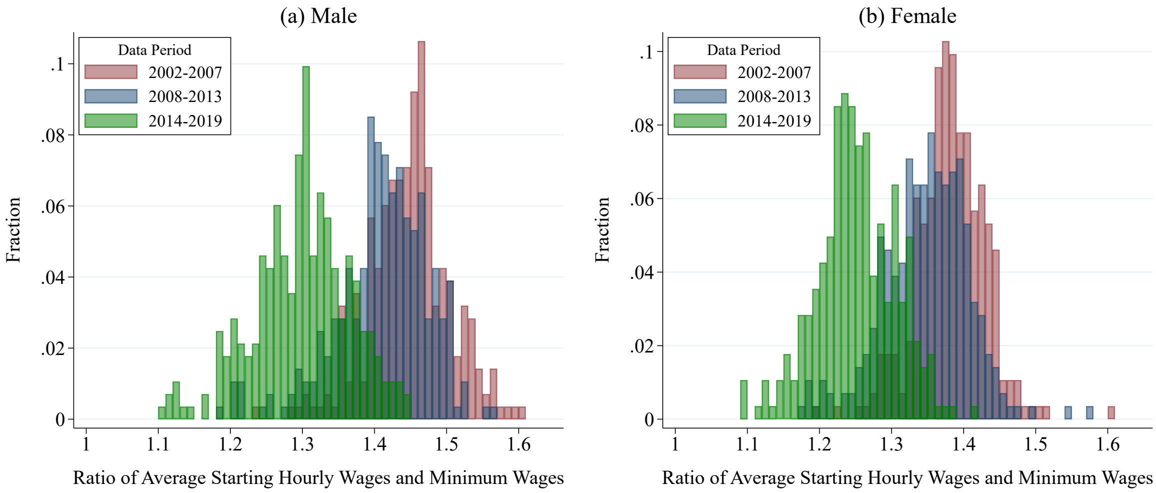


Figure 3. Distribution of Ratio of Average Starting Hourly Wages for New High School Graduates and Minimum Wages

Note: Authors' creation based on the Basic Survey on Wage Structure (Starting salary) and Monthly Labour Survey (Ministry of Health, Labour and Welfare) data. Average starting hourly wages are calculated by the ratio of average scheduled cash earnings and average scheduled hours in June of each year.

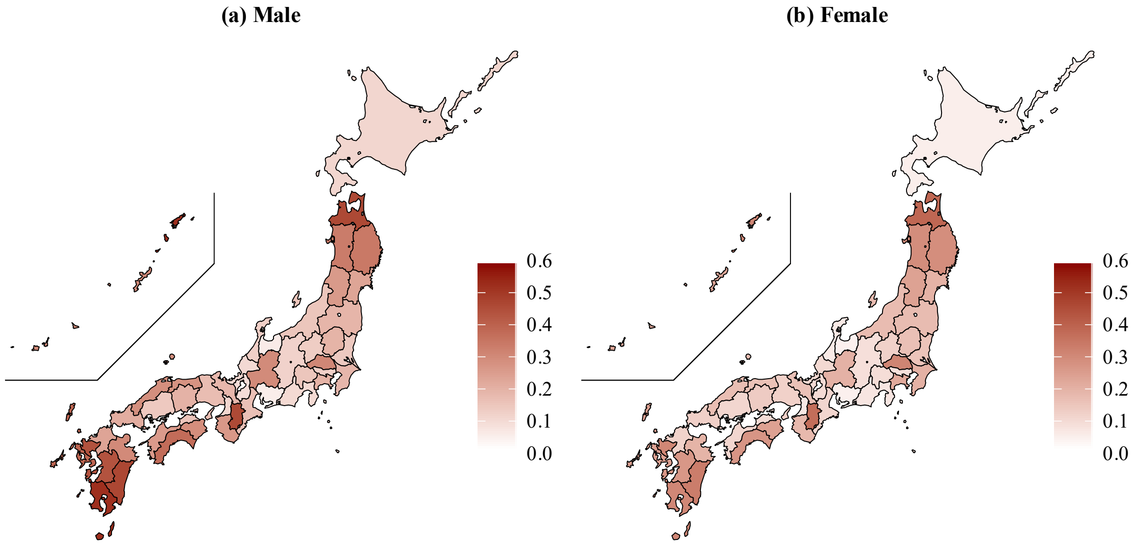


Figure 4. The Ratio of New High School Graduates Seeking Jobs Outside and Inside Their Prefectures of Residence in 2019

Note: Authors' creation based on the Survey on Job Search of New High School Graduates (Ministry of Education, Culture, Sports, Science and Technology) data.

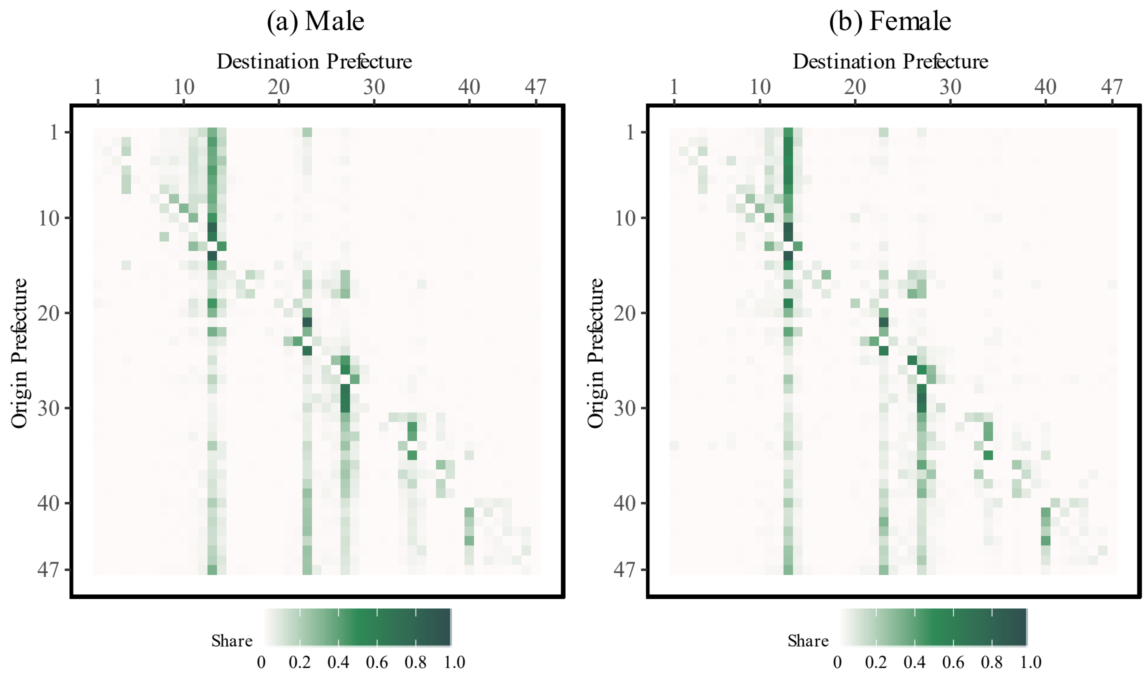


Figure 5. Origin–Destination Matrix of Matched Job Flows in FY2007

Note: Authors' creation based on the data from the School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology). The sum of elements in each row is equal to one. The diagonal elements in this figure are set to zero. The number of vertical and horizontal axes indicates the prefecture code.

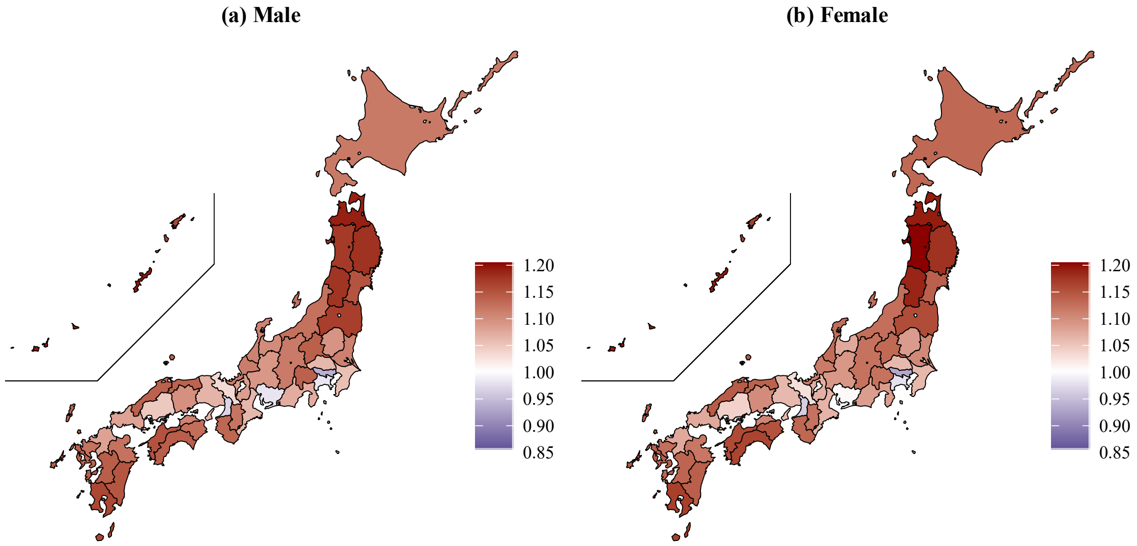
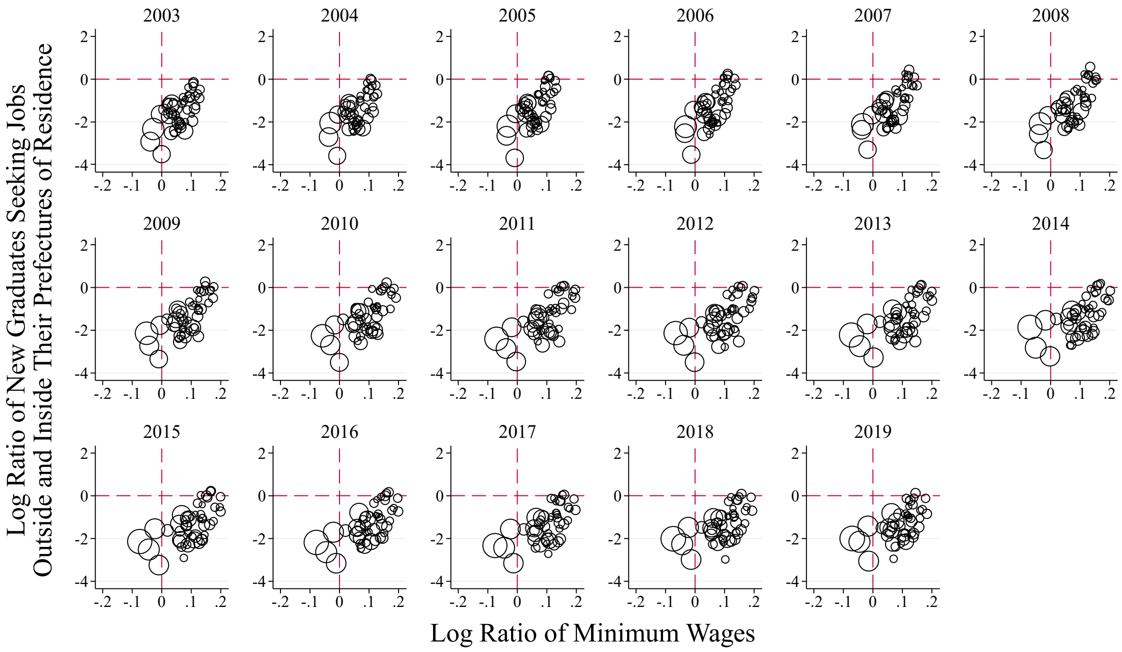


Figure 6. The Ratio of Minimum Wages between Outside and Inside Prefectures of Residence in 2019

Note: Authors' creation based on the minimum wages of 47 prefectures (Ministry of Health, Labour and Welfare).

(a) Male



(b) Female

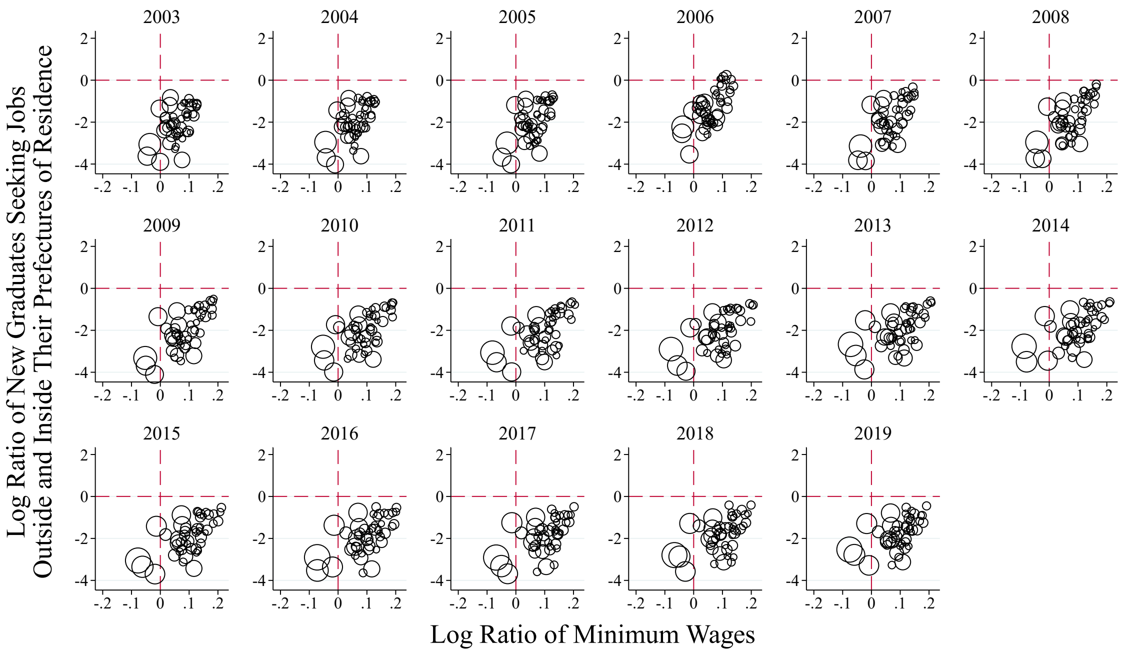
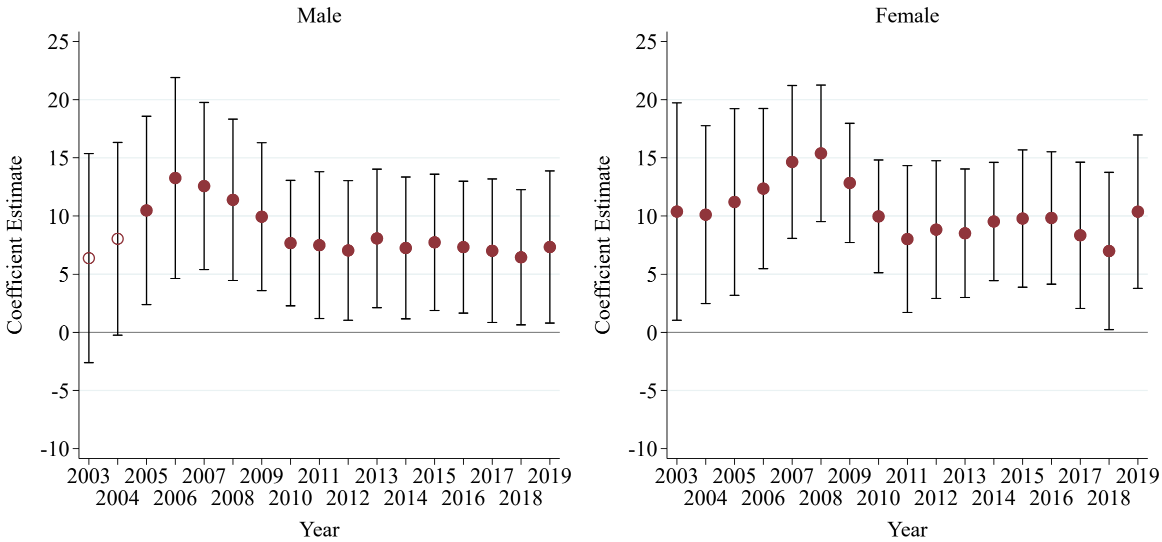


Figure 7. Correlation between Ratio of Job Seekers and Ratio of Minimum Wages

Note: The logarithm is taken in both axes.

(a) Without controls



(b) With controls

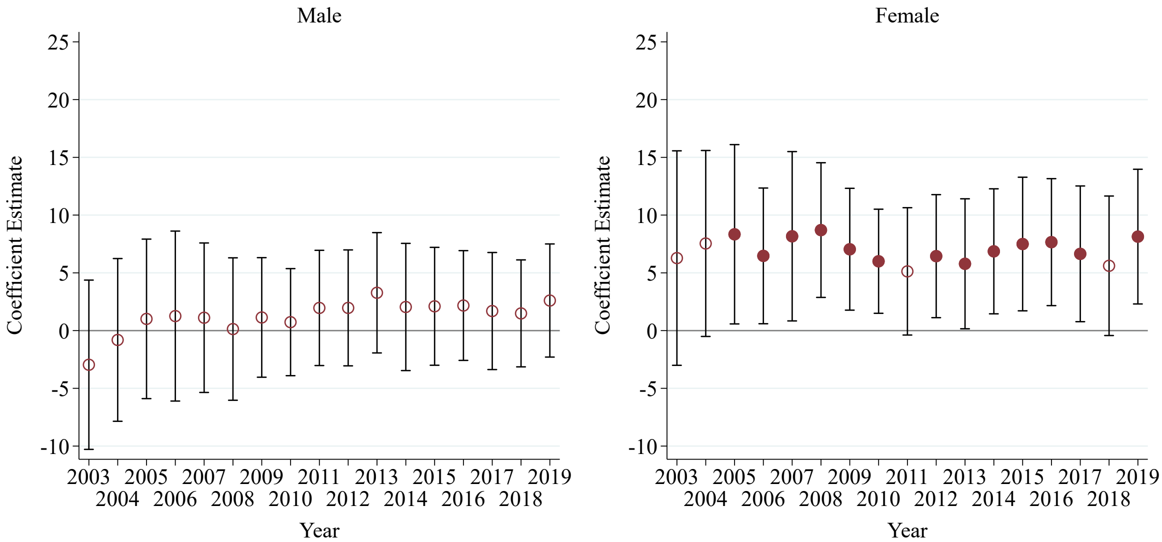


Figure 8. OLS Estimation Results

Note: The coefficient estimates of spatial percentage changes in minimum wages in Table 2 are plotted. The solid circle marker indicates statistical significance at the 5% level, and the hollow circle marker does not. The lines represent the 95% confidence intervals.

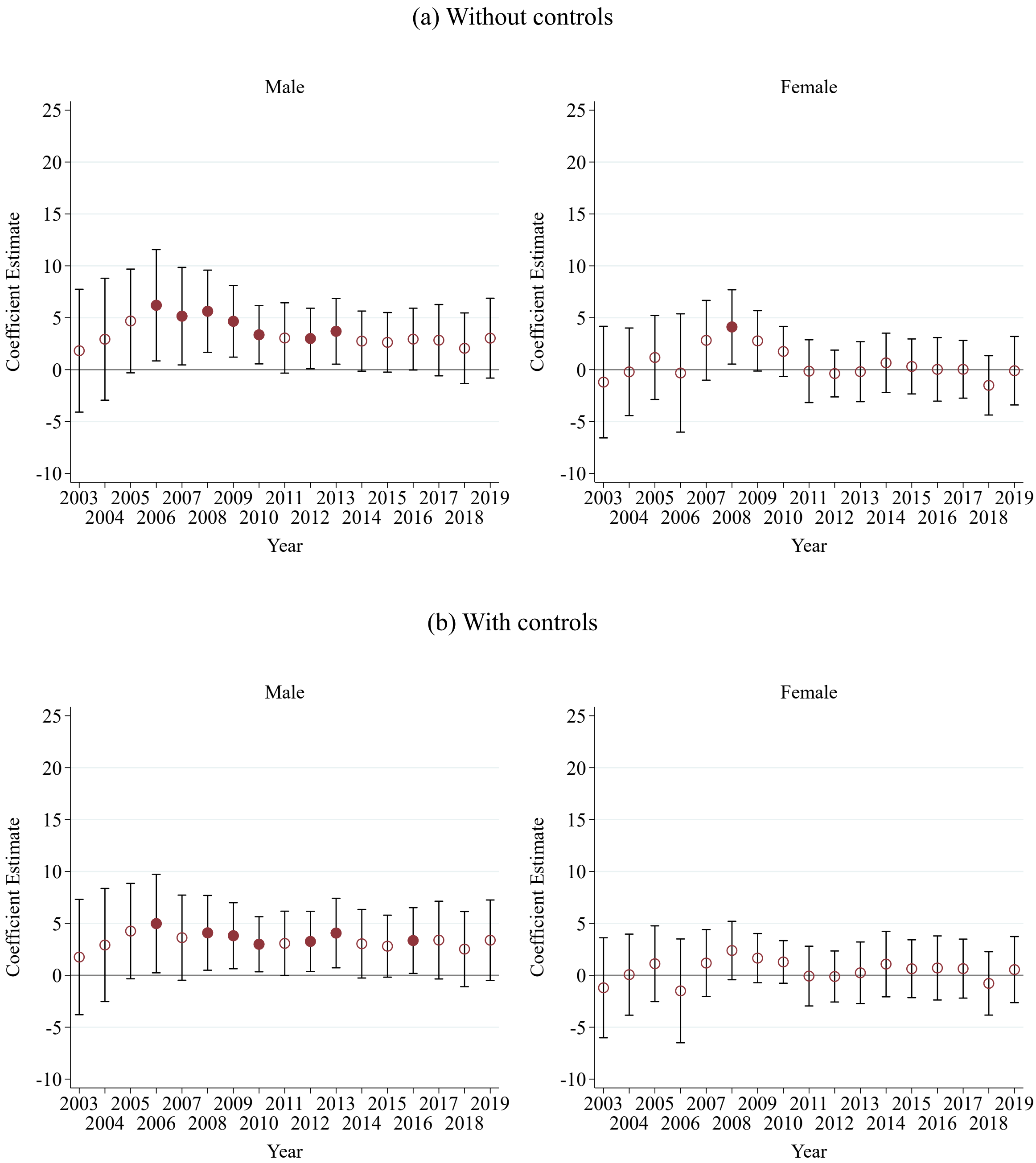


Figure 9. Fixed-Effect Estimation Results

Note: The coefficient estimates of spatial percentage changes in minimum wages in Table 3 are plotted. The solid circle marker indicates statistical significance at the 5% level, and the hollow circle marker does not. The lines represent the 95% confidence intervals.

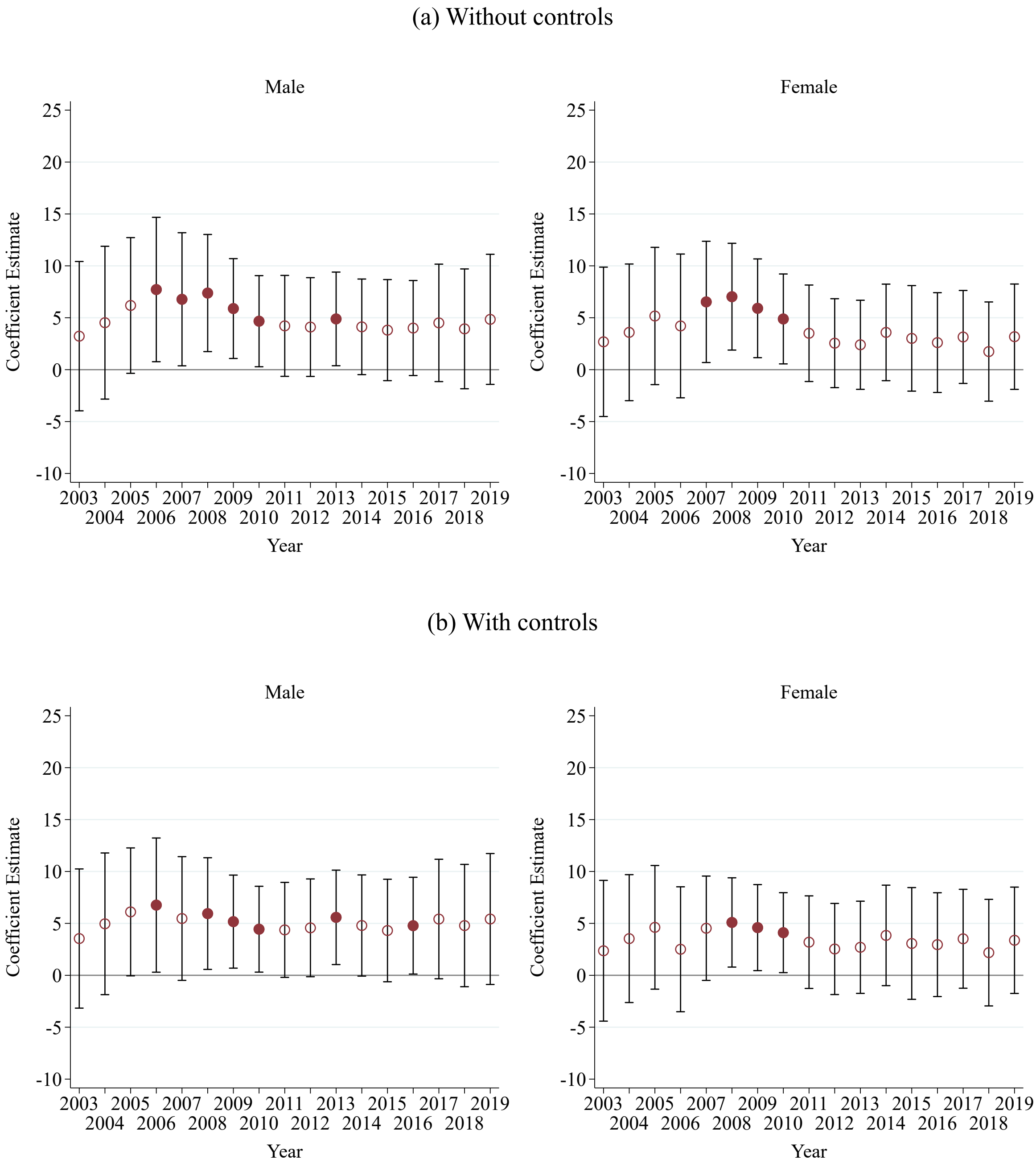


Figure 10. IV Fixed-Effect Estimation Results

Note: The coefficient estimates of spatial percentage changes in minimum wages in Table 4 are plotted. The solid circle marker indicates statistical significance at the 5% level, and the hollow circle marker does not. The lines represent the 95% confidence intervals.

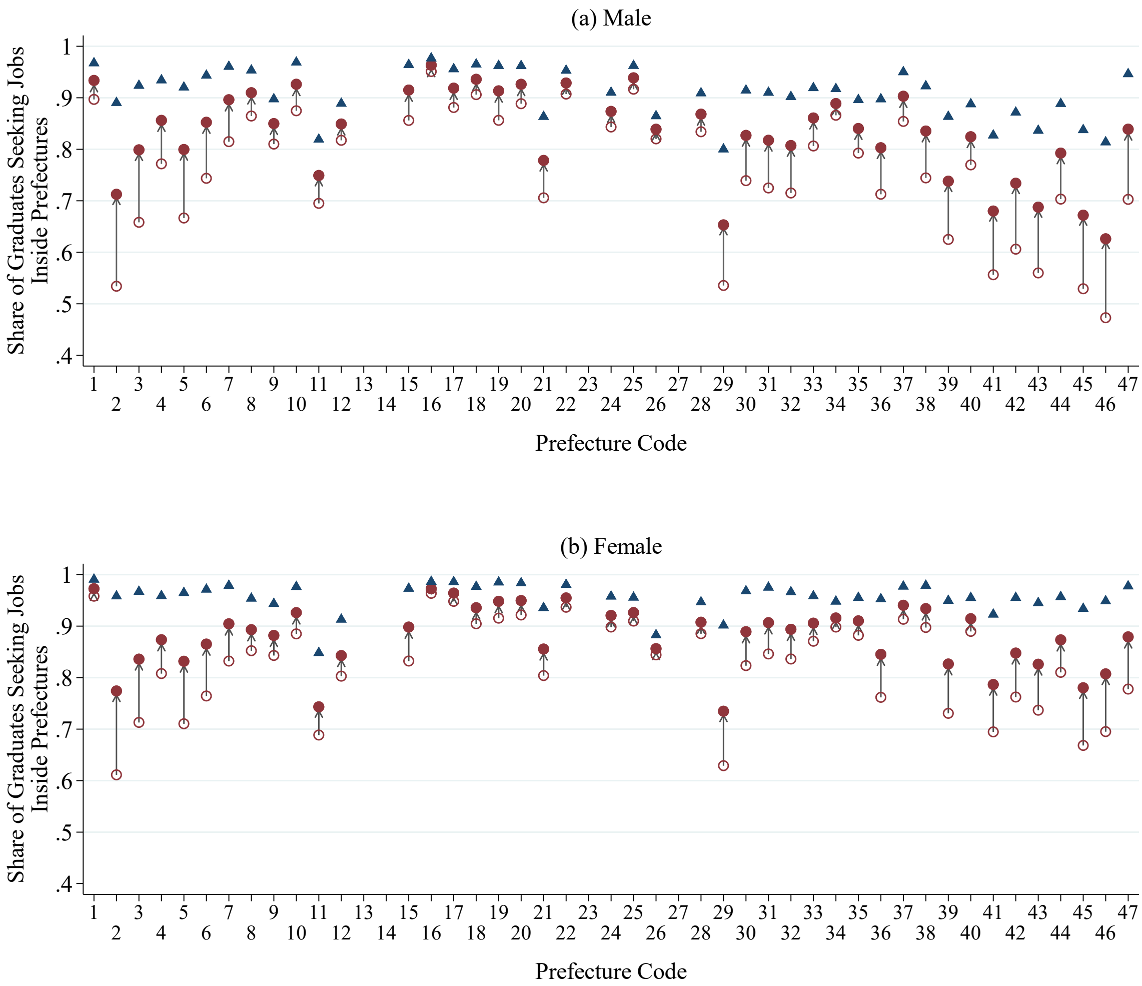


Figure 11. Counterfactual Evaluation for Uniform Minimum Wage Policy

Note: Authors' creation based on Equation (21). In the counterfactual evaluation, the averaged coefficient estimates of the logarithm of relative minimum wages between 2007 and 2009 in Columns (2) and (4) of Table 4 are used for circle markers. For comparison, the averaged OLS coefficient estimates of the logarithm of relative minimum wages between 2007 and 2009 in Columns (1) and (3) of Table 2 are used for triangle markers.