# The Effects of Public Sector Wages: A Local Labor Market Approach*

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**Abstract**

We study how public sector wages affect the local economic outcomes, especially private sector wages and population. For identification, we combine Japanese national policy reform that exogenously cut the public sector wages in some areas, and the institutional setting in which young workers are primarily affected by the public sector in the labor market. We find that 1% decrease in the public sector wages reduces the wages of young workers by 0.34% and the young population by 0.41%. Moreover, these declines are even larger in areas with a larger share of public sector workers. These results imply that decreasing public sector wages harms young workers' welfare in light of a simple spatial economic model.

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*Keywords*: public sector wages, spillover, quasi-experiment, spatial equilibrium, Japan.

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# 1 Introduction

The public sector is a sizable employer in the economy. Among the OECD countries, the average employment share of the public sector is 18% and the compensation of public employees accounts for, on average, 23% of the total government expenditure (OECD 2021). The public sector wage has also been used as an important policy tool to achieve various objectives, such gaining votes in the US federal elections (Borjas 1984) and achieving fiscal consolidation after the Global Financial Crisis (Forni and Novta 2014). At the same time, the large size of the public sector implies that it may also have a substantial impact on private economic activities, which should be taken into account in assessing the impact of public sector wage reforms. Therefore, understanding how public sector wages affect private economic outcomes is indispensable in considering the desirable level of public sector wages.

This paper evaluates the causal effects of public sector wage cuts on local economic outcomes, especially private sector wages and population. A key empirical challenge for identifying the effects of public sector wages is the endogeneity concern that the public sector wage may be determined in reference to local economic conditions (e.g., wages) in the private sector, inducing the reverse causality. We overcome this by combining a Japanese quasi-experimental variation in the public sector wages across local labor markets and the institutional setting in which the private labor market for young workers, defined as workers under the age of 30, is primarily affected by the public sector. We find that 1% public sector wage cut reduces the private wages of young workers by 0.34%. Although the public sector wage decrease is suggestive of young workers' welfare loss, it may also affect the welfare through other channels such as the quality of public goods and job amenities. To address this possibility, we analyze the effects on the population of young workers, which serve as sufficient statistics for qualitative welfare implications in our simple spatial equilibrium model. We find that 1% of the public sector wage cut reduces the young workers' population by about 0.41%. The decline in population suggests that the public wage hike improves young workers' welfare. Moreover, our heterogeneity analysis reveals that the effects on private wages and young population are stronger in areas with a higher share of public sector workers, which confirms that our estimates indeed capture the effect of public sector wages.

A key novelty of this paper is to utilize the Japanese quasi-experiment that created a significant variation in the public sector wages across local labor markets. In Japan, the wage level of the public sector in a municipality is largely determined by the national government through setting the wage level of nationally-employed workers working in that municipality (Kawasaki and Nagashima 2007; Aoki 2021; Marumi 2023). Prior to 2005, there was criticism that public sector workers in relatively rural areas were overpaid compared with their private counterparts. The criticism led to the public wage reform during 2006 and 2010, which lowered the nationally-uniform base wage rate.

To compensate for the higher cost of living in urban areas, the reform also introduced a municipality-specific wage premium, the regional allowances (RA), which is calculated based on each region's 10-year average wage index every ten years. As a result, conditional on municipal fixed effects, this national policy reform created a plausibly exogenous variation in the overall wage level of local public sector workers by decreasing it in relatively rural areas while keeping or slightly increasing it in relatively urban areas. We exploit this exogenous variation in the public sector wage cuts to identify its effect on local economic outcomes.

To identify the effect of public wage cuts even more credibly, we combine the above-mentioned quasi-experiment with the Japanese institutional setting in which young workers are disproportionally affected by the public sector in the labor market. Specifically, the attractiveness of the public sector jobs affects only the sector choice of young workers because (i) the conventional lifelong employment system in Japan implies that job flows are concentrated among the young workers (Genda, Kondo and Ohta 2010; Ito and Hoshi 2020) and (ii) many primary public sector jobs impose an upper age limit of around 30. This implies that the public sector and the private sector compete with each other only in the labor market for young workers. Motivated by this institutional setting, within the same municipality, we take the young workers as the treated group and the older workers as the control group. Combining this with the quasi-experiment leads to the triple-difference strategy (Olden and Møen 2022). Importantly, the triple-difference strategy accommodates any municipality-specific time trend common for young and older workers, where the municipality is the level at which the public sector wage varies. This identification strategy allows us to accommodate flexible municipality-specific time trends, the level at which the public sector wage varies.

We find that the wages of young workers in the private sector declined by 0.34% in response to 1% cut in the public sector wage. The estimate is both statistically and economically significant. In particular, the private wage decrease by going from the lowest regional allowances rate to the highest in the sample is comparable to one-fifth of the gender wage gap and one-third of the college premium in our data. The estimation results are robust to including control variables and there is little indication that the pre-trend induces our result.

Motivated by a simple spatial equilibrium model that we introduce, we next look at the effects of public sector wage increases on population. In addition to the importance of these outcomes on their own, they are also informative of the welfare effect of the public wage reform. Although the increase in the private wage is suggestive of the welfare improvement of young workers, the private wage alone provides only incomplete evidence because the public sector wage may also affect welfare through other outcomes such as the quality of local public goods and job amenities. However, the effect on population summarizes the welfare impact of the public wage reform, inclusive of such channels not mediated through the private wage (c.f., Chetty 2009). Intuitively, if the local public sector wage increase improves workers' welfare relative to other areas, then it should induce

migration inflow (Rosen 1979; Roback 1982). As in the analysis of the private wages, we use a triple-difference strategy in which we set the young population as treated group and the older population as the control group.

We find that the public wage cut induces the outflow of young workers: the 1% decrease in the public wages induces 0.41% decrease in the young population. These results are robust to the inclusion of control variables and there is little indication that pre-trends induce our result. Given our spatial economic model, the decline in the young population implies a deterioration in the welfare of young workers, even unobserved effects of public sector wages (e.g., public goods, job amenities) are taken into account.

Moreover, we find that the effects of public sector wage cuts on private wages and population are stronger in the regions with a larger share of public sector workers. This confirms our intuition that there should be a larger impact on public sector wage reform when there are more public sector workers. Therefore, as intended, our empirical strategy is likely to capture the effects of the public sector workers rather than confounding factors.

We also conduct several supplementary analysis. First, we estimate the effects of public sector wages on youth unemployment rates and land prices. We find suggestive evidence that unemployment rate rises and land prices fall in response to public-sector wage cuts. Second, we explore the heterogeneous effects on private sector wages with respect to gender, education attainment, and firm size. We find evidence that the effects are larger for women and non-college-educated workers, while we find little heterogeneity in terms of firm size. Third, we investigate sensitivity of our results to largest cities and public sector wages of neighboring municipalities, finding that our results are robust to these considerations. Finally, we illustrate the aggregate impact of the policy reform by calculating the national-level impacts of the 2006–2010 public sector wage cut calculated based on our estimates.

Our results carry policy implications on how public sector wages should be set. For instance, our results are suggestive of the potential impact of the public wage cuts to achieve fiscal consolidation. In particular, such policies may significantly lower private sector wages and reduce workers' welfare, which should be counted as a cost of such an austerity measure. Our results are also suggestive of a macroeconomic policy to combat wage stagnation: Raising the public sector wages may help resolve it. In our context, the Japanese economy over the last 30 years is characterized by the stagnation of both nominal and real wages (Ito and Hoshi 2020). It has been suggested that increasing the public sector wages may be an effective policy measure to combat this wage stagnation (e.g., Bernanke 2017), but its effectiveness has not been empirically investigated.[1] Our finding

[1]Despite the lack of formal evidence, this possibility has also been noted by some politicians. For example, Goshi Hosono, a member of the House of Representatives and a former Minister of the Environment, stated that "To achieve a wage increase, especially in a rural area, we should increase the public sector wages to promote the private sector increase" (https://twitter.com/hosono_54/status/1585775663314702336, last access on November 22, 2022. The original

rationalizes such a proposal by providing causal evidence that a public sector wage cut restrains private wages. Moreover, our results also imply that workers' welfare may also improve, at least for young ones.

This paper relates to four strands of literature. First, our paper contributes to the reduced-form studies on the relationship between public and private wages. The majority of studies have documented the positive relationship between public sector and private sector wages (e.g., Ehrenberg and Goldstein 1975; Lacroix and Dussault 1984; Gregory and Borland 1999; Lamo, Pérez and Schuknecht 2012; Afonso and Gomes 2014; Abdallah, Coady and Fah Jirasavetakul 2023).[2] An important concern is that public sector wages tend to be increased when private sector wages are also increasing, threatening the causal interpretation of the positive relationship between public and private wages. However, most studies in this literature do not use a quasi-experimental variation in public sector wages, presumably because such an exogenous variation is rare. An important exception is Telegdy (2018), which uses a national wage reform in Hungary that uniformly raised the public sector wages across locations. Consistently with our findings, he finds that private sector workers that are more strongly hit by the public wage shock, especially young workers, experienced the wage increase. Our contribution is to exploit the novel exogenous variation in the local public wage itself, and causally estimate the elasticity of private wages with respect to public wages. Moreover, our local variation in the public wage also allows us to estimate the causal effects on population, allowing us to conduct a welfare evaluation of the policy reform based on a spatial economic model.

Second, more broadly, our paper relates to studies examining the spillover effect of wages of an employer into those of other employers (e.g., Staiger, Spetz and Phibbs 2010; Cengiz, Dube, Lindner and Zipperer 2019; Derenoncourt, Noelke, Weil and Taska 2021). Relative to this literature, our paper is distinctive in analyzing the spillover effect of public sector wages on private wages using a quasi-experiment. Moreover, the positive spillover of public sector wages is consistent with the monopsony power of the public sector as an employer, which is sensible given the significant employment share of the public sector.[3] Reinforcing the interpretation that the public sector has monopsony power, we also find evidence that the wage spillover is larger in areas in which the public sector share is higher. Furthermore, we find evidence that the public sector wage cut decreases wages and employment in the private sector. This finding is consistent with the increased monopsony power of the private sector employers, which is in line with the monopsony power of private firms extensively documented in this literature.

Third, our study also relates to studies analyzing the impact of reforms in public wages and

quote in Japanese is translated by the authors).

[2]That said, some studies do not find a positive relationship (e.g., Auld, Christofides, Swidinsky and Wilton 1980).

[3]The monopsony power of the public sector in the labor market is also consistent with the experimental evidence of Dal Bó, Finan and Rossi (2013).

employment by fully specifying and calibrating an economic model of labor market (e.g., Burdett 2012; Gomes 2015, 2018; Bradley, Postel-Vinay and Turon 2017; Bermperoglou, Pappa and Vella 2017; Albrecht, Robayo-Abril and Vroman 2019; Chang, Lin, Traum and Yang 2021). Since we exploit a quasi-experiment, we could estimate the causal impact of public wages without committing to a particular labor market structure. Moreover, our spatial equilibrium model implies that population serves as a sufficient statistic for inferring the qualitative welfare implication of the public wage reform (Chetty 2009). Therefore, by estimating the effect on population, we could analyze the welfare implication without fully specifying the labor market structure.

Finally, our paper relates to the local labor market approach that exploits a cross-section variation to study policy impacts (e.g., Rosen 1979; Roback 1982; Kline and Moretti 2014; Suárez Serrato and Zidar 2016; Nakamura and Steinsson 2018; Monras 2019; Yamagishi 2021). In particular, a growing number of studies adopt a local labor market approach to study the effect of the public *employment* (Faggio and Overman 2014; Zou 2018; Faggio 2019; Auricchio, Ciani, Dalmazzo and de Blasio 2020; Jofre-Monseny, Silva and Vázquez-Grenno 2020; Becker, Heblich and Sturm 2021; Guillouzouic, Henry and Monras 2021; Lee, Ko and Kim 2023; Chirakijja forthcoming; Franklin, Imbert, Abebe and Mejia-Mantilla forthcoming). Although this burgeoning literature exemplifies substantial academic and policy interests in the spatial economic impacts of the public sector, the impact of public sector *wages* has not been investigated possibly because either suitable data or a quasi-experimental variation was unavailable. This omission is unsatisfactory because, as mentioned in the introduction, public wages are widely used as a policy tool and there are many recent examples of public wage reforms. Our key novelty is to collect various data from Japan and exploit a distinctive Japanese quasi-experiment that created a local variation in the public wages, allowing us to evaluate how the public sector wages affect various private sector outcomes and welfare in a spatial economic framework.

This paper is organized as follows. Section 2 presents a simple spatial economic model that guides our empirical analysis. Section 3 explains the relevant institutional background. Section 4 describes the data. Section 5 presents our empirical model and identification strategy. Section 6 shows our main empirical results: the effects of public sector wages on private wages, population, and land prices. Section 7 analyzes heterogeneity in the effects of public sector wages. Section 8 concludes.

# 2 Theoretical Framework

To guide our empirical analysis on the public sector wages, this section describes a spatial economic model that builds on the canonical Rosen (1979) and Roback (1982) model. In the main text, we provide intuitive arguments about how public sector wages may affect local economic outcomes,

such as private wages and population. Appendix D provides a formal treatment of our arguments.

Consider a small region in which both private and public sector jobs are available. Suppose that the public sector wage is exogenously reduced due to a policy change. As discussed in the structural literature on public sector (e.g., Burdett 2012; Gomes 2015, 2018; Bradley et al. 2017; Bermperoglou et al. 2017; Albrecht et al. 2019; Chang et al. 2021), the public sector wage cut may increase or decrease private sector wages because public sector wages can have various impacts.[4] For instance, the public sector wage reforms may affect the equilibrium wage rate in the private sector by changing workers' job search behavior, firms' job posting behavior, and the quality of public goods used for production.[5] We do not theoretically impose a priori whether a lower public sector wage increases or decreases the private sector wage. Rather, we empirically answer this question in this paper. Similarly, our theoretical framework also remains agnostic about how public wages affect local unemployment rates.

We suppose that workers can choose to live in the small region or elsewhere. The incentive to live in the small region depends on the local labor market conditions and local amenities. The local labor market conditions are affected by the public sector wages directly through the attractiveness of public employment and indirectly through changing the private sector wages and employment. The local amenities are also likely a function of public sector wages. For example, the quality of public goods may depend on the efforts of the public sector workers, which depend on the level of public sector wages (c.f., Borjas 1984; Shapiro and Stiglitz 1984).[6] The local amenities also include the job amenities in this local labor market, including in-kind benefits and unpaid overtime working hours, which may also respond to public sector wages. Better local labor market conditions and local amenities provide stronger incentive for workers to live in the small region. The potential dependence of amenities on public sector wages implies that we cannot determine how the public sector wage reform affects the local welfare solely from the impacts on private wages and unemployment rates.

In the spatial equilibrium, workers must be indifferent between living in the small region and elsewhere since otherwise, migration responses would continue. To illustrate, suppose that the government lowers the public sector wage rate in the small region. As long as this makes this region

[4]While public sector wages cut may reduce the private wages by decreasing the local aggregate demand (e.g., Bermperoglou et al. 2017; Chang et al. 2021), our estimates of the private sector wages omit the effect through local aggregate demand because our triple-difference strategy, described in Section 5, absorbs it as long as the local aggregate demand effect is common for the young and the older workers. Therefore, our estimates on private sector wages may be conservative. Note, however, that this omission may not be consequential in our context because the share of public sector workers is relatively small in Japan (OECD 2021). In particular, the median share of the local public sector workers is just 1% of the total population (see Section 6.3).

[5]A more specific example is the "demonstration effect" of public sector wages: private firms may set their wages using public sector wages as yardsticks (Afonso and Gomes 2014).

[6]The public service quality can be considered as net of the local tax payment for financing them, which would increase as the public sector wage increases (Brueckner 1982).

less attractive, the migration outflow would be observed. The migration outflow stops when the land prices, which workers pay for housing, become lower enough to offset the decreased attractiveness of this region. Therefore, as the region becomes less attractive, we posit that the population in the spatial equilibrium decreases due to the migration inflow and land prices become lower due to the lower housing demand.

This model yields simple welfare implications about the public wage cut: it lowers workers' welfare if it reduces population and lowers land prices. Intuitively, without discerning the effects of public sector wages on local labor market attractiveness and amenities, the decline in workers' welfare must reduce land prices by inducing out-migration so that the spatial equilibrium condition holds. Therefore, population and land prices serve as sufficient statistics for qualitative welfare implication of the welfare implication of policy reform in the public sector wages (Chetty 2009). This result motivates us to empirically examine population (Section 6.2) and land prices (Section 7.2) as outcome variables.

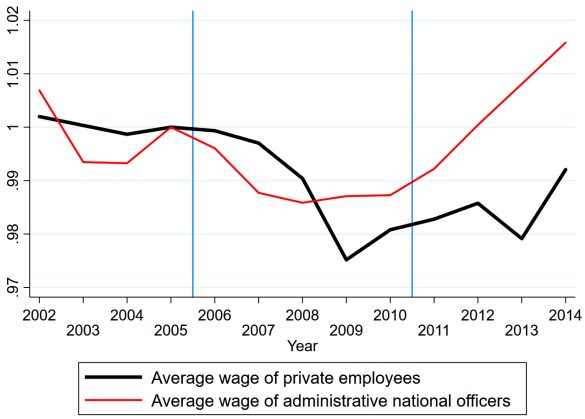
What we have so far discussed was concerned with mobile workers, there may also be immobile workers. However, as discussed in Appendix D, we can readily extend our model to include immobile workers. We suppose in our empirical analysis that young workers are affected by public sector wage reform while older workers are not. Given the empirical evidence that young workers are much more mobile than older workers (e.g., Ishikawa 2016; Kaplan and Schulhofer-Wohl 2017), young workers may correspond to mobile workers and older workers may correspond to immobile workers in our model. A caveat is that the above welfare characterization based on population and land prices applies only to mobile workers. If there are additional immobile workers, then such workers may experience a welfare gain even if the population or land prices decrease. For instance, the public sector wage cut may decrease the land price without any effects on wages, unemployment rates, and amenities of the older workers. In this case, while the decreased land price must entail lower welfare of the young workers, the lower housing cost improves the welfare of older workers.[7] As we see in Sections 6.2 and 7.2, this situation may be empirically relevant in our context.

# 3 Empirical Setting

**Background Information on Japanese Public Sector** We begin by describing the relevant background information about the Japanese public sector. The total number of public officials in Japan was about 3.5 million in 2010. It constitutes around 6% of the total employment, and the compensation of public employees constitutes 14% of the total government expenditure. Both are among the lowest in OECD countries (the OECD averages are, respectively, 18% and 23%, OECD 2021). Therefore, finding a significant impact of public sector wages in the Japanese context would suggest

[7] See Yamagishi (2021) for more discussions on workers' heterogeneity and welfare implications.

**Figure 1:** Trend of national average wages relative to 2005 basis




Source: Basic Survey on Wage Structure and White Paper on Public Employees. Note: National average wages of private employees and national officers relative to 2005 basis are shown in black and red lines respectively. Following the definition of wage in Basic Survey on Wage Structure, the wage here includes the base salary and all allowances except overtime pay and bonus.

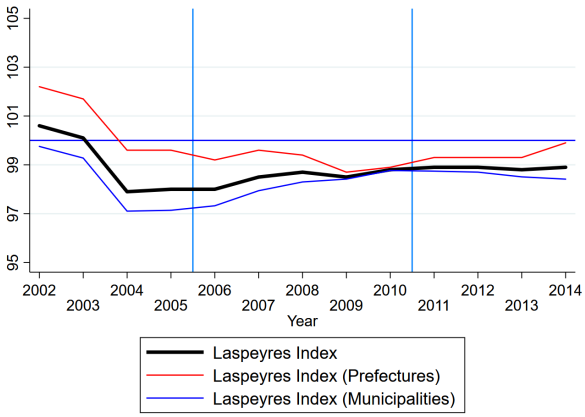
a significant impact also in other countries in which public sectors are more sizable. Among the public officials, 2.85 million, or more than 80%, were local public officials. The remaining 20% are national public officials.

Salary levels for national public sector workers are set to balance with those of private sector employees by the National Personnel Authority, the central administrative agency in charge of human resource management in public administration. In Japan, public wages are not determined through negotiations between employers and unions because collective bargaining rights and the right to strike are severely restricted for most public workers (Shimoi 2017). Figure 1 shows the national average private wages and the national public officials. While both wages tend to exhibit a similar trend, the wage levels of national public sector workers do not necessarily equal to those of the private sector. It implies that not only by labor market conditions, the average wages of national public sector workers are affected by the administration's discretionary policies.[8] Later in this section, we introduce a policy reform that suddenly changed the public sector wages irrespective of the contemporaneous trends of private wages.

According to Local Public Service Act, the wage level of local public sector workers must be determined to be balanced with the wage level of national public sector workers, local public sector workers of other jurisdictions, and local private sector workers. This rule is called as "equal pay"

[8]For example, to raise funds for reconstruction following the Great East Japan Earthquake, an average of about 7.8% reduced wages for national public servants in 2012 and 2013, and some local governments followed this measure. Since this measure is temporal and our results are robust even excluding data after 2012, we ignore this measure in the figures and analyses of this paper.

**Figure 2:** Trend of the average Laspeyres index of all local governments




Note: Laspeyres Index shows the previous year's wage level of each local government relative to the central government. The index represents the base salary level of local government employees when the base salary level of national ones is set at 100. To eliminate the influence of academic background, years of experience, and the composition of staff in local governments, the index is calculated by applying the average salary of local officials by education and years of experience to the national staff composition.

principle and following this rule implies the causality that the wage level of local public sector workers depends on the wage level of local private sector workers. However, as shown by Kawasaki and Nagashima (2007), Aoki (2021), and Marumi (2023), local governments actually focus on the wage gap between the local and national governments because of the strict guidance of the national government to minimize the gap. As an example of such guidance, the national government annually publicizes the index called "Laspeyres Index" which shows the previous year's wage level of each local government relative to the central government. The local governments of relatively high wages are frequently reported in newspapers and magazines by referring to the index (Morikawa, 2016), pressuring them to lower the local public sector wage. Figure 2 shows the Laspeyres index for local governments, in total and separately for prefectural and municipal governments. Figure 2 shows that throughout our sample period, the Laspeyres index is stably near 100 and ranges from 97 to 102, implying that the gap between the wages of nationally-employed and locally-employed public officials is just 3%, at most.

Regardless of job duties, national government employees receive a regional allowances of a certain percentage of their base salary depending on their place of residence. The regional allowances is a place-based wage premium to adjust for the price level in each region, so that the effective wage rate of municipality $i$ becomes

$$\text{Effective wage}_i = (1 + \text{Regional allowances rate}_i) \times \text{Base wage}. \tag{1}$$

As such, the regional allowances acts as a wage premium on top of the nationally-uniform base wage. Local governments also provide regional allowances to local officials. Although local governments have discretion over the level of regional allowances, they usually follow the national level as it does for the base salary.[9]

Note that the Japanese public sector wage system is not an outlier in the sense that a similar system can be found in other countries. For example, France has a regional allowances (indemnité de résidence) system, where the local civil service pay is expected to follow the national one.[10] However, the Japanese system is distinctive in that the amount of regional allowances is large (0-20%) while the French one ranges from 0% to 3% of the base salary (Ministry of Public Transformation and Service of France, 2023). The large variation of regional allowances in Japan is helpful in empirically identifying the effects of public sector wages.

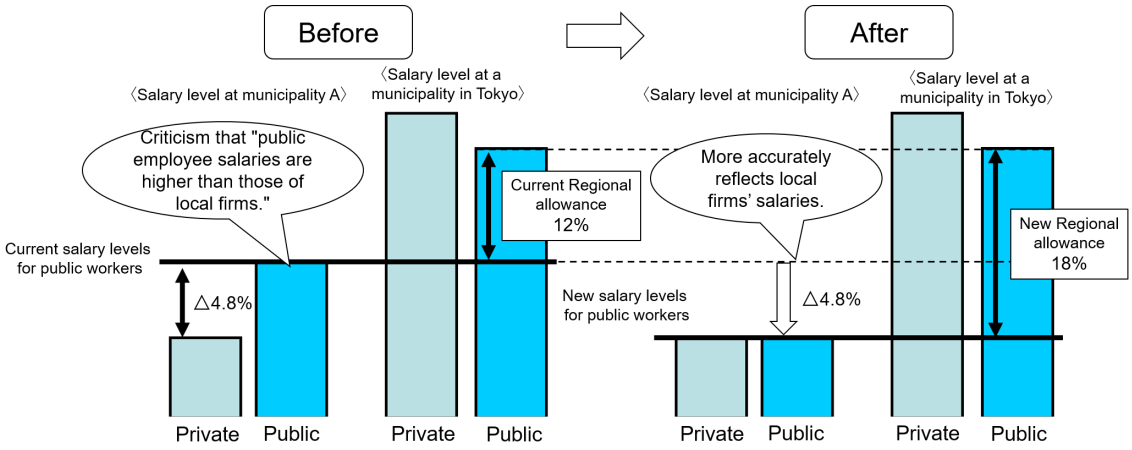
**Public Sector Wage Reform During 2006–2010.** During 2006-2010, the Japanese government reformed the national public sector wages by reducing the base wage and introducing a new regional allowances schedule with a larger regional variation. The reform is illustrated in Figure 3. The main goal of the reform was to improve fiscal balance by reducing the wage rate of national public sector workers in non-urban areas, which was criticized as being too high relative to private wages. This was achieved by combining the following two reforms. First, the base salary, which was nationally uniform, was gradually reduced each year during the five years. The total wage cut was 4.8% of the original base wage. This reform reduces the public wage of non-urban areas ("municipality A" in Figure 3), but it also reduces the public wage rate in urban areas ("a municipality in Tokyo" in Figure 3), which seems undesirable as the public wage becomes too lower than the private wage. The second reform corrected this by introducing new regional allowances rates. Although the old regional allowances was paid in limited locations and in limited amounts, the new regional allowances expanded the coverage and amounts. As a result, urban areas, such as Tokyo, did not experience a public wage decrease or even some increase due to the increased regional allowances despite the reduction in the base wage.

We make three further remarks about the implementation of the policy reform. First, note that the new regional allowances system both increased the wage premium in municipalities that were already covered in the older regional allowances system (e.g., "a municipality in Tokyo" in Figure 3), and also newly covered municipalities that did not receive the wage premium in the older

[9]The wage gap between national and local governments, taking into account regional allowances, is also stable and is published annually as the "modified Laspeyres index".

[10]While in some countries, trade unions are either involved in the salary determination process or the federal system dictates that local public officials are paid differently in different regions, Japan and France are similar in that trade unions have relatively a limited role in salary determination and local governments are expected to follow the central government salary determination process.

**Figure 3:** Graphical illustration of the national public sector wage reform



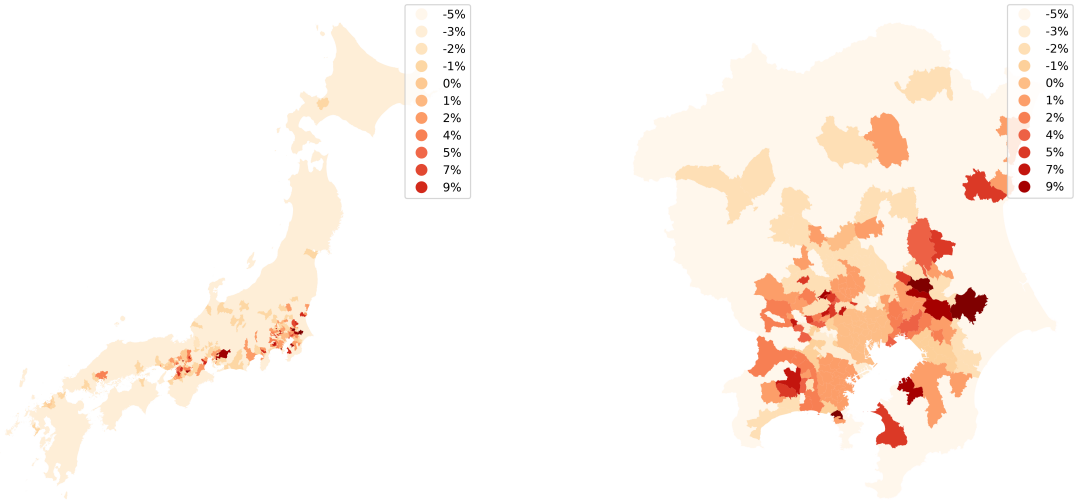

Note: This figure illustrates the national public sector wage reform, which reduced the base salary and introduced a new regional allowances system. The figure is taken from https://www.mext.go.jp/b_menu/shingi/chukyo/chukyo3/041/siryo/__icsFiles/afieldfile/2019/05/15/1416840_001.pdf (in Japanese, last accessed on June 5, 2023), where comments in the figure are partly modified and translated into English by the authors.

system. Second, the new regional allowances system was introduced in 2006, from which the regional allowances rates gradually increased over five years to complete the policy reform in 2010.[11] Finally, the amount of the new regional allowances was calculated based on each municipality's 10-year average wage index, which means that the regional allowances does not take into account the contemporaneous trends in the labor market.

This new regional allowances created a larger cross-section variation in public sector wages at the municipality level, which we exploit to identify their effects on local economic outcomes. Figure 4 shows the impacts of the policy reform on the effective wages of public workers in municipalities in Japan as a whole and in the Kanto region of Japan. Panel 4a clarifies that the increase in the effective wages due to the increased regional allowances rates is concentrated in urban areas, most notably in the three largest metropolitan areas (Tokyo, Osaka, and Nagoya). Panel 4b, however, clarifies that there is a substantial variation in the change in the effective wage across municipalities within a smaller region or a metropolitan area. In particular, while urban municipalities tend to experience an increase in the regional allowances, most urban municipalities did not receive the largest increase, and the increase in the effective wage there is limited (e.g., Tokyo 23 wards experienced about 0% change in the effective wage). This is because our policy variation has both intensive and extensive margins, providing a large increase in regional allowances rates for municipalities that are newly eligible for the regional allowances. Taken together, the base salary of the public sector was reduced

[11]For instance, Tokyo experienced a rate of regional allowances increased by six percentage points, where the rate annually increased by about one percentage point from 2005 to 2010.

**Figure 4:** Changes in the level of effective wage




**(a)** Japan **(b)** Kanto area

Note: These figures show the changes in the level of effective wage before and after the introduction of the new regional allowances in Japan (panel 4a) and the Kanto region (panel 4b). Kanto region is one of the regions of Japan centered on Tokyo metropolitan area. The darker red areas indicate a higher percentage change in the level of regional allowances payments. In both panels, some small islands (e.g., Okinawa) are omitted for visibility. From the equation (1), the effective wage in 2010 can be shown as $(1 + RA_{i,2010}) \times \text{Base wage}_{i,2010}$, where $RA$ is the regional allowances rate. The change in effective wage can be calculated as $(1 + RA_{i,2010}) \times \text{Base wage}_{i,2010} - (1 + RA_{i,2005}) \times \text{Base wage}_{i,2005} = (\text{Base wage}_{i,2010} - \text{Base wage}_{i,2005})(1 + RA_{i,2010}) + (RA_{i,2010} - RA_{i,2005}) \times \text{Base wage}_{i,2005} = -0.048 \times (1 + RA_{i,2010}) + (RA_{i,2010} - RA_{i,2005})$, where we normalize Base $\text{Wage}_{i,2005}$ to 1 in the last equation. The wage changes shown in the figures are based on this calculation, where we round the values to the nearest decimal place.

in the most part of Japan due to the reform, while some areas even experienced an increase in the public sector wage thanks to the new regional allowances schedule. Thus, the new regional allowances policy exogenously created a greater variation in the public sector wage across local labor markets.

As shown in Kawasaki and Nagashima (2007), Aoki (2021), and Marumi (2023), the wage rates of local public officials closely track that of national public officials working in the same area through administrative guidance by the national government, despite that local governments can, in principle, determine the wage rates of their public officials. Therefore, although the policy reform during 2006–2010 concerns the national public officials, it accompanies an almost parallel change in the wages of the local public sector. Consequently, what we identify as the effect of national public

sector wages in a given municipality can be approximately interpreted as the effects of overall public sector wages in the municipality, including both locally-employed and nationally-employed public officials.

**Workers' Age and Public Sector Jobs in the Labor Market.** In addition to the policy reform described above, we also harness the Japanese institutional setting in which only young workers are primarily affected by public sector jobs in the labor market. There are two key institutional features behind this situation.[12] First, the lifelong employment system is conventionally popular in the Japanese labor market, which substantially limits labor mobility for non-young workers (e.g., Genda et al. 2010; Ito and Hoshi 2020). Second, most public sector jobs mandate a recruitment exam for screening, and an upper age limit is typically imposed for taking it.[13] For national public officials, the upper limit age is usually set at 30.[14] There are similar upper-age limits for exams for local public officials.[15]

In line with the institutional setting described above, two pieces of evidence also suggest that young and older workers are separated in the labor market. First, workers of different ages face different wage trends. In Figure A.2, we present the wage time-series for each 10-year age category. For workers below 30, we observe little divergence of the wage trends in regions with and without regional allowances, while we observe the substantial divergence for workers above 30. Second, population increase in response to a higher public sector wage is observed only among workers below 30, while no response is observed for workers above 30 (Figures A.4 and A.5). These results are consistent with our argument that workers below 30 were affected by the public sector wage reform, while those above 30 were hardly affected.

Therefore, young workers are primarily expected to be affected by public sector wages, while little effect is expected for older workers. In particular, only young workers are directly influenced by the decrease in the public sector wages because only young workers could effectively take up a public sector job. Moreover, as private sector firms employing young workers engage in competition with the public sector, their wage policies are also expected to be affected by public sector wages. In contrast, older workers cannot directly enjoy the public sector wage increase by obtaining public sector jobs, and private firms employing them would not change their wage policies as they do not

[12]Beyond the Japanese institutional features, there are also two general reasons to suppose that the impact is concentrated in young workers. First, Telegdy (2018) finds that public sector wage reform in Hungary primarily affected young workers. Second, there may exist information asymmetry about workers' productivity. In particular, firms may well observe older worker's productivity from past task performances, but the productivity of young workers is harder to observe and firms may use the public sector wage as a yardstick to determine their wages.

[13]There is exceptional mid-career recruitment that is free of the upper age limit, but it constitutes only a negligible fraction of total public sector employment.

[14]See, for example, https://jp.stanby.com/magazine/entry/220961 (In Japanese, last accessed on May 13, 2023).

[15]The upper age limit of 30 is most prevalent in the local public sector, but some local governments are slightly more tolerant than the national government (see Figure A.1).

compete with the public sector in the labor market. In this paper, motivated by the upper age limit of the recruitment exams in the public sector, we define young workers as workers below the age of 30 and the rest as older workers.

# 4 Data

We put together various datasets to examine the effect of the reform of national officials' regional allowances from 2006 to 2010. We first analyze two key outcome variables: the wage rate of the private sector and population. We also investigate unemployment rates and land prices as additional analyses. We construct two datasets: one is based on individual private workers' data for the analysis of the private sector's wage levels, and the other is based on municipality-level data for the analysis of population, unemployment rates, and land prices. Our data cover from 2002 to 2014, covering four years before and after the policy-reform period (2006–2010).

We use the definition of municipalities as of 2015 throughout our sample period.[16] Because of the large-scale mergers of municipalities in Japan in the 2000s, we need to suitably aggregate merged municipalities in constructing the municipal-level variables. We follow Kondo (2023) to identify merged municipalities. In constructing municipality-level variables, we take the sum of merged municipalities for aggregate values (e.g., population), and we take a weighted average for per-capita values (e.g., the tax income per capita).[17]

**Public Sector Wages.** The policy variable we focus on is the regional allowances rate for the national public workers.[18] Since the regional allowances payment level is stipulated in rule 9-49 of the National Personnel Authority for the year in question, the payment level for each year was obtained using D1-law.com, a database of Japanese laws and rules. The revised regional allowances levels are also included in the Fact-finding Survey on Compensation of Local Government Employees, which was also used in compiling the data.

As a potential control variable, we also consider the number of local officials and their salary levels. We obtain them from the Fact-finding Survey on the Compensation of Local Government Employees. The local officials' average salary is available on education and years of experience. The average salary in our definition contains a base salary and allowances (except the regional allowances) but not overtime pay and bonuses since overtime pay and bonuses heavily depend on

[16]The last municipal merger was in 2014, so we are using the 2015 criteria.

[17]For example, the tax income per capita is calculated by taking the weighted average of the tax income per capita of merged municipalities, where we use the pre-merger population of each municipality as weights.

[18]In studying the effect of national public sector wages, we do not need the data on the base wage of national public officials because year-fixed effects in our regression models absorb changes in the nationally-uniform base wage over time (see also equation 1 and footnote 26).

firm-specific idiosyncratic shocks.[19]

**Private Sector Wages.** We use the individual-level microdata from the Basic Survey on Wage Structure. The target population for this survey is randomly selected employees from randomly selected establishments from regional and industry strata, and we weight observations by sampling weights included in the data to ensure representativeness. The survey takes different employees' data every year and records the location, scale, and industry of each employee's workplace, as well as sampling rates and the information of each employee such as wage, gender, age, and education. While individual earnings information includes base salary, allowances, overtime pay, and bonuses, we construct the salary as the base salary and the allowances since the overtime pay and the bonuses are substantially influenced by the idiosyncratic shocks at the firm level.[20] Moreover, we focus on the full-time workers with the ages between 15 and 64 in our analysis since the Basic Survey on Wage Structure does not contain the temporal workers' data before 2005.[21] For the analysis, we use the wage as a dependent variable, which is calculated by dividing the salary by the scheduled working hours. The summary statistics of this data are shown in Table C.1.

**Population.** We take each municipality's demographic information from the population, demographic and household surveys based on the Basic Resident Registration System. It allows us to annually observe the municipal population, separately for five-year age groups. For the population analysis, the municipal data is required and we make balanced panel data of 1731 municipalities.[22] The summary statistics of this dataset are shown in Table C.2.

**Unemployment Rates.** The unemployment rate is taken from the Population Census. The unemployment rate is based on self-reporting and defined as the number of people searching for a new job, divided by the working population. Since the census data is available only every five years (2000, 2005, 2010, 2015), we use the linear interpolation for obtaining unemployment rates in intermediate years. As in population analysis, 1731 municipalities are in the sample.

[19] We exclude the regional allowances from the local officials' salaries because it is determined in strong reference to the regional allowances rate of national public officials (see Section 3).

[20] The salary here is defined as the amount of cash paid for June, when the survey time for the Basic Survey on Wage Structure, by the payment conditions and calculation method predetermined by the labor contract, collective labor agreement, or employment regulations of the business office, including base salary and allowances but excluding overtime pay and bonuses. It is not take-home pay; the amount before income tax, social insurance premiums, etc., are deducted.

[21] This is likely a modest limitation for our purpose because part-time jobs in the Japanese public sector were relatively rare in the data period (Goto 2021).

[22] While Japan has 1741 municipalities as of 2015, ten municipalities with missing data due to the Great East Japan Earthquake are omitted. These municipalities are also omitted in the analysis of unemployment rate and land price.

**Land Prices.** We take the land price information from the Land Market Value Publication (*kouji chika*). Our municipal land price data is based on the changes in repeated appraisal prices for the same land plot. Specifically, we first calculate the ratio of the current year's official land price to that of the previous year for all land plots that are appraised in two consecutive years.[23] For each year, we then calculate the average ratio within each municipality. Finally, we use this ratio to construct a municipality-level land price index, normalizing the 2002 price to 1. Importantly, our land price data take account of any fixed characteristics of each land plot, even if they are unobservable.[24] The number of municipalities included in the land price analysis is 1355, which is somewhat fewer than our population and unemployment analysis because it only includes municipalities with a land price survey point. The summary statistics of this dataset are shown in Table C.3.

**Municipal fiscal data** As potential control variables, we obtain each municipality's fiscal information from the System of Social and Demographic Statistics. We collect local tax revenues per capita, lump-sum transfer (called local allocation tax, LAT) per capita, and earmarked subsidies (called national treasury disbursements, NTD) per capita.

# 5 Empirical Strategy

This section introduces our empirical strategies to analyze private sector wages of young workers and young population. In both cases, we exploit the quasi-experimental variation in the public sector wage cut while taking the young workers as treated group and the older workers as control group. This empirical strategy is motivated by the institutional setting in Section 3.

**Private Sector Wages.** We estimate the effect of public workers' wages on private workers' ones considering the heterogeneity of the generations by following the triple-difference model:

[23] We use land price data of any land use in our main analysis. Focusing on residential land plots hardly changes our conclusion.

[24] This feature is analogous to the repeat sales index of Case and Shiller (1987, 1989) in that it utilizes multiple observations of prices for the same land plot, but our price data is based on multiple appraisals rather than multiple transactions. LaPoint (2021) uses a similar land price index as ours in a different context, calling it "repeat appraisal index."

$$\ln w_{i,j,t,private} = \beta RA_{j,t} \times Young_i + \mu_{j,t} + \sum_{k=\text{young or old}} (\iota_j^k + \tau_t^k) + \gamma X_{i,j,t} + \epsilon_{i,t} \tag{2}$$

$$\ln w_{i,j,t,private} = \sum_{t \neq 2005} \beta_t \{\tau_t \times (RA_{j,2010} - RA_{j,2005}) \times Young_i\} + \mu_{j,t} + \sum_{k=\text{young or old}} (\iota_j^k + \tau_t^k) + \gamma X_{i,j,t} + \epsilon_{i,t}, \tag{3}$$

where $i$ is an individual worker, $j$ is the municipality where worker $i$ lives, and $t$ is the year. $Young_i$ is a dummy variable taking 1 if $i$'s age is less than 30 and 0 otherwise. $X_{i,j,t}$ is the vector of control variables (i.e., individual characteristics[25]) and $\epsilon_{i,t}$ is the error term. $\mu_{j,t}$, $\iota_j^k$, and $\tau_t^k$ respectively capture the municipal-year-, municipal-, and year-fixed effects. $w_{i,j,t,private}$ is the salary level of private worker $i$ in the municipality $j$ at $t$. $RA_{j,t}$ is the regional allowances rate at the national public sector, and this can be interpreted as the index of the public sector wage level.[26]

The coefficient of interest in equation (4) is $\beta$, which shows the elasticity of private sector wages relative to public sector wages. In equation (5), the event study specification, the coefficients of interest are $\beta_t$, which is the elasticity of the private sector wage in year $t$ with respect to the total change in the regional allowances rate from this policy change (i.e., $RA_{j,2010} - RA_{j,2005}$). Note that both approaches are complementary. The first specification (4) summarizes all the information in the single elasticity $\beta$, while the second specification (5) permits that the policy reform has a different impact on the private wages in different years.

Our identification assumption behind equations (2) and (3) is a triple-difference strategy that combines a quasi-experiment in regional allowances and an institutional setting in which only young workers are primarily exposed to the policy change. Note that simply regressing the public workers' salary level on the corresponding private workers' salary level may suffer from the endogeneity that the public workers' base wage is annually determined in reference to the previous year's base wage of the corresponding private workers. In particular, we expect a positive bias in $\beta$ if public sector wages tend to be raised when private sector wages are high. To address this endogeneity issue, we first utilize the quasi-experimental variations in the national officials' regional allowances level in each municipality $j$, $RA_{j,t}$. Given that the change in regional allowances resulted from a 2006 reform was unexpectedly introduced to mitigate Japan's fiscal deterioration and the previous 10-year

[25] Note that our specification include municipal-year-fixed effects, which absorb all municipal characteristics.

[26] To see why, let $Base_{t,k}$ be the index of the base salary level of national public sector workers in year $t$ for worker type $k$ (= young or old), which is location-independent because the uniform base salary schedule applies to national workers. Then, the wage of national public sector workers inclusive of the regional allowances in municipality $j$ and year $t$ is written as $\ln(1 + RA_{j,t})Base_{t,k}$, and its associated regression coefficient for $k$ =young is $\beta$. Here, $\ln(1 + RA_{j,t})Base_{t,k} = \ln(1 + RA_{j,t}) + \ln Base_{t,k} \simeq RA_{j,t} + \ln Base_{t,k}$, but we do not need to explicitly control for $\ln Base_{t,k}$ as it is absorbed by the year fixed effects $\tau_t^k$.

average wage index determined the regional allowances rate, $RA_{j,t}$ is less likely to suffer from the endogeneity.

To further address potentially endogeneity that $RA_{j,t}$ is systematically correlated with municipality-specific time trends, we take the older workers as the control group and compare the evolution of the wage difference between the young and the older workers across municipalities. For implementing such a triple-difference strategy, we introduce the municipality-year fixed effects $\mu_{j,t}$, which can flexibly capture municipality-specific trends. Importantly, it includes the municipality-specific wage trend that may be correlated with the regional allowances rate $RA_{j,t}$. We also control for the municipality and year-fixed effects, separately for the young and the old ($\iota_j^k$ and $\tau_t^k$). As a result, we compare differential private wage gap between the young and older workers in municipalities with different regional allowances rate to estimate the elasticities $\beta$ and $\beta_t$. Note that although this is a two-way fixed effects specification, we use the Ordinary-Least-Square estimation since the so-called "negative weight" problem does not arise as the timing of the policy change is the same across all municipalities (Roth, Sant'Anna, Bilinski and Poe 2022). Our triple-difference strategy relaxes the common trend assumption required in a difference-in-difference strategy by accommodating any municipality-specific time trend common for young workers and others, where the municipality is the level at which the public sector wage schedule varies (Olden and Møen 2022).

As covariates, $X_{i,j,t}$, we use individual $i$'s characteristics, which consist of the dummies for gender and a university degree, age categories with 5-year intervals from 15 to 64, and their interaction terms. In addition, we also include the logarithm of scheduled working hours. The inclusion of these control variables is analogous to the earnings functions à la Mincer, but we use dummy variables to relax functional form restrictions (Kawaguchi 2011).[27] In addition, although the salary level of municipal public workers corresponding to the private worker $i$ in the municipality $j$ at $t$, $w_{i,j,t,public}$, could suffer from the endogeneity, we include it in some specifications to investigate the sensitivity of our results to the potential discretionary wage changes by the municipal government.[28]

**Young Population.** Using the municipality-level panel data, we estimate the following regression equations for estimating the effect of public workers' wages on the young population:

[27] Our control variables are meant to compare workers with similar observable characteristics because our aim is identifying the elasticity with respect to public sector wages $\beta$. The coefficients on our covariates should not necessarily be taken as causal due to endogeneity such as self-selection of schooling (Heckman, Lochner and Todd 2006).

[28] Because the average wages of local public employees by education and years of service are available, we matched each private worker's corresponding salary level of municipal public workers by the education and years of service estimated from age and education to construct this variable. A worker who does not have a corresponding municipal public worker is omitted from the sample.

$$\ln(\text{YO ratio of Pop})_{j,t} = \beta RA_{j,t} + \iota_j + \eta_{t,p} + \gamma X_{j,t} + \epsilon_{j,t} \tag{4}$$

$$\ln(\text{YO ratio of Pop})_{j,t} = \sum_{t \neq 2005} \beta_t \{\tau_t \times (RA_{j,2010} - RA_{j,2005})\} + \iota_j + \eta_{t,p} + \gamma X_{j,t} + \epsilon_{j,t}, \tag{5}$$

where $j$ is the municipality in prefecture $p$ and $t$ is the year. The outcome variable, $\ln(\text{YO ratio of Pop})_{j,t}$, is defined as the logarithm of the ratio of the young population to the older population ($\text{Young Pop}_{j,t}/\text{Older Pop}_{j,t}$). $X_{j,t}$ is the vector of control variables (i.e., municipal characteristics) and $\epsilon_{j,t}$ is the error term. $\iota_j$, $\eta_{t,p}$, and $\tau_t$ capture the municipal, prefecture-year-, and year-fixed effects respectively.

The coefficients of interest, $\beta$ and $\beta_t$ in equations (4) and (5), are interpreted as the elasticity of the young population with respect to the regional allowances. This is because as in the triple-difference strategy in analyzing the private wages, using the young-to-older population ratio allows us to flexibly control for municipality-specific trends by taking the older population as the control group. To illustrate this point, suppose the following model of young population: $\ln(\text{Young Pop})_{j,t} = \beta RA_{j,t} + \iota'_j + \eta'_{t,p} + \Xi'_{j,t} + \gamma' X_{j,t} + \epsilon'_{j,t}$, where $\iota'_j$, $\eta'_{t,p}$, $\Xi'_{j,t}$ are, respectively, municipality, prefecture-year, and municipality-year fixed effects. Since the municipality-year specific trend $\Xi'_{j,t}$ is perfectly colinear with the regional allowances $RA_{j,t}$, this model does not identify $\beta$. However, now suppose an analogous model for older population: $\ln(\text{Older Pop})_{j,t} = \iota''_j + \eta''_{t,p} + \Xi'_{j,t} + \gamma'' X_{j,t} + \epsilon''_{j,t}$. Here, the regional allowances ($RA_{j,t}$) does not appear because it is assumed to have no effect on the older population. Note also that the municipality-year fixed effect ($\Xi'_{j,t}$) is assumed to be age-independent. Then, by subtracting the former by the latter, we obtain estimation equation (4).[29] The coefficient $\beta$ is therefore interpreted as the effect of the regional allowances on the young population.[30] The similar argument implies that $\beta_t$ in equation (5) is also interpreted as the effect on the young population.

As potential control variables, we use the logarithms of local tax revenue per capita, lump-sum transfer per capita, earmarked subsidies per capita, and the number of local officials per capita.[31] We also consider the average salary level of municipal public workers in some specifications. We weigh observations by population as of 2000. We use the cluster standard errors at the municipality level.

[29] To see this, note that we can define $\iota_j \equiv \iota'_j - \iota''_j$. Other variables are defined analogously.

[30] Note that the result is qualitatively the same even when we use the logarithm of the young population as the dependent variable.

[31] In the logarithmic transformation, one is added to the original number to avoid omitted data.

# 6 Main Empirical Results

## 6.1 Effects on Private Wages

Figure 5 shows the effect of public sector wages on private wages from the event-study specification (3). Given that the public sector wage reform led to a reduction in wages, note that the positive coefficients indicate the reduction in private sector wages. In each panel, $\beta_t$ is estimated based on the specifications with different sets of control variables. In all panels, there is little indication that the parallel trend assumption is violated in the pre-treatment period. Reflecting the fact that the reform of the regional allowances was gradually conducted from 2006 to 2010, the estimated $\beta_t$s in each panel gradually increase from 2006 to 2010 and take around 0.4 after 2011. The positive impact on private wages is also confirmed by Table 1, which reports the elasticity estimate of around 0.35 from the specification (2). In particular, our preferred estimate in column 2, which controls for individual characteristics, suggests that 1% public sector wage cut induces the decrease of private wages by 0.34%.[32] Given that the municipal-year fixed effect is controlled for in our triple-difference strategy, municipal-specific shocks would not explain this result. Therefore, this result suggests that the policy change in the regional allowances induced the spillover from the wage of the public workers to that of the private workers.

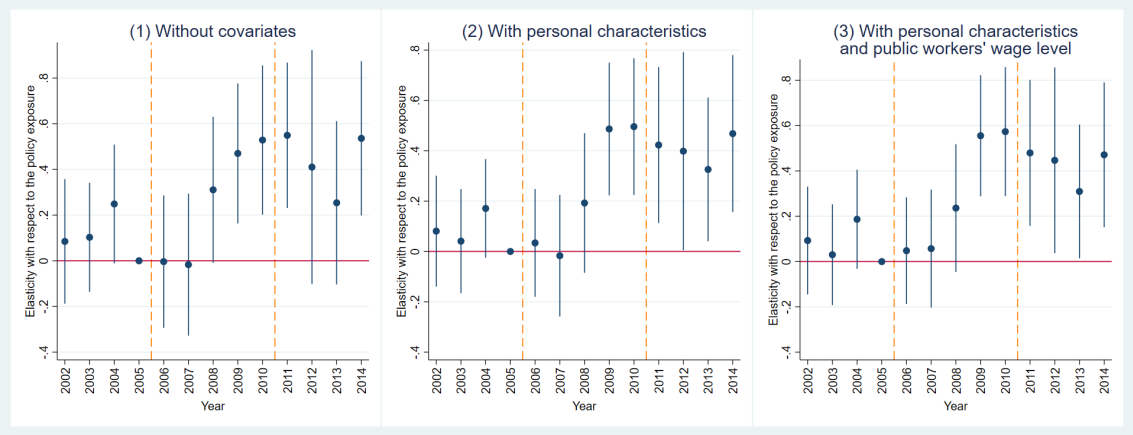
The identified effect of the public sector wage on the private wage is not only statistically significant but also economically meaningful. We illustrate this in two ways. First, we compare the effect size to the gender wage gap and college premium, two of the most salient wage disparities in data. The regional allowances rate $RA_{j,t}$ ranges 0–0.18 in our data, implying that moving from the lowest regional allowances rate to the highest increases the wages by roughly 6% ($0.34 \times 0.18 \simeq 0.06$). This amounts to about one-fifth of the gender wage gap and one-third of the college premium in our sample.[33] Second, the estimated elasticity implies a substantial aggregate impact on the private wages. In particular, we calculate in Section 7.4 that at the national level, the private sector wages decreased by 111.6 billion yen due to the policy reform.

The positive spillover effect on the private wages is suggestive that public sector wage increase improves workers' welfare. However, it is still inconclusive because the welfare effect also depends on other factors such as amenities (e.g., public goods and job amenities) and unemployment rates, which can also be affected by the public sector wage reform. In the next section, we analyze the impact of the public sector wage increase in population, which serve as a sufficient statistic for

[32] The estimated coefficients on control variables are consistent with the results of Kawaguchi (2011), which applies the Mincer wage equation to Japanese Data.

[33] We calculate the gender wage gap and college premium in our sample as follows. First, our regression results in column 2 of Table 1 include gender and college dummies, interacting with five-year age categories. We then construct the weighted average of gender dummies and college dummies, where the weight is the frequency of each age category in the sample.

**Figure 5:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010




Note: This figure shows the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Table 1:** Regression results on private sector wages based on (2)

| | (1) | (2) | (3) |
|---|---|---|---|
| | log(wage rate of private workers) | | |
| Regional allowances × Young dummy | 0.3580*** | 0.3410*** | 0.3785*** |
| | (0.1119) | (0.0981) | (0.0924) |
| log(base wage of local municipal workers) | | | 0.0761*** |
| | | | (0.0104) |
| Year fixed effect | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes |
| $N$ | 12161479 | 12161479 | 11638820 |
| $R^2$ | 0.266 | 0.519 | 0.513 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The regression results of estimating equation (2) are presented. In columns (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in column (3). Note that the sample size of column (3) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

qualitative welfare implications in the theoretical framework of Section 2.

## 6.2 Effects on Young Population

**Effects on Young Population.** Figure 6 shows the impact of public sector wages on the young population from the event-study specification (5). In all specifications, the downward trend in the young population (relative to older population) in municipalities that experienced an increase in public wages stopped after 2006. This indicates that the increase in the public wage stopped the decline in the young population. Therefore, this result supports the prediction that the increase in the public wage induces the inflow of the young population.

Table 2 reports the elasticity of the young population with respect to public wages from the regression specification (4). In Columns (1)-(3), we find the elasticity around 0 for all specifications. However, this regression estimate of the public-wage elasticity is misleading because it does not take account of the preexisting trends apparent in Figure 6, leading to substantial underestimation of the true elasticity of the public sector wages. To correct for this underestimation, in Columns (4)-(6), we take account of the pre-existing trends by following a common detrending procedure of the outcome variable (e.g., Kleven, Landais, Saez and Schultz 2013; Monras 2019; Garcia-López, Jofre-Monseny, Martínez-Mazza and Segú 2020).[34] Columns (4)-(6) show that the young population becomes about 0.4% smaller in response to a 1% cut in public sector wages, after controlling for preexisting trends. In particular, our preferred in column 5, which takes account of observable municipality-year control variables and pre-existing trends, suggests that young population decreased by 0.41% in response to 1% cut in public sector wages.

Figure A.4 in Appendix presents the additional analysis where the dependent variable is the logarithm of the young population, rather than the ratio of the young population to the older population, in the event-study specification (5). Consistent with Figure 6, it shows that the young population increased in municipalities that experienced an increase in the public wage after 2006. Figure A.5 in Appendix conducts a similar analysis to Figure A.4 but the outcome variable is replaced with the logarithm of the older population. Figure A.5 shows little indication that there was an effect on the older population. These results are consistent with our identification assumption that only the young workers are primarily affected by the public sector wage reform.

[34] Specifically, to construct the detrended outcome variable $\widetilde{\ln(\text{YO ratio of Pop})}_{ijt}$, we first estimate the municipality-specific pretrend by the following equation

$$\ln(\text{YO ratio of Pop})_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{jt} \quad \text{for} \quad t < 2006.$$

We make predicted values of $\ln(\text{YO ratio of Pop})_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\ln(\text{YO ratio of Pop})}_{jt}$.

**Welfare Implications based on a Spatial Equilibrium Model.** In light of our spatial equilibrium model in Section 2, the decrease in the young population in response to public sector wage cut implies that the wage cut harmed young workers' welfare. This result leads to several policy implications. For instance, public sector wage cuts to achieve fiscal consolidation, which was widely adopted in many countries in the aftermath of the Global Financial Crisis (Forni and Novta 2014), may have harmed young workers. Another implication is that raising the public sector wages may be an effective policy tool to achieve wage increase and improve welfare, which may be particularly useful when wages stagnate due to prolonged recession, as in the Japanese context (as suggested by, for example, Bernanke 2017).

That said, it should also be noted that the public sector wage cut may be beneficial for older workers. First, the wage spillovers and the opportunity of getting a better job in the public sector may be irrelevant for older workers, which is likely to be the case in our context in which there is little opportunity for older workers to get a public sector job. Second, the decreased young population may lower land prices, which decreases the housing cost of older workers. In contrast to young workers that are mobile, the lower housing cost may actually increase the older workers' welfare (see Section 2). Consistent with the lower housing cost due to the out-migration of young workers, Section 7.2 provides suggestive evidence that the public sector wage cut had a negative impact on land prices. Overall, the welfare effect of the public sector wage cut would be heterogeneous across workers with different age: young workers likely suffered from the public sector wage cut but older workers might have benefited from it.

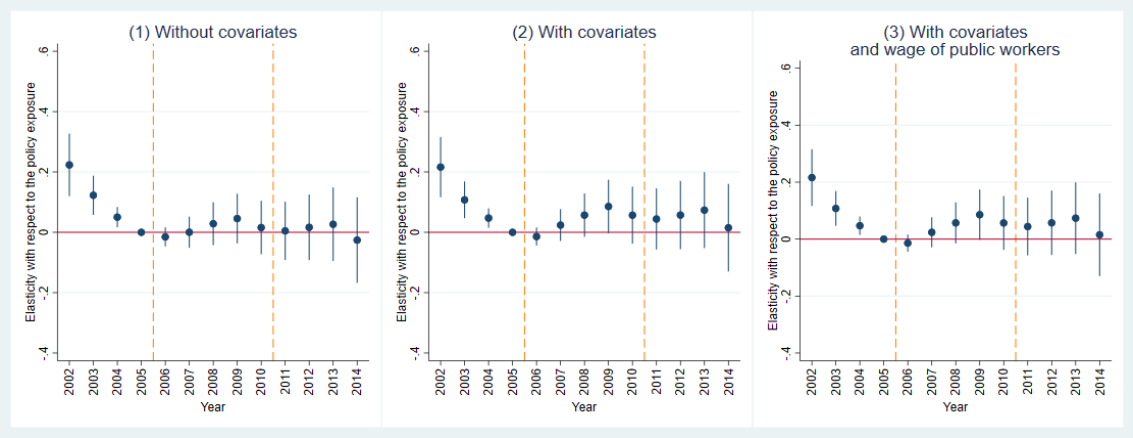
## 6.3 Share of Public Sector Workers

We may naturally hypothesize that the influence of the public sector would be stronger in areas with a higher share of public sector workers. To understand this heterogeneity, we repeat the same analysis as Sections 6.1 and 6.2 to the two subsamples, where the sample was split by the share of public workers in that region: one is regions with higher-than-median municipal public workers per capita and the other is regions with lower-than-median. In our data, the median number of municipal public workers per capita is about 0.01, i.e. one municipal public worker for every 100 residents.[35] We expect the effects of public sector wages on private wages and young population to be stronger in the sample with a higher share of public sector workers.

Consistent with this hypothesis, our results show that the impact of public wages is larger in municipalities with a larger share of public employees. For the effect on private wages, Figure 7 and Table B.1 show the results. Figure 7 shows that the spillover of public wage on the private wage

[35]Strictly speaking, it is 0.0098 for the data of private wage, 0.0120 for the data of population, and 0.0106 for the data of land price in FY2005.

**Figure 6:** The elasticity of the young population in year $t$ with respect to the regional allowances change during 2006-2010




Note: This figure shows the estimated $\beta_t$ for each year in the eq.(5) that the logarithm of the ratio of young to older population is the dependent variable. As discussed in Section 5, this corresponds to the elasticity of the young population in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. In all panels, we control municipal, year, and prefecture-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

**Table 2:** Regression results on the young population based on (4)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | log(YO ratio of Pop) | | | $\widetilde{\log(\text{YO ratio of Pop})}$ | | |
| Regional allowances | -0.0748 | -0.0246 | -0.0269 | 0.4609*** | 0.4065*** | 0.3730*** |
| | (0.0550) | (0.0556) | (0.0560) | (0.1069) | (0.1043) | (0.1029) |
| log(tax revenue per capita) | | 0.0534*** | 0.0544*** | | -0.0897*** | -0.0748*** |
| | | (0.0176) | (0.0178) | | (0.0243) | (0.0234) |
| log(LAT per capita) | | 0.0033 | 0.0032 | | 0.0065** | 0.0065* |
| | | (0.0022) | (0.0022) | | (0.0032) | (0.0034) |
| log(NTD per capita) | | 0.0012 | 0.0013 | | -0.0019 | -0.0005 |
| | | (0.0021) | (0.0021) | | (0.0037) | (0.0036) |
| log(municipal public workers per capita) | | 0.0173* | 0.0168* | | -0.0444*** | -0.0517*** |
| | | (0.0093) | (0.0093) | | (0.0160) | (0.0158) |
| log(base wage of local municipal workers) | | | -0.0224 | | | -0.3305*** |
| | | | (0.0311) | | | (0.0453) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Prefecture-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Detrended outcome variable | No | No | No | Yes | Yes | Yes |
| $N$ | 22503 | 22503 | 22503 | 22503 | 22503 | 22503 |
| $R^2$ | 0.967 | 0.967 | 0.967 | 1.000 | 1.000 | 1.000 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results of estimating equation (4) that the logarithm of the ratio of young to older population, log(YO ratio of Pop), and its detrended variable, $\widetilde{\log(\text{YO ratio of Pop})}$, are the dependent variables are presented. As discussed in Section 5, this allows us to estimate the elasticity of young population with respect to public sector wages. Young and older populations correspond to the 15-29 and 30-64 age groups, respectively. $\widetilde{\log(\text{YO ratio of Pop})}$ is the value that detrended the 2002-2005 region-specific linear trends from log(YO ratio of Pop). Specifically, to construct the detrended outcome variable $\widetilde{\log(\text{YO ratio of Pop})}_{jt}$, we first estimate the municipality-specific pretrend by the following equation

$$\ln(\text{YO ratio of Pop})_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{jt} \quad \text{for} \quad t < 2006.$$

We make predicted values of $\ln(\text{YO ratio of Pop})_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\ln(\text{YO ratio of Pop})}_{jt}$.

The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in Columns (3) and (6) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

is larger in the regions with more public workers, especially in the post-treatment period 2011–2014. Moreover, while the coefficients are statistically significant after the policy reform in regions with a higher share of public sector workers, the significance is more limited in regions with a lower share. Consistent with this, Table B.1 shows that while the size of coefficients in the specification (2) for the regions with the higher-than-median are 0.38 in panel (a), the corresponding estimates are around 0.27 for the regions with lower-than-median municipal public workers per capita.

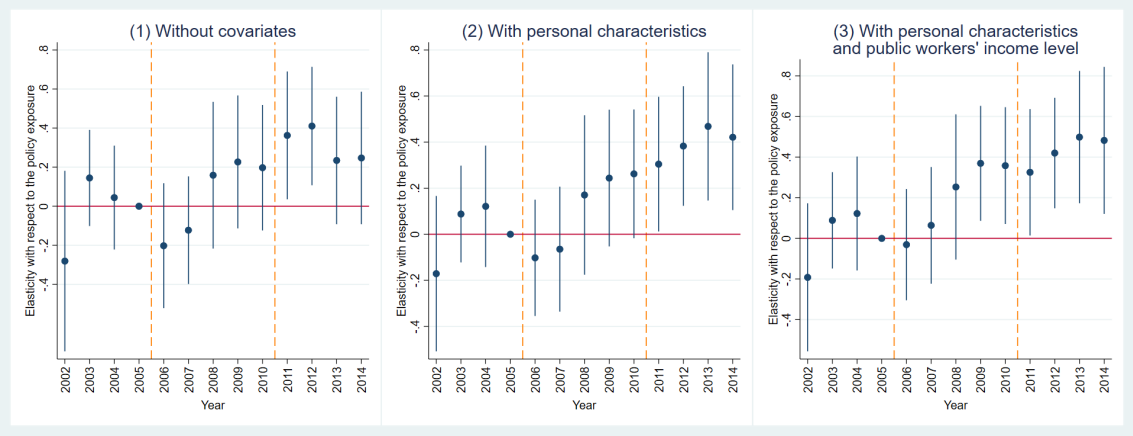
For the effects on the young population, Figure 8 and Table B.2 show the results. Figure 8 shows that the larger pre-existing trend can be seen for the region with many public workers compared with the region with few public workers, while such trends changed after 2006 in both regions. This suggests that the policy effect of public wage reduction on the young population is larger for the regions with many public workers when the pre-existing trend is controlled. Table B.2 indeed shows that after the pre-existing trend is removed, the magnitude of coefficient is around 0.66 in the regions with many public workers and the ones for the regions with few public workers 0.37.

Overall, the effects of public sector wages on private wages and young population are all larger in areas with higher share of public workers. Given the relatively small share of public sector workers in Japan compared to other OECD countries (OECD 2021), the results in this section suggests that our main estimates in Section 6 may potentially serve as a lower-bound for the effects of public sector wages in other countries. Moreover, the larger effects in areas with higher share of public workers suggests that our empirical analysis indeed captures the effects of public sector wages, but not other confounding factors. Indeed, it would be difficult to explain the heterogeneous effects with respect to the public worker share if our results are spuriously driven by confounding factors unrelated to the public sector.[36]

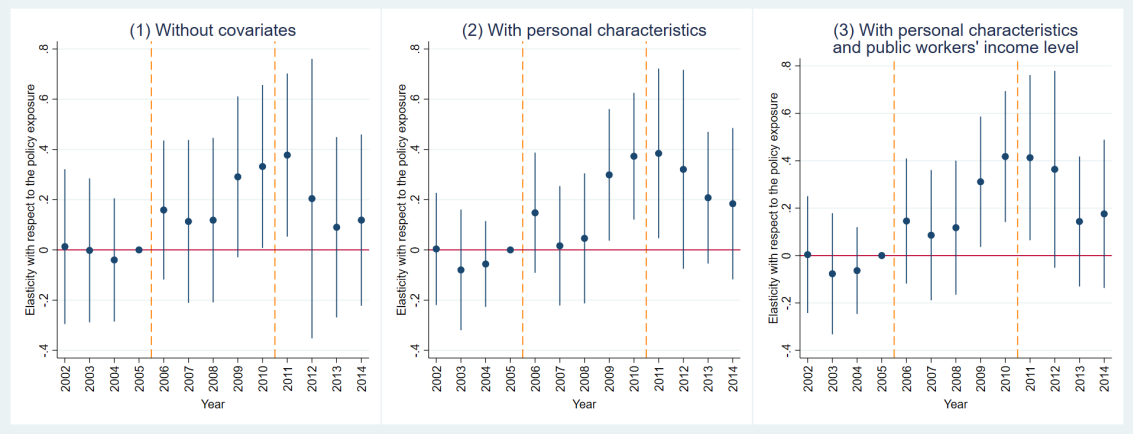
[36]In addition to the wage and young population analyses, we also confirm that the similar analyses of young unemployment and land prices show larger effects in areas with a higher share of public workers. The results are available from the authors upon request.

**Figure 7:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010 in the regions with a higher- and lower-than-median share of public employees

**(a)** Analysis for the regions with a higher-than-median share of public employees



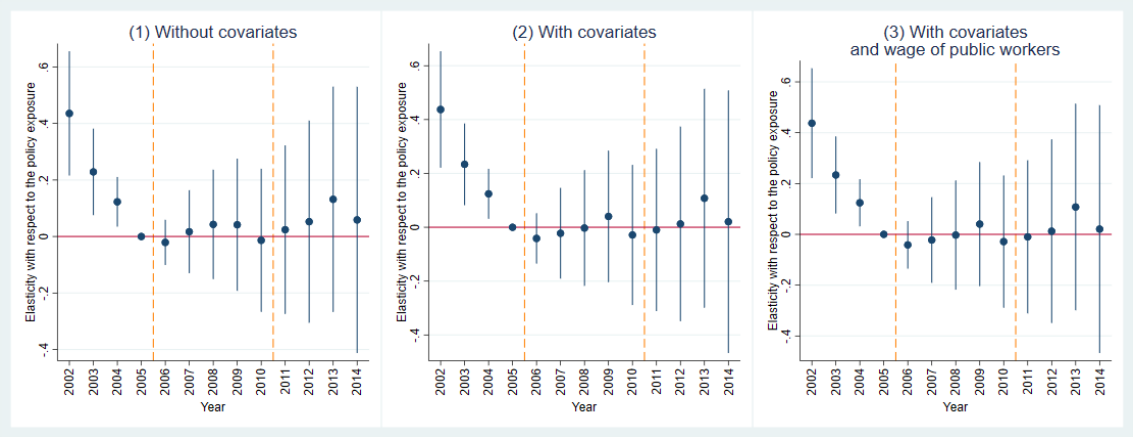

**(b)** Analysis for the regions with a lower-than-median share of public employees



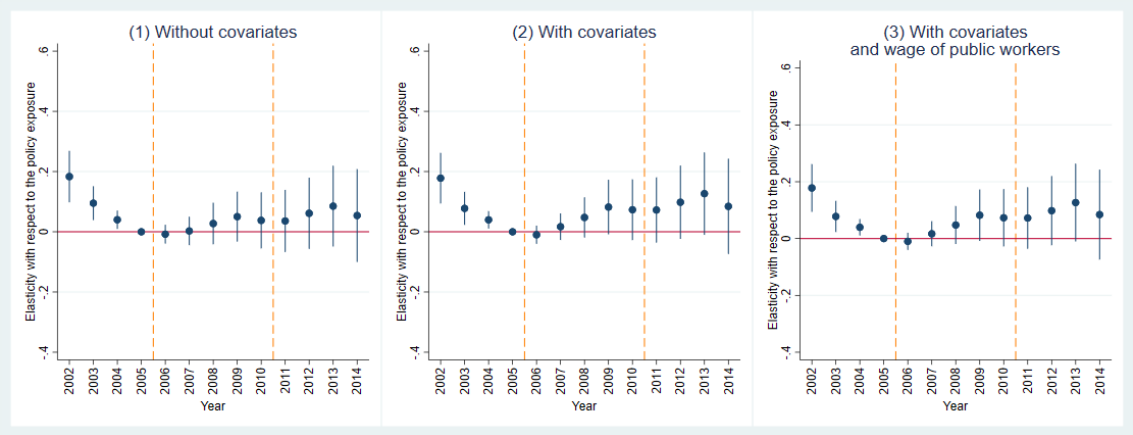

Note: These figures show the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to regions with a higher-than-median (lower-than-median) share of public employees in 2005 to make figures (a) and (b). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. We control covariates about individual characteristics (age dummies, university dummy, gender dummy, and their interactions) and the logarithm of prescribed working hours in panels (2) and (3). The salary level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in column (3) although it is not controlled in the other columns. Note that the sample size of column (3) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Figure 8:** The elasticity of the young population in year $t$ with respect to the regional allowances change during 2006-2010 for the regions with a higher- and lower-than-median share of public employees

**(a)** Analysis for the regions with a higher-than-median share of public employees




**(b)** Analysis for the regions with a lower-than-median share of public employees




Note: This figure shows the estimated $\beta_t$ for each year in the eq.(5) that the ratio of young to older population is the dependent variable. As discussed in Section 5, this corresponds to the elasticity of the young population in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to regions with a higher-than-median (lower-than-median) share of public employees in 2005 to make panels (a) and (b). In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

# 7 Additional Analysis

We also conduct several supplementary analysis. Section 7.1 estimates the effect of public sector wages on youth unemployment rates, finding that public sector wage cut might increase youth unemployment rates. Section 7.2 estimates the effect on land prices. We find that public sector wage cut decreases land prices consistent with population decline found in Section 6.2. Section 7.3 the heterogeneous effects on private sector wages with respect to gender, education attainment, and firm size. We find that the wage elasticity is larger for women and less-educated workers, while we find little heterogeneity in terms of firm size. Section 7.4 presents further additional results. We first investigate sensitivity of our results to largest cities and public sector wages of neighboring municipalities, finding that our results are robust to these considerations. We also calculate based on our estimates the national-level impacts of the 2006–2010 public sector wage cut calculated based on our estimates.

## 7.1 The Effects on Youth Unemployment Rates

So far, we have focused on the private wage of young workers and young population as the outcomes of the analyses. In addition to these outcomes, the unemployment rate may depend on the public sector wage rate in our theoretical framework in Section 2 and Appendix D.[37] Therefore, we analyze the effect of the change in the regional allowances on the unemployment rate through the regression based on the specification of (4) and (5). We note upfront that our results on unemployment should be interpreted with caution because of data frequency: the data of unemployment rate at the municipality level is available only for census years (2000, 2005, 2010, 2015). We use the linear interpolation for intermediate years.

We use the municipality-level panel data for analyzing the unemployment rates. We use the specifications (4) and (5), where the outcome variables are replaced with the log ratio of the unemployment rate of young workers to that of older workers. By the same argument as in Section 5, the estimate corresponds to the elasticity of the unemployment rate of young workers with respect to public sector wages. Figure A.6 and Table B.3 present the results. Figure A.6 indicates that although there is overall positive trend, the increase in the unemployment rate became smaller after 2005 in municipalities that did not experience the public-sector wage cut. In terms of the magnitude of the effect, Columns 4–6 of Table B.3, which take account of the positive preexisting trend, show that 1% increase in the regional allowances reduces around 0.49% of the unemployment rate for young workers. Although the estimate is somewhat noisy and statistically insignificant, it indicates

[37]Note that population and land prices serve as sufficient statistics for the qualitative welfare implication in our theoretical framework, and they are inclusive of the potential welfare effects through unemployment. Yamagishi (2021) makes a similar argument in the context of minimum wages.

the possibility that public sector wage cuts might exacerbate youth unemployment rates.

Overall, we find suggestive evidence that the unemployment rate of young workers increased in response to the public sector wage cut. Note our result on the unemployment rate is consistent with the monopsony power of private firms in the labor market.[38] Indeed, for young workers, private wages fall unemployment rate rises, which would happen if the public wage cut exacerbates monopsony power in the labor market so that both wages and employment fall.

## 7.2 The Effects on Land Prices

We have shown in Section 6.2 that the young population decreased in response to the cut in the public sector wages. The decreased population is, in turn, predicted to lower land prices due to weaker housing demand (see our theoretical framework in Section 2).

Motivated by this, this subsection analyzes land prices. We use the municipality-level panel data for analyzing land prices. We use the specifications (4) and (5), where the outcome variables are replaced with the log land price index.

Figure A.7 and Table B.4 show the results for the effect on the land prices. In Figure A.7, the effect of public wage on the land price can be seen after the reform, where the elasticity is about 0.5. Table B.4 shows that 1% decrease in public sector wages induces 0.54% decrease in land prices.[39]

Overall, we find evidence that land prices decreased in response to the public sector wage cut, which is consistent with the decrease in population found in Section 6.2. Based on our theoretical prediction in Section 2, the decreased land prices suggest that the welfare of young workers decreased. However, the decline in land prices may have benefited older workers, who are unlikely to be affected by the public sector wage cut in the labor market but benefit from the decreased housing cost (see the discussion in Section 6.2). As such, the land price responses are indicative that the public sector wage cut may have harmed young workers, but not older workers.

## 7.3 Heterogeneity in the Effects on Private Wages

We investigate the heterogeneity in the effect on private wages with respect to firms' and workers' characteristics. In summary, we find that the effects of public sector wages on private wages tend to be larger for non-college-educated workers and women, while the effect is similar across the firm size.

[38] Azar, Huet-Vaughn, Marinescu, Taska and Von Wachter (forthcoming) shows that the monopsony power tends to be larger in areas with low population density. The monopsony power in our context is consistent with this because the public wage cut had a larger negative impact on private wages in rural areas (Section 6.3).

[39] When analyzed as in Section 6.3, we also find that the elasticity is larger for regions with higher share of public workers: 1.03 for regions with the higher share and 0.46 for regions with the lower share. This is consistent with Section 6.3 that population decrease by more in regions with higher share of public workers.

**Gender.** Figure A.9 and Table B.7 present the estimated elasticity of private wages, separately for men and women. Although the estimates are somewhat noisy, they suggest that the wage spillover might be larger for women. Specifically, Table B.7 shows that the estimated elasticity is around 0.25 for men but around 0.33 for women, after the inclusion of control variables.

The larger spillover for women may be natural given that the public sector jobs have been more attractive options for women. In particular, studies have documented that the gender wage gap is smaller in the public sector (Gregory and Borland 1999; Morikawa 2016) and other job amenities, such as low unemployment risk and childcare, are attractive for women (Gomes and Kuehn 2019). If so, private firms trying to recruit women in the labor market may need to compete more fiercely with the public sector, making them more responsive to the wage rate in the public sector.

**Education.** A subsample analysis of college graduates and non-graduates finds that non-graduates are more affected by the public wages of the local municipality. Figure A.8 and Table B.6 respectively show that the elasticity of the private wages is around 0.36 and statistically significantly positive for the non-university graduates, but it is near zero and insignificant for the university graduates after including control variables. Given that our research design exploits the variation in the public sector wages across municipalities, this result implies that the private wages for university graduates less refer to the public wage in the local municipality, while the private wage for non-college graduates is heavily influenced by it.

We view this result as stemming from the locality of job search of non-college graduates. First, studies have documented that the geographical scope of job search is generally narrower for non-college graduates (Kaplan and Schulhofer-Wohl 2017; Marinescu and Rathelot 2018). Moreover, the Japanese institutional setting reinforces the locality of job search in the labor market for high-school graduates. In Japan, firms first send job postings to high schools, and high schools allocate the job openings to their students (Genda et al. 2010). Since it is rare for students themselves to apply for jobs and firms are likely to send their job postings to nearby high schools, this institutional system limits the geographical scope of job search for high-school graduates. In contrast, college graduates are generally more mobile and they search for more distant jobs. As a result, in hiring a worker, firms that are recruiting non-college graduates are more likely to recruit within the municipality, and the labor market competition for workers is more likely influenced by the public sector wage rate in the same municipality, the level of our identifying variation. Overall, our result that public wages affect the wages of non-college graduates but not those of college-graduates could stem from the local nature of our identifying variation.[40]

[40]Therefore, other variations of public sector wages (e.g., nationally-uniform reform) might detect a significant impact on college-graduate workers (c.f., Telegdy 2018).

**Firm size.** We analyze whether large and small firms differently react to public sector wages. Figure A.3 and Table B.5 show the results of the subsample analysis by whether the worker belongs to a company with over 100 employees or not.[41] Table B.5 shows that the effect of public wage on private wages is around 0.27 for workers with over 100 employees and 0.22 for those with less than 100 employees. Figure A.3 confirms a similar tendency and shows that the effect of public wages on private wages is similar for both small and large companies. Therefore, both large and small firms might be similarly influenced by public sector wages.

## 7.4 Other Additional Analyses

**Sensitivity of results to largest cities.** We confirm that our result is not due to the fact that the increased regional allowances rates are concentrated in the three major metropolitan areas centred on Tokyo, Osaka and Nagoya. While excluding these areas from the sample in the analysis, Table B.8 replicates Table 1 for private wages of young workers and Table B.9 replicates Table 2 for young population. In this analysis, the coefficients for the policy effect tend to be larger than in the baseline analyses. This may be because areas other than the three largest metropolitan areas tend to have a higher share of public employees, and the policy effect of public employees was more significant as discussed in Section 6.3.

**Public sector wages of neighboring municipalities.** We analyze the possibility that not only the public sector wage rate of the own municipality, that of neighboring municipalities may also affect the outcomes.[42] For this purpose, we use the so-called "SLX" model in spatial econometrics (Halleck Vega and Elhorst 2015), which adds to our main regression the spatial lag that summarizes the regional allowances rates of neighboring municipalities. Adding such spatial lag term, Figure A.12 and Table B.10 repeat the analysis of Figure 5 and Table 1 for private wages. Similarly, Figure A.13 and Table B.11 repeat the analysis of Figure 6 and Table 2 for young population. The result of this analysis shows that the effect of regional allowances has a slight positive spillover effect on the neighboring municipalities, especially for the young population, but such an effect is limited. Reassuringly, the inclusion of the spatial lag does not change the main result, which implies that our baseline result is robust.

[41] The threshold of 100 is chosen because the government sets public sector wages referring to the private wage rates of firms with more than 100 employees, arguing that the working conditions are similar to those in the public sector (Aoki 2021).

[42] Such spatial spillover effects can arise for various reasons. For instance, general-equilibrium impacts of migration responses might induce such spillovers as migration inflow in one region may entail population outflow in other regions (Borusyak, Dix-Carneiro and Kovak 2022). Another reason could be that in setting their wage rates, private firms use as yardsticks not only the public wage rates in the own municipality but also those in neighboring municipalities (Besley and Case 1995; Kishishita and Yamagishi 2021).

**National-level aggregate economic impacts.** Based on our elasticity estimates of the effects of public sector wages on local economy we have presented so far, we quantify the national-level aggregate economic impacts of the public wage cut during 2006–2010, the policy reform analyzed in this paper. As discussed in Section 3, the public wage reform was intended to improve fiscal balance by reducing the base wage of public workers, although the public wage reform increased local public wages in some municipalities due to the increase in regional allowances. However, as our analyses show, the effect of this reform has not been limited to reductions in public wages, but has also been linked to declines in private-sector wages, land prices, and increases in the youth unemployment rate.[43] While such potential side effects were recognized by some policymakers (see, for example, House of Representatives 2015), we provide quantitative evidence on such side effects. We briefly present results in the main text, and Appendix E provides technical details.

We first calculate the fiscal benefit from the policy reform. In line with the Japanese government's estimate (House of Representatives 2015), we estimate that other things being equal, the public wage reform was estimated to reduce local public wages by about 200 billion yen in 2010.

However, as our analyses show, the effect of this reform has not been limited to reductions in public wages, but has also been linked to declines in private-sector wages, land prices, and increases in the youth unemployment rate. While such potential side effects were recognized by some policymakers (see, for example, House of Representatives 2015), we provide quantitative evidence on such side effects. Taking into account the differences in public wage changes by region and the result of our estimates, we calculate that at the national level, the public wage reform would have reduced the wages of young full-time workers by about 111.6 billion yen, reduced the taxable assessed value of land by about 193.9 billion yen, and increased youth unemployment by about 10,470 in 2010. It is important to recognize the possibility that the fiscal benefit of 200 billion yen might accompany negative effects on private wages and unemployment of young workers and land prices.[44]

# 8 Conclusion

This paper studies how public sector wages affect the local economic outcomes in the private sector, especially wages and population of young workers. We address the identification challenges by

[43]Note that the national-level impact on population is nearly zero since international migration is negligible in our context. For example. just about 0.0001% of the total population moved out of Japan from 2009 to 2010.

[44]The presence of personal income tax and residential tax on labor income and property tax on land implies that the actual fiscal benefit could be significantly smaller than 200 billion yen. In particular, assuming the marginal income tax rate of 10%, the residential tax rate of 10%, and the property tax rate of 1.4% based on the Japanese tax system, the income tax revenue decreases by about 40 billion yen and the property tax revenue by 2.7 billion yen, implying that the actual fiscal benefit might be around 157.3 billion yen. While this back-of-the-envelope calculation is incomplete because it misses other taxes (e.g., corporate income taxes), it illustrates that taking into account the side effects of the public wage reform is important just for estimating the fiscal benefit of the reform.

exploiting Japanese national policy reform that created cross-section variation in the public sector wages and the institutional setting in which young workers are primarily affected by the public sector in the labor market. We find that young workers experience around 0.34% wage decrease in the private labor market in response to 1% cut in the public sector wages. We also find that 1% cut in the public sector wages decreases the young population by around 0.41%. Moreover, these effects are even larger in areas with larger share of public sector workers, which confirms that our empirical estimates indeed capture the effects of public sector wages. These results imply that increasing public sector wages enhances young workers' welfare in light of our simple spatial economic model. Overall, our paper provides novel quasi-experimental estimates on the effects of public sector wages on the private sector, and such effects should be taken into account in considering the impact of public sector wage reforms.

We close this paper by reminding that since our identification is based on the local variation in public sector wages within a country, the effect size may be different when the policy reform is at the national level. This is an inherent problem in recent empirical studies that exploit cross-section variation to shed light on macroeconomic issues, and a carefully-designed structural model may be useful in bridging the effects of local policy changes to the effects of the national one (Nakamura and Steinsson 2018). Using quasi-experimental variation to infer the national-level public wage reform in the context of public sector wages is an important next question.

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# Appendix to "The Effects of Public Sector Wages: A Local Labor Market Approach" (Not for Publication)


A Omitted Figures A1

B Omitted Tables A13

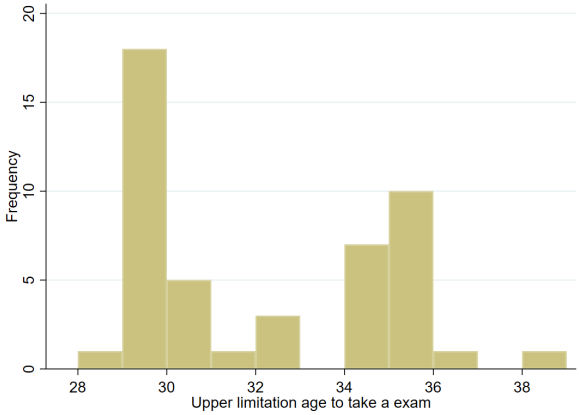
C Summary Statistics A24

D A Formal Exposition of the Theoretical Framework A26

E Details on Calculating the Aggregate Economic Impact A29

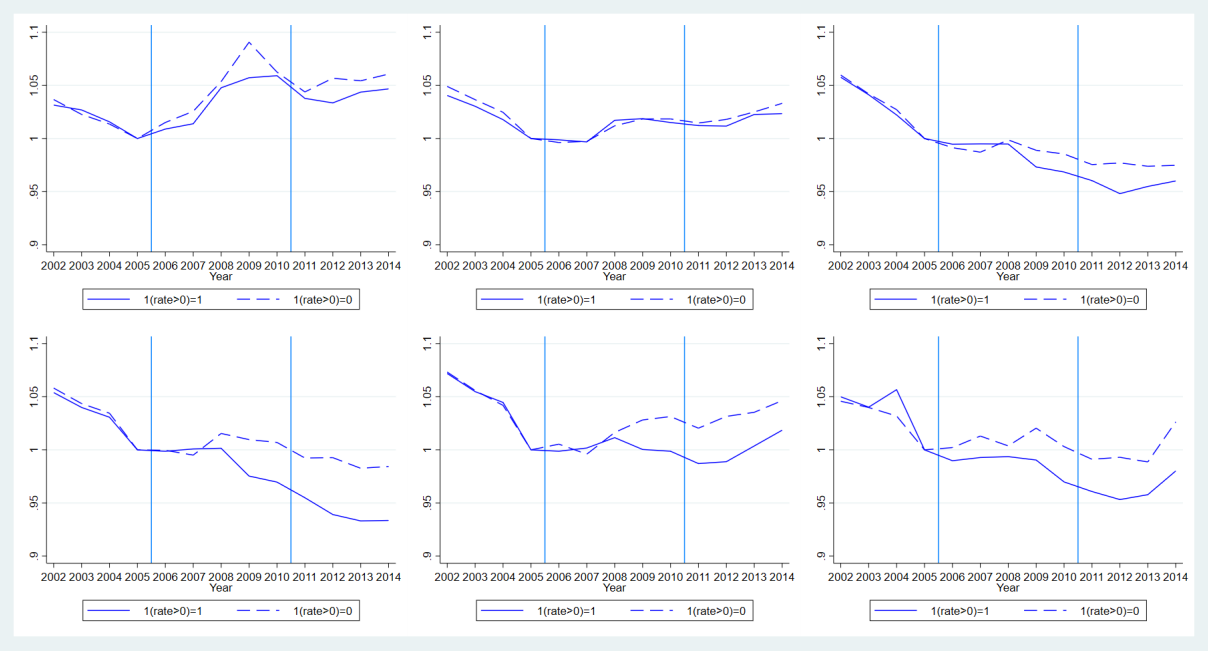

# A Omitted Figures

**Figure A.1:** Upper age limit for taking the employment examination in 47 prefectures




Source: https://90r.jp/nenrei.html. Note: The histogram shows the frequency of the upper age limit for taking the 2016 employment examination for general administration workers in 47 prefectures.

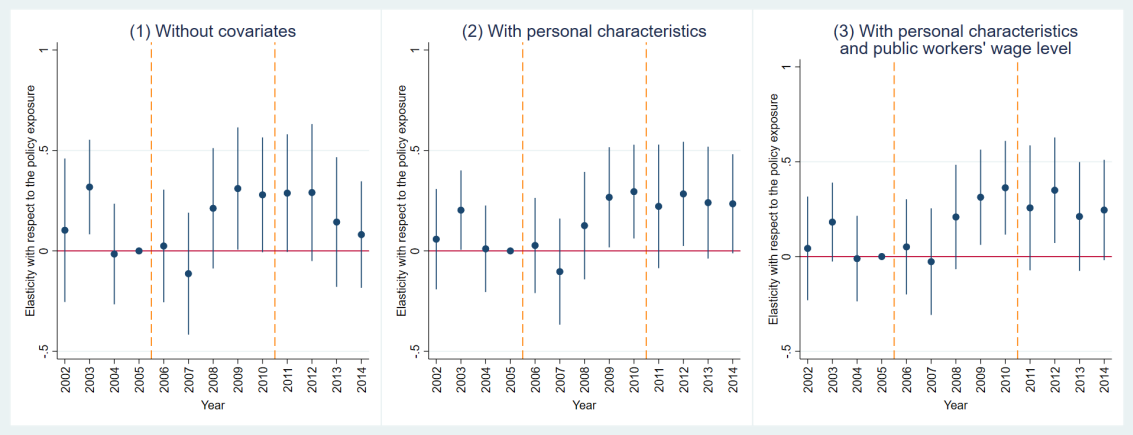
**Figure A.2:** The trend of average wages by location of regional allowances payment by age groups



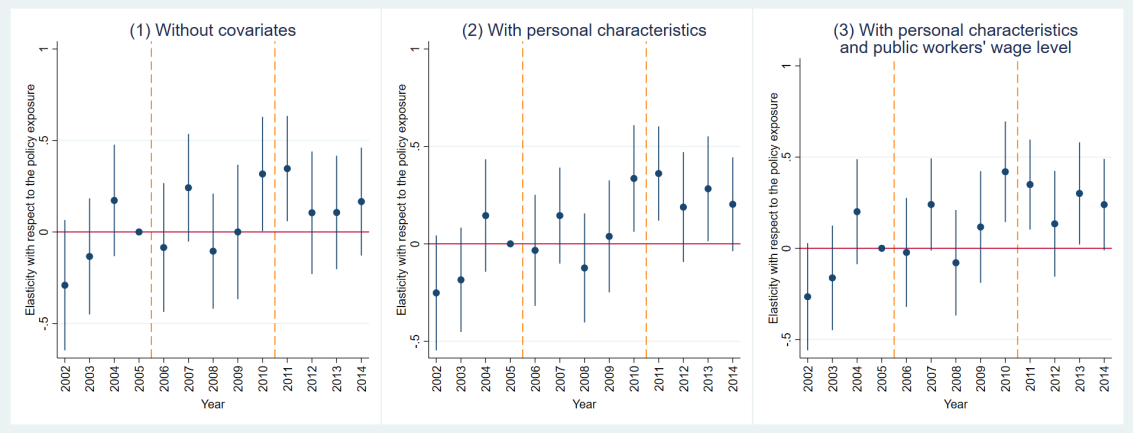

Note: Each panel shows average wages normalized as 1 to the 2005 level by the location of the regional allowances payment for each age group. The solid and dashed lines show, respectively, the average wage in areas where regional allowances were paid at least once and in areas where regional allowances were never paid.

**Figure A.3:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010

**(a)** Analysis for workers belonging to large companies (with over 100 employees)

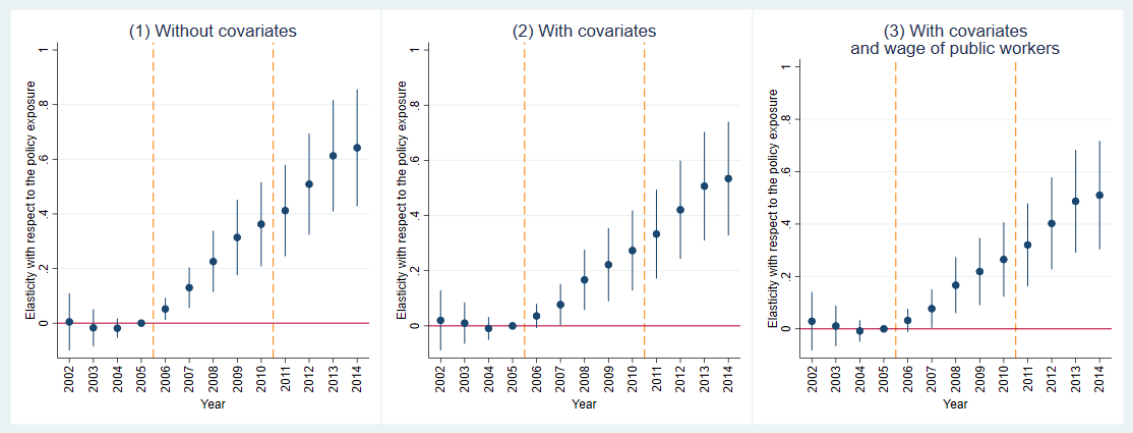



**(b)** Analysis for workers belonging to small companies (with less than 100 employees)



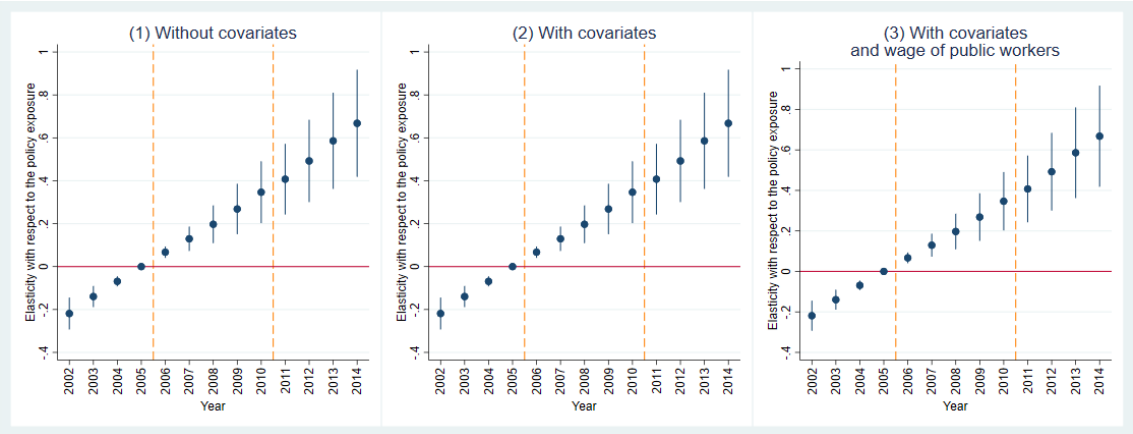

Note: These figures show the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to the workers belongs to companies with over (less than) 100 employees to make figure (a) ((b)). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Figure A.4:** The elasticity of the population aged 15-29 in year $t$ with respect to the regional allowances change during 2006-2010



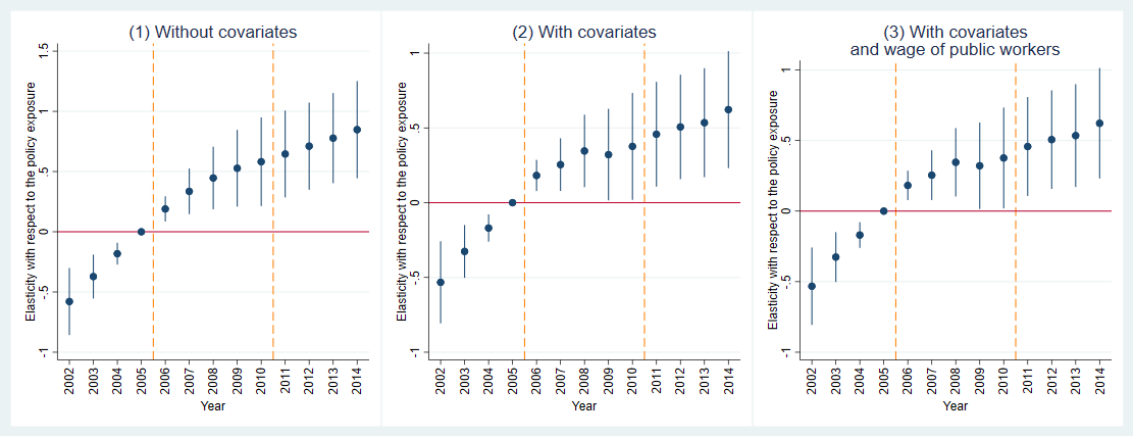

Note: These figures show the estimated $\beta_t$ for each year in the eq.(5) that the population aged 15-29 is the dependent variable. This corresponds to the elasticity of the population aged 15-29 in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

**Figure A.5:** The elasticity of the population aged 30-64 in year $t$ with respect to the regional allowances change during 2006-2010



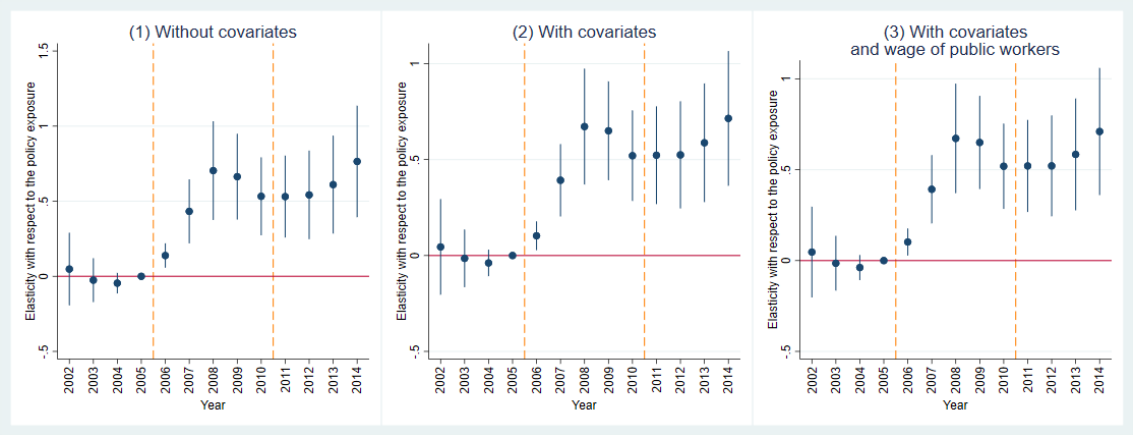

Note: This figure shows the estimated $\beta_t$ for each year in the eq.(5) that the population aged 15-29 is the dependent variable. This corresponds to the elasticity of the population aged 15-29 in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. In all panels, we control municipal, year, and prefecture-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

**Figure A.6:** The elasticity of the ratio of young and old unemployment rate in year $t$ with respect to the regional allowances change during 2006-2010




Note: These figures show the estimated $\beta_t$ for each year in the eq.(5) that the dependent variable is the ratio of young and old unemployment rate. This corresponds to the elasticity of the ratio of the unemployment rate for the 15-29 year olds and the unemployment rate for the 30-64 year olds in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. The unemployment rate is a linear interpolation of five-year census data to one-year data. 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and prefecture-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3).

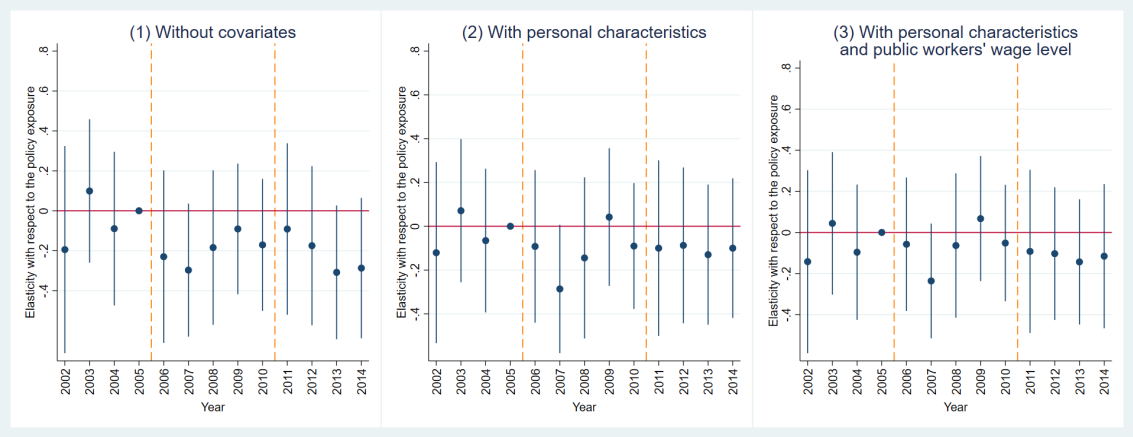
**Figure A.7:** The elasticity of land price in year $t$ with respect to the regional allowances change during 2006-2010



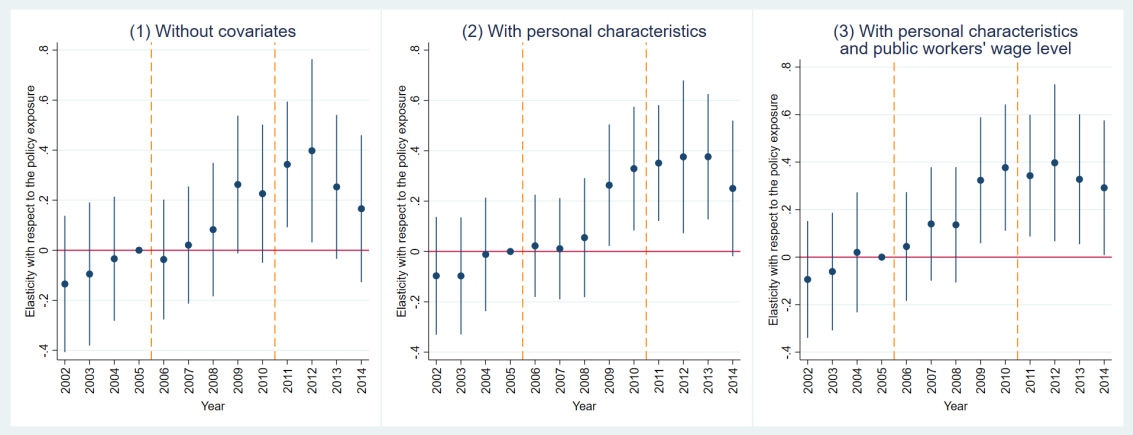

Note: These figures show the estimated $\beta_t$ for each year in the eq.(5) that land price is the dependent variable. This corresponds to the elasticity of land price in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

**Figure A.8:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010

**(a)** Analysis for the university graduates



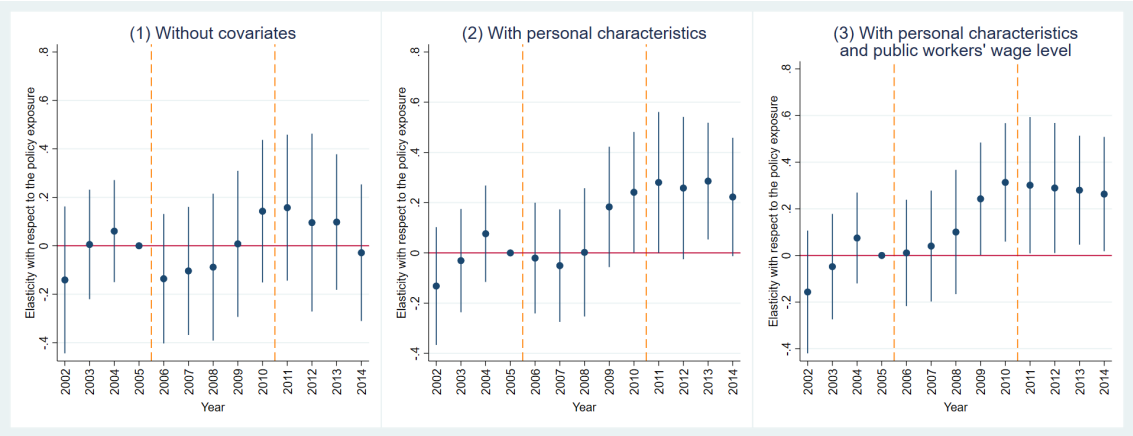

**(b)** Analysis for the non university graduates



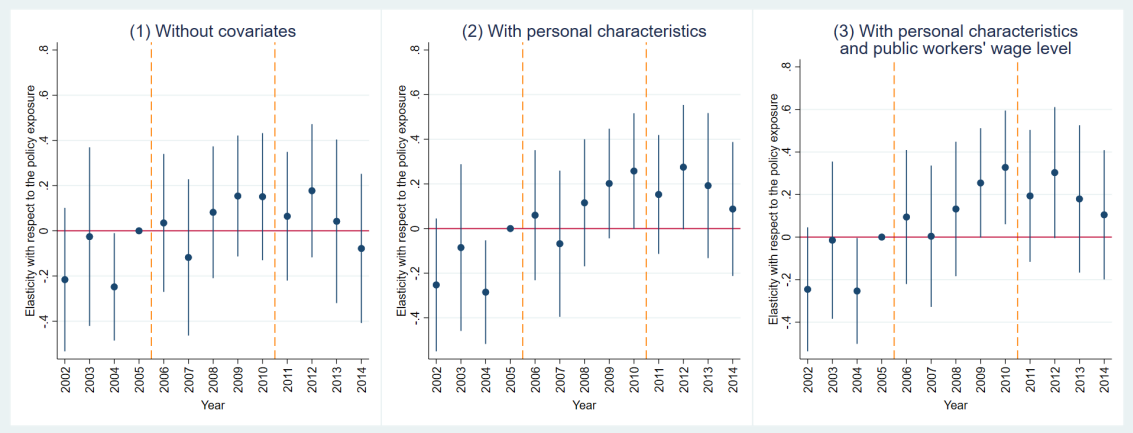

Note: These figures show the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to the (non) university graduates to make figure (a) ((b)). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Figure A.9:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010 for men and women

**(a)** Analysis for men

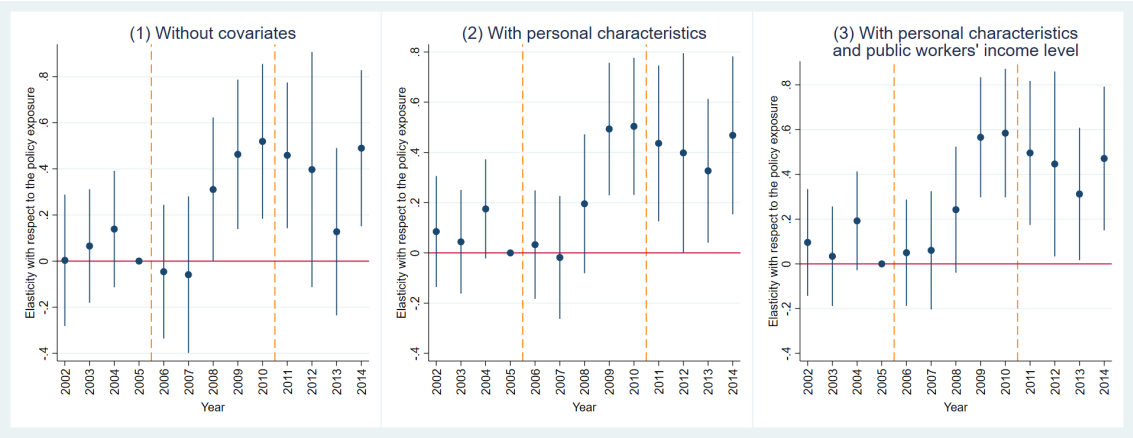



**(b)** Analysis for women



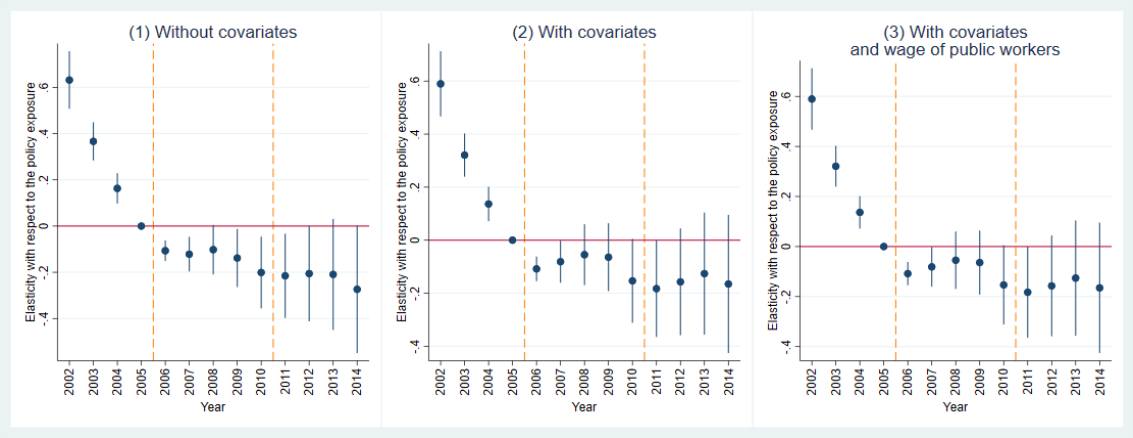

Note: These figures show the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to men (women) to make figure (a) ((b)). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Figure A.10:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010 for the regions other than three largest metropolitan areas



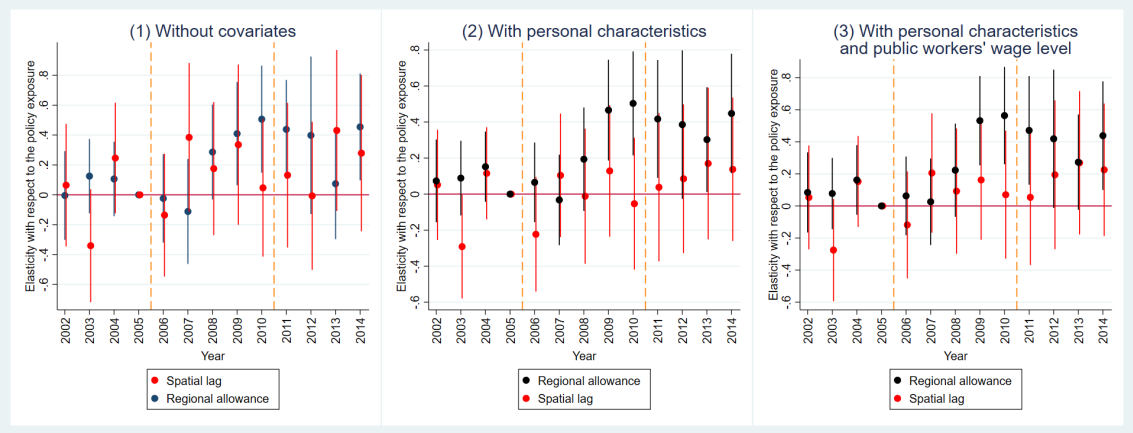

Note: These figures show the estimated $\beta_t$ for each year in the eq.(3). This corresponds to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010, when the reform of regional allowances was conducted. We restrict the sample to regions other than three metropolitan areas (Tokyo, Kanagawa, Chiba, Ibaraki, Saitama, Aichi, Mie, Osaka, Kyoto, Nara, and Hyogo prefectures), which the laws for the respective regions designate as the three metropolitan areas, to make figure. 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Figure A.11:** The elasticity of the ratio of young to older population in year $t$ with respect to the regional allowances change during 2006-2010 for the regions other than three largest metropolitan areas




Note: These figures show the estimated $\beta_t$ for each year in the eq.(5) that the ratio of young to older population is the dependent variable. We restrict the sample to regions other than three metropolitan areas (Tokyo, Kanagawa, Chiba, Ibaraki, Saitama, Aichi, Mie, Osaka, Kyoto, Nara, and Hyogo prefectures), which the laws for the respective regions designate as the three metropolitan areas, to make figure. In all panels, we control municipal, year, and municipal-year fixed effects. In panel (1), we do not control any other variables. We control covariates (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita) in panels (2) and (3). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

**Figure A.12:** The elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010 estimated based on SLX model




Note: These figures show the estimated $\beta_t$ (the black one) and $\beta_t^{SLX}$ (the red one) for each year in the equation

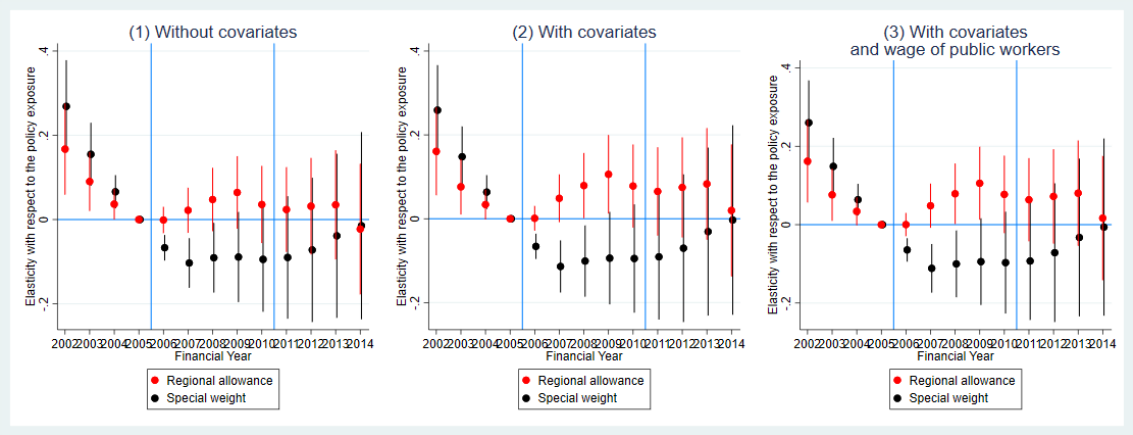
$$\ln w_{i,j,t,private} = \sum_{t \neq 2005} [\beta_t \{\tau_t \times (RA_{j,2010} - RA_{j,2005})\} + \beta_t^{SLX} \{\tau_t \times (\boldsymbol{W}RA_{j,2010} - \boldsymbol{W}RA_{j,2005})\}] \times Young_i + \mu_{j,t} + \sum_{k=\text{young or old}} (\iota_j^k + \tau_t^k) + \gamma X_{i,j,t} + \epsilon_{i,t}. \tag{A.1}$$

$\beta_t$ and $\beta_t^{SLX}$ respectively correspond to the elasticity of the private sector wage in year $t$ with respect to the regional allowances change during 2006-2010 and the one with respect to the spatial lag of the regional allowances change, when the reform of regional allowances was conducted. The spatial lag is made based on the exponential type of spatial weight matrix whose $(i, j)$ element is

$$\omega_{i,j} = \begin{cases} \frac{\exp(-\delta d_{i,j})}{\sum_{j=1}^{n} \exp(-\delta d_{i,j})}, & \text{if } d_{i,j} < d, i \neq j, \delta > 0 \\ 0 \quad \text{otherwise,} \end{cases} \tag{A.2}$$

where we set decay parameter $\delta$ as 1.2 kilo meter by using `spgen` command of Stata (See Kondo 2016 for details). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in panel (3).

**Figure A.13:** The elasticity of the ratio of young to older population in year $t$ with respect to the regional allowances change during 2006-2010 estimated based on SLX model




Note: These figures show the estimated $\beta_t$ (the black one) and $\beta_t^{SLX}$ (the red one) for each year in the equation

$$\ln(YOratio)_{j,t} = \sum_{t \neq 2005} [\beta_t \{\tau_t \times (RA_{j,2010} - RA_{j,2005})\} + \beta_t^{SLX} \{\tau_t \times (\boldsymbol{W}RA_{j,2010} - \boldsymbol{W}RA_{j,2005})\}] + \iota_j + \eta_{t,p} + \gamma X_{j,t} + \epsilon_{j,t}. \tag{A.3}$$

$\beta_t$ and $\beta_t^{SLX}$ respectively correspond to the elasticity of the ratio of young to older population in year $t$ with respect to the regional allowances change during 2006-2010 and the one with respect to the spatial lag of the regional allowances change, when the reform of regional allowances was conducted. The spatial lag is made based on the exponential type of spatial weight matrix whose $(i, j)$ element is

$$\omega_{i,j} = \begin{cases} \frac{\exp(-\delta d_{i,j})}{\sum_{j=1}^{n} \exp(-\delta d_{i,j})}, & \text{if } d_{i,j} < d, i \neq j, \delta > 0 \\ 0 \text{ otherwise,} \end{cases} \tag{A.4}$$

where we set decay parameter $\delta$ as 1.2 kilo meter by using `spgen` command of Stata (See Kondo 2016 for details). 95% confidence intervals based on standard errors clustered at the municipality level are also shown. In panel (1), we do not control any other variables. In panels (2)-(3) we control for the covariates about municipalities (the logarithms of local tax revenue per capita, LAT per capita, NTD per capita, and the number of local officials per capita). We add the average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$ in panel (3). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

# B Omitted Tables

**Table B.1:** Regression results on private sector wages based on (2) for the regions with a higher- and lower-than-median share of public employees

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | (a) Region with many public workers | | | (b) Region with few public workers | | |
| | log(wage rate of private workers) | | | | | |
| Regional allowances × Young dummy | 0.3277*** | 0.3841*** | 0.4398*** | 0.1642* | 0.2660*** | 0.2793*** |
| | (0.1003) | (0.0820) | (0.0731) | (0.0932) | (0.0723) | (0.0685) |
| log(base wage of local municipal workers) | | | 0.1088*** | | | 0.0534*** |
| | | | (0.0174) | | | (0.0088) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes | No | Yes | Yes |
| $N$ | 6835172 | 6835172 | 6525438 | 7231236 | 7231236 | 6931425 |
| $R^2$ | 0.309 | 0.550 | 0.544 | 0.215 | 0.476 | 0.471 |

Standard errors clustered at a municipal level in parentheses

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

Note: The regression results of estimating equation (2) are presented. We restrict the sample to regions with a higher-than-median (lower-than-median) share of public employees in 2005 to make panel (a) ((b)). In columns (2), (3), (5), and (6), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in columns (3) and (6) although it is not controlled in the other columns. Note that the sample size of columns (3) and (6) are limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.2:** Regression results on the ratio of young to older population based on (4) for the regions with a higher- and lower-than-median share of public employees

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Region with many public workers | | | | | |
| | log(YO ratio of Pop) | | | $\widetilde{\log(\text{YO ratio of Pop})}$ | | |
| Regional allowances | -0.1303 | -0.1368 | -0.1461 | 0.7781*** | 0.6597** | 0.6081** |
| | (0.1628) | (0.1666) | (0.1656) | (0.2467) | (0.2660) | (0.2575) |
| log(tax revenue per capita) | | -0.0113 | -0.0099 | | -0.1086*** | -0.1007*** |
| | | (0.0148) | (0.0147) | | (0.0257) | (0.0254) |
| log(LAT per capita) | | -0.0016 | -0.0013 | | 0.0033 | 0.0049 |
| | | (0.0060) | (0.0059) | | (0.0079) | (0.0079) |
| log(NTD per capita) | | 0.0058** | 0.0059** | | 0.0045 | 0.0046 |
| | | (0.0027) | (0.0027) | | (0.0045) | (0.0044) |
| log(municipal public workers per capita) | | 0.0062 | 0.0060 | | -0.0364 | -0.0374 |
| | | (0.0116) | (0.0117) | | (0.0231) | (0.0240) |
| log(base wage of local municipal workers) | | | -0.0372 | | | -0.2076*** |
| | | | (0.0372) | | | (0.0694) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Prefecture-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Detrended outcome variable | No | No | No | Yes | Yes | Yes |
| $N$ | 11245 | 11245 | 11245 | 11245 | 11245 | 11245 |
| $R^2$ | 0.968 | 0.968 | 0.968 | 1.000 | 1.000 | 1.000 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Region with few public workers | | | | | |
| | log(YO ratio of Pop) | | | $\widetilde{\log(\text{YO ratio of Pop})}$ | | |
| Regional allowances | -0.0276 | 0.0168 | 0.0154 | 0.4071*** | 0.3718*** | 0.3552*** |
| | (0.0559) | (0.0574) | (0.0575) | (0.0987) | (0.0994) | (0.0985) |
| log(tax revenue per capita) | | 0.0793*** | 0.0800*** | | -0.0376 | -0.0292 |
| | | (0.0296) | (0.0298) | | (0.0339) | (0.0332) |
| log(LAT per capita) | | 0.0049** | 0.0049** | | 0.0054 | 0.0050 |
| | | (0.0023) | (0.0023) | | (0.0035) | (0.0036) |
| log(NTD per capita) | | -0.0028 | -0.0026 | | -0.0114*** | -0.0091** |
| | | (0.0032) | (0.0032) | | (0.0043) | (0.0041) |
| log(municipal public workers per capita) | | 0.0132 | 0.0123 | | -0.0542*** | -0.0644*** |
| | | (0.0126) | (0.0126) | | (0.0189) | (0.0180) |
| log(base wage of local municipal workers) | | | -0.0240 | | | -0.2785*** |
| | | | (0.0403) | | | (0.0583) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Prefecture-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Detrended outcome variable | No | No | No | Yes | Yes | Yes |
| $N$ | 11258 | 11258 | 11258 | 11258 | 11258 | 11258 |
| $R^2$ | 0.970 | 0.970 | 0.970 | 1.000 | 1.000 | 1.000 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results of estimating equation (4) that the logarithm of the ratio of young to older population, log(YO ratio of Pop), and its detrended variable, $\widetilde{\log(\text{YO ratio of Pop})}$, are the dependent variables are presented. Young and older populations correspond to the 15-29 and 30-64 age groups, respectively. $\widetilde{\log(\text{YO ratio of Pop})}$ is the value that detrended the 2002-2005 region-specific linear trends from log(YO ratio of Pop). Specifically, to construct the detrended outcome variable $\widetilde{\log(\text{YO ratio of Pop})}_{jt}$, we first estimate the municipality-specific pretrend by the following equation

$$\ln(\text{YO ratio of Pop})_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{j,t} \quad \text{for} \quad t < 2006.$$

We make predicted values of $\ln(\text{YO ratio of Pop})_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\ln(\text{YO ratio of Pop})}_{jt}$.

The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in Columns (3) and (6) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

**Table B.3:** Regression results on the ratio of the young unemployment rate and old unemployment rate based on (4)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | YO ratio of unemployment rate | | | $\widetilde{\text{YO ratio of unemployment rate}}$ | | |
| Regional allowances | 0.8607*** | 0.6609*** | 0.6297*** | -0.5124 | -0.4945 | -0.4914 |
| | (0.1467) | (0.1426) | (0.1410) | (0.3701) | (0.3564) | (0.3561) |
| log(tax revenue per capita) | | -0.1870*** | -0.1731*** | | 0.1516* | 0.1502* |
| | | (0.0395) | (0.0390) | | (0.0860) | (0.0858) |
| log(LAT per capita) | | -0.0091** | -0.0091** | | -0.0260** | -0.0260** |
| | | (0.0044) | (0.0043) | | (0.0102) | (0.0102) |
| log(NTD per capita) | | -0.0257*** | -0.0244*** | | -0.0043 | -0.0044 |
| | | (0.0056) | (0.0055) | | (0.0131) | (0.0131) |
| log(municipal public workers per capita) | | -0.0549* | -0.0616** | | 0.0387 | 0.0394 |
| | | (0.0287) | (0.0280) | | (0.0677) | (0.0684) |
| log(base wage of local municipal workers) | | | -0.3077*** | | | 0.0305 |
| | | | (0.0729) | | | (0.1741) |
| $N$ | 22479 | 22479 | 22479 | 22479 | 22479 | 22479 |
| $R^2$ | 0.904 | 0.905 | 0.906 | 1.000 | 1.000 | 1.000 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results of estimating equation (4) that the ratio of the ratio of the unemployment rate for those aged 15-29 and one for those aged 30-64, YO ratio of Pop, and its detrended variable, $\widetilde{\text{YO ratio of Unemployment rate}}$, are the dependent variables are presented. Young and older populations correspond to the 15-29 and 30-64 age groups, respectively. $\widetilde{\text{YO ratio of Unemployment rate}}$ is the value that detrended the 2002-2005 region-specific linear trends from YO ratio of Unemployment rate. Specifically, to construct the detrended outcome variable $\widetilde{\text{YO ratio of Unemployment rate}}_{jt}$, we first estimate the municipality-specific pretrend by the following equation

$$\text{YO ratio of Unemployment rate}_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{jt} \quad \text{for} \quad t < 2006.$$

We make predicted values of YO ratio of Unemployment rate$_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\text{YO ratio of Unemployment rate}}_{jt}$.

The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in Columns (3) and (6) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

**Table B.4:** Regression results on land price based on (4)

| | (1) | (2) | (3) |
|---|---|---|---|
| | log(land prices) | | |
| Regional allowances | 0.5677*** | 0.5423*** | 0.5395*** |
| | (0.1573) | (0.1421) | (0.1413) |
| log(tax revenue per capita) | | 0.0909** | 0.0924** |
| | | (0.0370) | (0.0367) |
| log(LAT per capita) | | -0.0177*** | -0.0177*** |
| | | (0.0052) | (0.0052) |
| log(NTD per capita) | | -0.0048 | -0.0047 |
| | | (0.0046) | (0.0046) |
| log(municipal public workers per capita) | | -0.0321 | -0.0329 |
| | | (0.0225) | (0.0227) |
| log(base wage of local municipal workers) | | | -0.0322 |
| | | | (0.0679) |
| Year fixed effect | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes |
| Prefecture-year fixed effect | Yes | Yes | Yes |
| $N$ | 17615 | 17615 | 17615 |
| $R^2$ | 0.922 | 0.924 | 0.924 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results of estimating equation (4) that land price is the dependent variable are presented. The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in column (3) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

**Table B.5:** Regression results on private sector wages based on (2) for workers belongs to large and small companies

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | (a) Workers belonging to large companies | | | (b) Workers belonging to small companies | | |
| | log(wage rate of private workers) | | | | | |
| Regional allowances × Young dummy | 0.2207*** | 0.2699*** | 0.2561*** | 0.1225 | 0.2201*** | 0.2706*** |
| | (0.0677) | (0.0648) | (0.0619) | (0.0817) | (0.0614) | (0.0568) |
| log(base wage of local municipal workers) | | | 0.0431*** | | | 0.1118*** |
| | | | (0.0077) | | | (0.0112) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes | No | Yes | Yes |
| $N$ | 4892683 | 4892683 | 4615638 | 9173634 | 9173634 | 8841100 |
| $R^2$ | 0.265 | 0.448 | 0.441 | 0.272 | 0.545 | 0.538 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The regression results of estimating equation (2) are presented. We restrict the sample to the workers belonging to companies with over (less than) 100 employees to make figure (a) ((b)). In columns (2), (3), (5), and (6), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in columns (3) and (6) although it is not controlled in the other columns. Note that the sample size of columns (3) and (6) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.6:** Regression results on private sector wages based on (2) for university graduates and non-university graduates

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | (a) University graduates | | | (b) Non university graduates | | |
| | log(wage rate of private workers) | | | | | |
| Regional allowances × Young dummy | -0.2459*** | -0.0706 | -0.0315 | 0.3139*** | 0.3612*** | 0.3605*** |
| | (0.0951) | (0.0874) | (0.0809) | (0.0758) | (0.0639) | (0.0649) |
| log(base wage of local municipal workers) | | | 0.3371*** | | | -0.0268*** |
| | | | (0.0056) | | | (0.0071) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes | No | Yes | Yes |
| $N$ | 4283564 | 4283564 | 4276449 | 9781788 | 9781788 | 9179352 |
| $R^2$ | 0.315 | 0.528 | 0.531 | 0.224 | 0.417 | 0.410 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The regression results of estimating equation (2) are presented. We restrict the sample to the (non) university graduates to make figure (a) ((b)). In columns (2), (3), (5), and (6), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in columns (3) and (6) although it is not controlled in the other columns. Note that the sample size of columns (3) and (6) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.7:** Regression results on private sector wages based on (2) for men and women

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | (a) Men | | | (b) Women | |
| | log(wage rate of private workers) | | | | | |
| Regional allowances × Young dummy | 0.0648 | 0.2527*** | 0.2945*** | 0.1599* | 0.3310*** | 0.3326*** |
| | (0.0884) | (0.0705) | (0.0669) | (0.0934) | (0.0830) | (0.0845) |
| log(base wage of local municipal workers) | | | 0.1614*** | | | -0.1142*** |
| | | | (0.0076) | | | (0.0185) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes | No | Yes | Yes |
| $N$ | 9772307 | 9772307 | 9393159 | 4293587 | 4293587 | 4063104 |
| $R^2$ | 0.286 | 0.502 | 0.495 | 0.252 | 0.359 | 0.352 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The regression results of estimating equation (2) are presented. We restrict the sample to regions with a higher-than-median (lower-than-median) share of public employees in 2005 to make panel (a) ((b)). In columns (2), (3), (5), and (6), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in columns (3) and (6) although it is not controlled in the other columns. Note that the sample size of columns (3) and (6) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.8:** Regression results on private sector wages for the regions excluding three metropolitan areas

| | (1) | (2) | (3) |
|---|---|---|---|
| | log(wage rate of private workers) | | |
| Regional allowances × Young dummy | 0.4565*** | 0.4478*** | 0.5061*** |
| | (0.1014) | (0.0970) | (0.1014) |
| log(base wage of local municipal workers) | | | 0.0235*** |
| | | | (0.0083) |
| Year fixed effect | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes |
| $N$ | 8876545 | 8876545 | 8479345 |
| $R^2$ | 0.178 | 0.444 | 0.438 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The regression results of estimating equation (2) are presented. We restrict the sample to regions other than three metropolitan areas (Tokyo, Kanagawa, Chiba, Ibaraki, Saitama, Aichi, Mie, Osaka, Kyoto, Nara, and Hyogo prefectures), which the laws for the respective regions designate as the three metropolitan areas. In columns (2) and (3), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in column (3) although it is not controlled in the other columns. Note that the sample size of column (3) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.9:** Regression results on the ratio of young to older population based on (4) excluding three metropolitan areas

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | log(YO ratio of Pop) | | | $\widetilde{\log(\text{YO ratio of Pop})}$ | | |
| Regional allowances | -0.4755*** | -0.3710*** | -0.3850*** | 1.0637*** | 0.7348*** | 0.6270*** |
| | (0.0916) | (0.0828) | (0.0832) | (0.1394) | (0.1369) | (0.1293) |
| log(tax revenue per capita) | | 0.0150 | 0.0172 | | -0.1832*** | -0.1662*** |
| | | (0.0123) | (0.0128) | | (0.0262) | (0.0254) |
| log(LAT per capita) | | 0.0167*** | 0.0171*** | | -0.0165*** | -0.0140** |
| | | (0.0039) | (0.0039) | | (0.0055) | (0.0056) |
| log(NTD per capita) | | 0.0033 | 0.0033 | | -0.0025 | -0.0025 |
| | | (0.0020) | (0.0020) | | (0.0037) | (0.0036) |
| log(municipal public workers per capita) | | 0.0178* | 0.0179* | | -0.0559*** | -0.0545*** |
| | | (0.0102) | (0.0102) | | (0.0166) | (0.0162) |
| log(base wage of local municipal workers) | | | -0.0385 | | | -0.2945*** |
| | | | (0.0325) | | | (0.0508) |
| $N$ | 16159 | 16159 | 16159 | 16159 | 16159 | 16159 |
| $R^2$ | 0.973 | 0.973 | 0.973 | 1.000 | 1.000 | 1.000 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results of estimating equation (4) that the logarithm of the ratio of young to older population, log(YO ratio of Pop), and its detrended variable, $\widetilde{\log(\text{YO ratio of Pop})}$, are the dependent variables are presented. Young and older populations correspond to the 15-29 and 30-64 age groups, respectively. $\widetilde{\log(\text{YO ratio of Pop})}$ is the value that detrended the 2002-2005 region-specific linear trends from log(YO ratio of Pop). Specifically, to construct the detrended outcome variable $\widetilde{\log(\text{YO ratio of Pop})}_{jt}$, we first estimate the municipality-specific pretrend by the following equation

$$\ln(\text{YO ratio of Pop})_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{jt} \quad \text{for} \quad t < 2006.$$

We make predicted values of $\ln(\text{YO ratio of Pop})_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\ln(\text{YO ratio of Pop})}_{jt}$. We restrict the sample to regions other than three metropolitan areas (Tokyo, Kanagawa, Chiba, Ibaraki, Saitama, Aichi, Mie, Osaka, Kyoto, Nara, and Hyogo prefectures), which the laws for the respective regions designate as the three metropolitan areas. The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in Columns (3) and (6) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

**Table B.10:** Regression results on private sector wages based on SLX model

| | (1) | (2) | (3) |
|---|---|---|---|
| | log(wage rate of private workers) | | |
| Regional allowances × Young dummy | 0.3297*** | 0.3217*** | 0.3534*** |
| | (0.1212) | (0.1073) | (0.1015) |
| Spatial lag of Regional allowances × Young dummy | 0.2053 | 0.1402 | 0.1824 |
| | (0.1303) | (0.1145) | (0.1154) |
| log(base wage of local municipal workers) | | | 0.0762*** |
| | | | (0.0104) |
| Year fixed effect | Yes | Yes | Yes |
| Municipal fixed effect | Yes | Yes | Yes |
| Municipal-year fixed effect | Yes | Yes | Yes |
| Individual characteristics | No | Yes | Yes |
| $N$ | 12161479 | 12161479 | 11638820 |
| $R^2$ | 0.266 | 0.519 | 0.513 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: These table show the estimated $\beta$ and $\beta^{SLX}$ in the equation

$$\ln w_{i,j,t,private} = [\beta RA_{j,t} + \beta^{SLX} \boldsymbol{W} RA_{j,t}] \times Young_i + \mu_{j,t} + \sum_{k=\text{young or old}} (\iota_j^k + \tau_t^k) + \gamma X_{i,j,t} + \epsilon_{i,t}. \tag{B.1}$$

The results of $\beta$ and $\beta^{SLX}$ are respectively shown

The spatial lag is made based on the exponential type of spatial weight matrix whose $(i, j)$ element is

$$\omega_{i,j} = \begin{cases} \frac{\exp(-\delta d_{i,j})}{\sum_{j=1}^{n} \exp(-\delta d_{i,j})}, & \text{if } d_{i,j} < d, i \neq j, \delta > 0 \\ 0 \text{ otherwise,} \end{cases} \tag{B.2}$$

where we set decay parameter $\delta$ as 1.2 kilo meter by using `spgen` command of Stata (See Kondo 2016 for details). In columns (2) and (3), we control for the individual characteristics (age dummies interacted with college education dummy and gender dummy, and the logarithm of prescribed working hours). The monthly income level of public workers corresponding in the sense of education level and experience to the private worker $i$ in municipality $j$ at $t$, $w_{i,j,t,public}$, is controlled in column (3) although it is not controlled in the other columns. Note that the sample size of column (3) is limited because the sample is omitted if the public workers corresponding to the municipal public worker in their education and experience do not exist.

**Table B.11:** The elasticity of the ratio of young to older population in year $t$ with respect to the regional allowances change during 2006-2010 estimated based on SLX model

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | log(YO ratio of Pop) | | | $\widetilde{\log(\text{YO ratio of Pop})}$ | | |
| Regional allowances | -0.0441 | 0.0039 | 0.0019 | 0.3590*** | 0.3151*** | 0.2890*** |
| | (0.0573) | (0.0590) | (0.0593) | (0.1112) | (0.1114) | (0.1108) |
| Spatial lag of regional allowances | -0.1608* | -0.1516* | -0.1543* | 0.5351*** | 0.4878*** | 0.4529*** |
| | (0.0858) | (0.0869) | (0.0874) | (0.1330) | (0.1346) | (0.1362) |
| log(tax revenue per capita) | | 0.0517*** | 0.0528*** | | -0.0843*** | -0.0701*** |
| | | (0.0175) | (0.0177) | | (0.0239) | (0.0231) |
| log(LAT per capita) | | 0.0037* | 0.0037* | | 0.0051 | 0.0052 |
| | | (0.0021) | (0.0021) | | (0.0033) | (0.0035) |
| log(NTD per capita) | | 0.0011 | 0.0012 | | -0.0015 | -0.0001 |
| | | (0.0021) | (0.0021) | | (0.0036) | (0.0035) |
| log(municipal public workers per capita) | | 0.0159* | 0.0153* | | -0.0399** | -0.0473*** |
| | | (0.0092) | (0.0092) | | (0.0162) | (0.0159) |
| log(base wage of local municipal workers) | | | -0.0252 | | | -0.3226*** |
| | | | (0.0313) | | | (0.0451) |
| $N$ | 22490 | 22490 | 22490 | 22490 | 22490 | 22490 |
| $R^2$ | 0.967 | 0.967 | 0.967 | 1.000 | 1.000 | 1.000 |

Standard errors clustered at a municipal level in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: These table show the estimated $\beta$ and $\beta^{SLX}$ in the equation

$$Y_{j,t} = \beta RA_{j,t} + \beta^{SLX} \boldsymbol{W} RA_{j,t} + \iota_j + \eta_{t,p} + \gamma X_{j,t} + \epsilon_{j,t}, \tag{B.3}$$

where the logarithm of the ratio of young to older population, log(YO ratio of Pop), and its detrended variable, $\widetilde{\log(\text{YO ratio of Pop})}$, are the dependent variables are presented. Young and older populations correspond to the 15-29 and 30-64 age groups, respectively.

$\widetilde{\log(\text{YO ratio of Pop})}$ is the value that detrended the 2002-2005 region-specific linear trends from log(YO ratio of Pop). Specifically, to construct the detrended outcome variable $\widetilde{\log(\text{YO ratio of Pop})}_{jt}$, we first estimate the municipality-specific pretrend by the following equation

$$\ln(\text{YO ratio of Pop})_{jt} = \iota_j + \tau_t + \iota_j \times \tau_t + \epsilon_{j,t} \quad \text{for } t < 2006.$$

We make predicted values of $\ln(\text{YO ratio of Pop})_{jt}$ for entire samples, including $t \geq 2006$, from this result and compute the residuals corresponding to $\widetilde{\ln(\text{YO ratio of Pop})}_{jt}$.

The spatial lag is made based on the exponential type of spatial weight matrix whose $(i, j)$ element is

$$\omega_{i,j} = \begin{cases} \frac{\exp(-\delta d_{i,j})}{\sum_{j=1}^{n} \exp(-\delta d_{i,j})}, & \text{if } d_{i,j} < d, i \neq j, \delta > 0 \\ 0 \text{ otherwise,} \end{cases} \tag{B.4}$$

where we set decay parameter $\delta$ as 1.2 kilo meter by using `spgen` command of Stata (See Kondo 2016 for details). 95% confidence intervals based on standard errors clustered at the municipality level are also shown.

The average salary level of public workers in municipality $j$ at $t$, $w_{j,t,public}$, is controlled in Columns (3) and (6) although it is not controlled in the other columns because it is likely to suffer from the endogeneity.

# C Summary Statistics

**Table C.1:** Summary statistics of the dataset for wage analysis

| | Areas without the regional allowances | | Areas receiving the regional allowances | |
|---|---|---|---|---|
| | (1) -2005 | (2) 2006- | (3) -2005 | (4) 2006- |
| Panel A. Regional allowances | | | | |
| Regional allowances | 0.00 | 0.00 | 0.04 | 0.08 |
| | (0.00) | (0.00) | (0.05) | (0.05) |
| Panel B. Individual private workers' characteristics | | | | |
| Wage of private workers | 16.63 | 16.13 | 21.11 | 20.16 |
| | (9.66) | (9.18) | (12.58) | (12.38) |
| gender | 0.70 | 0.68 | 0.74 | 0.69 |
| | (0.46) | (0.47) | (0.44) | (0.46) |
| Univ | 0.18 | 0.22 | 0.35 | 0.40 |
| | (0.38) | (0.41) | (0.48) | (0.49) |
| Age | 40.46 | 41.22 | 39.73 | 40.42 |
| | (11.76) | (12.02) | (11.65) | (11.82) |
| Prescribed working hours | 165.66 | 165.01 | 161.95 | 161.72 |
| | (20.12) | (20.16) | (19.55) | (20.63) |
| Percentage of workers aged less than 30 | 0.23 | 0.21 | 0.24 | 0.22 |
| | (0.42) | (0.40) | (0.43) | (0.42) |
| Percentage of workers in companies with over 100 employees | 0.44 | 0.41 | 0.28 | 0.29 |
| | (0.50) | (0.49) | (0.45) | (0.45) |
| Panel C. Municipal characteristics | | | | |
| Population | 1.6e+05 | 1.7e+05 | 7.6e+05 | 7.7e+05 |
| | (1.8e+05) | (1.8e+05) | (8.5e+05) | (8.6e+05) |
| Local tax revenue per capita | 120.02 | 130.04 | 170.60 | 175.82 |
| | (43.87) | (46.31) | (52.70) | (47.60) |
| LAT per capita | 104.24 | 113.77 | 27.71 | 26.44 |
| | (75.25) | (90.13) | (26.61) | (26.46) |
| NTD per capita | 38.27 | 60.82 | 45.97 | 59.78 |
| | (21.48) | (95.46) | (24.37) | (26.89) |
| Number of municipal public workers | 1,630.95 | 1,543.32 | 9,214.11 | 7,738.99 |
| | (1,676.98) | (1,588.70) | (12615.09) | (10024.84) |
| Average income of corresponding municipal public workers | 3,292.20 | 3,085.97 | 3,373.74 | 3,238.10 |
| | (1,104.79) | (1,082.50) | (1,058.83) | (992.56) |
| *N* | 1798242 | 4030178 | 2219901 | 4113361 |

The summary statistics of the areas where regional allowances have been provided (at least once) and the areas where regional allowances have not been provided. Means are shown as coefficients and standard deviations are given in parentheses. Note that the characteristics of urban municipalities are more representative, reflecting the larger sample size in urban areas.

**Table C.2:** Summary statistics of the dataset for population and unemployment rate analysis

| | Areas without the regional allowances | | Areas receiving the regional allowances | |
|---|---|---|---|---|
| | (1) -2005 | (2) 2006- | (3) -2005 | (4) 2006- |
| | Panel A. Regional allowances | | | |
| Regional allowances | 0.00 | 0.00 | 0.02 | 0.06 |
| | (0.00) | (0.00) | (0.04) | (0.05) |
| | Panel B. Demographic characteristics | | | |
| Population | 36932.27 | 35813.29 | 2.1e+05 | 2.1e+05 |
| | (60949.07) | (60672.33) | (3.3e+05) | (3.4e+05) |
| Population aged 15-29 | 6,439.55 | 5,410.02 | 40638.13 | 35151.25 |
| | (11423.97) | (9,779.60) | (64970.65) | (56893.69) |
| Population aged 30-64 | 16958.74 | 16490.95 | 1.0e+05 | 1.1e+05 |
| | (28776.33) | (28785.59) | (1.7e+05) | (1.7e+05) |
| Unemployment rate for 15-29 | 0.09 | 0.10 | 0.09 | 0.09 |
| | (0.04) | (0.04) | (0.02) | (0.02) |
| Unemployment rate for 30-64 | 0.04 | 0.05 | 0.05 | 0.05 |
| | (0.02) | (0.02) | (0.01) | (0.01) |
| | Panel C. Administrative characteristics | | | |
| Local tax revenue per capita | 107.38 | 120.25 | 144.26 | 151.14 |
| | (66.63) | (85.19) | (47.31) | (43.18) |
| LAT per capita | 230.33 | 264.15 | 34.68 | 34.08 |
| | (221.37) | (263.55) | (35.07) | (37.02) |
| NTD per capita | 47.97 | 75.31 | 29.17 | 44.15 |
| | (106.16) | (167.75) | (16.13) | (23.17) |
| Number of municipal public workers | 442.39 | 398.78 | 2,019.13 | 1,804.60 |
| | (613.37) | (568.93) | (4,047.27) | (3,453.39) |
| Average income of municipal public workers | 3,247.07 | 3,173.34 | 3,431.02 | 3,287.83 |
| | (212.19) | (191.96) | (218.37) | (183.57) |
| *N* | 5464 | 12294 | 1460 | 3285 |

The summary statistics of the areas where regional allowances have been provided (at least once) and the areas where regional allowances have not been provided. Means are shown as coefficients and standard deviations are given in parentheses.

**Table C.3:** Summary statistics of the dataset for land price analysis

| | Areas without the regional allowances | | Areas receiving the regional allowances | |
|---|---|---|---|---|
| | (1) -2005 | (2) 2006- | (3) -2005 | (4) 2006- |
| | Panel A. Regional allowances | | | |
| Regional allowances | 0.00 | 0.00 | 0.02 | 0.06 |
| | (0.00) | (0.00) | (0.04) | (0.05) |
| | Panel B. Demographic characteristics | | | |
| Land price | 0.93 | 0.74 | 0.90 | 0.78 |
| | (0.07) | (0.12) | (0.08) | (0.14) |
| | Panel C. Administrative characteristics | | | |
| Local tax revenue per capita | 110.11 | 120.49 | 144.36 | 151.26 |
| | (57.34) | (57.18) | (47.33) | (43.18) |
| LAT per capita | 151.26 | 171.21 | 34.67 | 34.07 |
| | (103.63) | (125.95) | (35.10) | (37.06) |
| NTD per capita | 35.51 | 61.62 | 29.20 | 44.20 |
| | (27.13) | (139.92) | (16.13) | (23.18) |
| Number of municipal public workers | 560.92 | 507.58 | 2,023.93 | 1,808.81 |
| | (681.25) | (632.58) | (4,051.79) | (3,457.19) |
| Average income of municipal public workers | 3,284.95 | 3,202.02 | 3,432.45 | 3,288.63 |
| | (190.12) | (173.82) | (216.93) | (183.17) |
| *N* | 3964 | 8919 | 1456 | 3276 |

The summary statistics of the areas where regional allowances have been provided (at least once) and the areas where regional allowances have not been provided. Means are shown as coefficients and standard deviations are given in parentheses.

# D A Formal Exposition of the Theoretical Framework

**Setup.** A worker can choose to live in a small region or the outside world. Workers consume local residential amenities and numeraire goods, and land. Workers are heterogeneous in their idiosyncratic tastes to live in the small region. $L$ denotes the population of the small region and the total population in this economy is normalized to one. Since the region is small, we take the utility of living in the outside world, $\bar{V}$, as exogenous.[D.1]

Upon choosing to live in the small region, a worker obtains a random job offer.[D.2] We denote the size of the public sector by $L_g$. Letting $u$ denote the unemployment rate in this region, the number of private sector workers is $(1-u)L - L_g$. Let $p_g$ be the probability of getting a public sector job and $w_g$ be the public sector wage. Then, the assumption of the random job offer implies $p_g = L_g/L$. With the probability $\left((1-u)L - L_g\right)/L = 1 - u - p_g$, the worker works for the private sector and

[D.1] We may consider an alternative situation where the outside utility $\bar{V}$ increases when a policy reform is improving welfare (e.g., a region is not small, a similar policy change is happening in the outside region). In such a case, we expect smaller responses to population and land prices in response to the beneficial policy reform because it would also improve the attractiveness of the outside option (Yamagishi 2021). Therefore, our estimated responses of population and land prices (in Section 6) are conservative and should be adjusted upward if we take into account the endogeneity of $\bar{V}$.

[D.2] While we assume the random job offer is for simplicity, our main arguments do not rely on this assumption.

gets the wage $w$. Finally, with probability $uL/L = u$, the worker remains unemployed and gets the home-production income $b$. We take $(w_g, L_g)$ as exogenous because the government can decide them by setting the public sector wage and the size. Prior to drawing a random job offer, we suppose that workers consider the expected income in evaluating the labor market attractiveness of the small region: $p_g w_g + ub + (1 - p_g - u)w$.

For our purpose, we simply posit that the private sector wages and the unemployment rate follow some functions of public sector variables $(w_g, L_g)$. Specifically, we assume that the private sector wage follows $w = W(L, u; w_g, L_g)$ and the unemployment rate follows $u = U(L, w; w_g, L_g)$. We do not specify a particular microfoundation of the private sector labor market to derive the functions $W$ and $U$ to accommodate various labor market structures considered in the fully-structural literature on the effects of public sector wages (see the "Related Literature" section for examples of such studies). For example, a higher public sector wage may affect the monopsony power of each private firm. In particular, a higher $w_g$ would shift the functions $W()$ upward and the function $U()$ downward by reducing the monopsony power if the higher public sector wage makes the labor supply more elastic. Alternatively, $W()$ may shift upward and $U()$ may shift downward if the increase in $w_g$ improves productivity of the private sector due to, for example, improving public goods quality (Bermperoglou, Pappa and Vella 2017) or agglomeration economies through population inflow (Becker, Heblich and Sturm 2021).

A worker also derives the utility from the amenity $A$, which again depends on $(w_g, L_g)$. For instance, a larger public sector may improve the public services. A higher public sector wage may also improve the quality of public services by, for example, inducing more efforts of the public sector workers (c.f., Borjas 1984; Shapiro and Stiglitz 1984).[D.3] An alternative interpretation is that $A()$ summarizes the job amenities in this region, including in-kind benefits and unpaid overtime working hours.[D.4] As in the inverse labor demand function $W()$, we choose not to specify a particular microfoundation of $A()$ to accommodate various situations.

Finally, there is a land market. A worker consumes one unit of land at a price $r$, regardless of their employment status. Letting $h(L)$ be the inverse land supply function, which is increasing because of the increasing marginal cost of land supply for landlords. Then, the housing market equilibrium requires $r = h(L)$. For simplicity, we suppose that the land is owned by absentee landlords who spend their revenue outside the economy.

Worker $i$ chooses to live in the small region if it brings utility higher than the outside world:

$$A + \left(p_g w_g + ub + (1 - p_g - u)w\right) - r + \epsilon_i \geq \bar{V}, \tag{D.1}$$

[D.3] The public service quality can be considered as net of the local tax payment for financing them, which may increase in the public sector wages (Brueckner 1982).

[D.4] For instance, we may write the expected job amenities as $A = p_g A_g + (1 - u - p_g)A_p$, where $A_g$ and $A_p$ are the job amenities in the public and private sector, respectively.

where $\epsilon_i$ is her idiosyncratic taste for the small region. The left-hand side is the expected utility of worker $i$ by living in the small region, which we specify as the sum of the amenities $A$, the consumption of the numeraire good $\big(p_g w_g + ub + (1 - p_g - u)w\big) - r$, and the idiosyncratic taste. Letting $\bar{\epsilon}$ be the marginal worker such that she is indifferent between the small region and the outside world, the population of the small region is given by $L = 1 - F(\bar{\epsilon})$, where $F()$ is the cumulative distribution function of $\epsilon_i$. In particular, this implies that $\bar{\epsilon} = F^{-1}(1 - L)$.

**Equilibrium Conditions.** Four endogenous variables $(w, u, L, r)$ are determined by the following four equilibrium conditions:

$$A + \big(p_g w_g + ub + (1 - p_g - u)w\big) - r + F^{-1}(1 - L) = \bar{V} \tag{D.2}$$

$$w = W(L, u; w_g, L_g) \tag{D.3}$$

$$u = U(L, w; w_g, L_g) \tag{D.4}$$

$$r = h(L) \tag{D.5}$$

Equation (D.2) is the spatial equilibrium condition for workers' mobility, equations (D.3) and (D.4) determine the private sector wage and unemploymetn rate, and equation (D.5) is the housing market equilibrium condition. These equilibrium conditions imply that the private sector wage $w$, unemployment rate $u$, the population level $L$, and land prices $r$ all depend on the public sector wage $w_g$. We empirically estimate the effects of $w_g$ on these four variables using the Japanese natural experiment.

Our model was concerned with a single type of mobile workers. In our empirical analysis, we posit that young workers are affected by public sector wage reform while older workers are not. We may interpret the mobile workers in our model as young workers. The simplest way of extending our model to introduce older workers is to assume that they are immobile and obtain the exogenous wage rate $w_o$, implying that it is independent of the public sector wages and employment $(w_g, L_g)$. The independence of the public sector variables is motivated by our argument that the public sector labor market for older workers is thin in our Japanese context (see Section 3), and the assumption of geographical immobility is consistent with the common empirical finding that the inter-city mobility rate sharply falls with age (e.g., Ishikawa 2016; Kaplan and Schulhofer-Wohl 2017). Then, after slightly modifying the land market equilibrium condition (D.5) as $r = h(L + L_o)$, where $L_o$ is the number of immobile older workers in the small region so that $L + L_o$ is the total number of workers, the equilibrium conditions are the same as the equilibrium conditions in (D.2)–(D.5).[D.5]

[D.5] Yamagishi (2021) formally shows in a similar model that when there are two groups of workers with different geographical mobility, the land prices more strongly reflect the more mobile workers' willingness-to-pay to live in the small region. The case of immobile older workers can be thought of as the limit case of this result.

**Welfare Implications of Changing public sector Wages.** Our model yields simple welfare implication about the public wage cut: it harms workers' welfare if it decreases population and lowers land prices.[D.6] Intuitively, holding land prices fixed, the public sector wage decrease affects workers' welfare by changing the wage when employed in the public sector, the wage when employed in the private sector, the unemployment rate, and the amenities. However, without discerning the underlying mechanisms behind the welfare, the welfare decrease lowers land prices by inducing out-migration so that the spatial equilibrium condition (D.2) holds. Moreover, the decreased population lowers land prices by decreasing the demand for land. Therefore, in light of our model, our empirical analysis of population and land prices serves as sufficient statistics for qualitative welfare implication of policy reform in the public sector wages (Chetty 2009). This result motivates us to examine population and land prices as outcome variables.

Note, however, that this result applies only to mobile workers in the model. If there are additional immobile workers, such as the older workers discussed above, then such workers may experience a welfare gain even if the population and land prices decrease. For instance, the public sector wage cut may lower the land price without any effects on wages, unemployment rates, and amenities of the older workers, which would increase their utility through lower housing cost.[D.7] As we see in Sections 6.2 and 7.2, this situation may be empirically relevant in our context.

# E Details on Calculating the Aggregate Economic Impact

In this appendix, we explain how we calculate the economic impact of the public wage reform in section 7.4.

Our estimation results in Sections 6 and 7 show the extent to which the outcomes change with the change in the regional public wage level. Therefore, by multiplying the coefficients of the outcomes, the changes in the effective public wage, and the actual amount of the outcome variables in each municipality, we can estimate how much the outcomes in each municipality changed due to the public wage reform.

For the changes in the effective public wage in each region, since the effective wage in region $i$ in 2010 can be shown as $(1 + RA_{i,2010}) \times \text{Base wage}_{i,2010}$, where $RA$ is the regional allowances rate, the change in the effective wage in region $i$ can be calculated as $(1 + RA_{i,2010}) \times \text{Base wage}_{i,2010} -$

[D.6] To see this, let $A + \left(p_g w_g + ub + (1 - p_g - u)w\right) - r + \epsilon_i$ be worker $i$'s welfare. Suppose that the population $L$ decreases after the cut in the public sector wage, which is equivalent to the decrease in $r$ because of the land market equilibrium condition (D.5). The decrease in the population implies that $\bar{\epsilon}$ is higher since $F^{-1}(1 - L) = \bar{\epsilon}$. The spatial equilibrium condition (D.2) then implies that $A + \left(p_g w_g + ub + (1 - p_g - u)w\right) - r$ is smaller. Therefore, for given $\epsilon_i$, the welfare is decreased if worker $i$ lives in a small region after the change in the public sector wage. The utility of workers in the outside economy remains constant, so that no worker in the economy benefits from the public sector wage cut.

[D.7] See Yamagishi (2021) for more discussions on workers' heterogeneity and welfare implications.

$(1 + RA_{i,2005}) \times \text{Base wage}_{i,2005} = (\text{Base wage}_{i,2010} - \text{Base wage}_{i,2005})(1 + RA_{i,2010}) + (RA_{i,2010} - RA_{i,2005}) \times \text{Base wage}_{i,2005} = -0.048 \times (1 + RA_{i,2010}) + (RA_{i,2010} - RA_{i,2005})$, where we normalized $\text{Base Wage}_{i,2005}$ to 1 in the last equation.

We now explain more details about each outcome variable. For each calculation, we use data from 2010, when the reform ended, to avoid differences due to the base year of each data.

**Impact on private wages** Since our study shows that a 1% decrease in public wages leads to about 0.35% decrease in private wages for young full-time workers aged 15 to 29, we can infer the impact of public wage reform on private wages if the total amount of wages for young full-time workers in each municipality is available.

However, since this data is not available, we approximate it using alternative data. Since the number of young full-time workers by municipality was not available, the number of young full-time workers was reproduced using the number of full-time workers in private sectors[E.1] and the percentage of the working age population aged 15-29 from the census in each municipality. In addition, since data on the average wage of young full-time workers were available only for some municipalities, we used the average wage of the prefecture from the Basic Survey on Wage Structure as the average wage in each municipality. We then construct the approximate total amount of wages for young full-time workers in each municipality by multiplying the approximate number of young full-time workers by the average wage of young full-time workers.

By multiplying the estimated elasticity of the private wage of young full-time workers, the changes in the effective public wage, and the approximate total amount of wages for young full-time workers in each municipality, the reduction in wages for young full-time workers due to the reduction in public wages is estimated as 111.6 billion yen for 2010.

**Impact on the taxable assessed value of land** Given that our analysis of land price shows that a 1% decrease in public wages leads to about 0.54% decrease in land price, we can infer the impact of public wage reform on land price if the total value of land in each municipality is available.

However, since the total value of land in each municipality is not available, we alternatively use data on the taxable assessed value of land, which is from the Local Government Finance Survey. It is measured when property taxes on land are levied. The assessed value of land may be reduced to a portion of the transaction value of land, depending on its use to reduce property taxes and is often said to average about 70% of the transaction value of land.[E.2] Therefore, note that our inference might be a lower bound on the impact of the reform on land transaction prices.

[E.1] The sample was limited to workers in the secondary and tertiary industries, which were the subject of the our analysis.

[E.2] Consistent with this, Yamagishi and Sato (2023) compares the land assessment values for property taxation and transacted land prices, finding that 1% increase in the former is associated with 1% increase in the latter.

By multiplying the estimated elasticity of land price, the changes in the effective public wage, and the taxable assessed value of land in each municipality, the reduction in the taxable assessed value of land due to the reduction in public wages is estimated as 193.9 billion yen for 2010.

**Impact on the young unemployment** The result of our analysis on unemployment shows that a 1% decrease in public wages leads to about 0.5% increase in the ratio of young and old unemployment rate, controlling for the preexisting trend. Although this result is insignificant, it is suggestive evidence that public wage cuts increase the youth unemployment rate. Therefore, we use this result to infer the impact of public wage reform on youth unemployment.

Consistent with our argument in Section 3 that only the young are affected by the public-sector wage reform, we suppose that the public sector wage reform affects the unemployment rate of the young. This changes the ratio of young and old unemployment rate due to the public wage reform can be derived by multiplying the changes in public wage and the estimation result, 0.5%. Denote it as "ΔYO ratio of Unemployment". Since the unemployment rate is the ratio of the unemployed to the labor force, the change in the number of the young unemployed can be calculated as "ΔYoung unemployment = ΔYO ratio of Unemployment × Old unemployment rate × Young labor force" in each municipality. Since the Census reports the labor force and unemployment by age group in each municipality, we use these data to infer the impact.

Applying the calculation, we can infer that the increase of the young unemployed is estimated as 10,471 for 2010.

**The total amount of public wage reduction in local governments** In addition to the economic impact on the various outcomes, we also infer the total amount of public wage reduction in local governments, considering that the changes in the effective public wage were different for each region. Since the Fact-Finding Survey on the Compensation of Local Government Employees includes the number and average wage of local government employees by age and education level for each locality, we calculate that the total amount of public wage reduction for all municipalities due to the reform can be estimated at 104.6 billion yen in 2010 based on this data.

However, the public wage reduction for prefectures cannot be exactly estimated because the different regional allowances rates are applied in different municipalities within the same prefecture and it is not known how many prefectural workers are located for each municipality. Since the number of prefectural workers is about 1.1 times larger than the number of municipal workers, and prefectural workers tend to be located in the prefectural capital, which tends to have higher regional allowances rates than the other region, we suppose that the total amount of public wage reduction for all prefectures due to the reform to be about the same as that for all municipalities, i.e. about 100 billion yen in 2010.

Taken together, the estimated total amount of local public wage reduction is about 200 billion yen in 2010.

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