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ESSAYS ON LOCAL PUBLIC FINANCE AND LABOR ECONOMICS

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Abstract

Essays on Local Public Finance and Labor Economics

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This dissertation consists of three papers on local government finance and labor economics, such as the impacts of intergovernmental fiscal transfer, information provision about the future extinction of municipalities, and raising the eligibility age of public pensions. My work investigates how individuals, municipalities, and housing markets respond to incentives created by policies and provides empirical evidence about these issues.

The first chapter studies the impacts of intergovernmental fiscal transfer on local public finance. I use a fuzzy regression kink design (RKD) and dynamic RKD to estimate the causal effect of Japan's unconditional intergovernmental grants on municipal fiscal spending, employment, and revenue. In Japan, the central government provides unconditional grants to municipalities based on a mechanical formula. As a result, I observe a significant positive kink in municipal spending and employment, especially in the general administration department. I also apply dynamic RKD and identify the statistically significant positive direct effect of the current unconditional grants on municipal spending and employment, separated from indirect effects via subsequent grant decisions. Since revenue results show a decline in tax rates and collection, I find that the impact of both crowding-in and crowding-out exists and that the crowding-in effect is more prominent. Thus, I provide new evidence of the impact of unconditional grants on local public finances.

The second chapter investigates the effect of a shrinking population on local government and housing markets. I use a unique event—the publication of a list of municipalities at risk of extinction by 2040 in Japan—to estimate the impacts of declining populations on municipalities and housing markets using difference-in-differences (DID) models. Many countries are facing the crisis of population decline, and the effect of this trend on economic growth and inter- and intra-generational inequalities is a significant issue. However, it is difficult to estimate the causal impact of population decline because it proceeds steadily, so it is not a shock, and endogenous to each situation. The information shock from the list publication conveys the significance of the population decline in specific areas; I can identify the causal effects of population decline. The results show that designating future "extinction" had the effect of an increase in regional revitalization and child-oriented spending and a decrease in home prices.

The third chapter evaluates the causal effects of public pension reform on the employment and time allocation of older people. Many countries are facing an aging population, and this trend is expected to accelerate in the future. Therefore, the sustainability of social security systems, including pensions, has become a serious common issue among policymakers. In Japan, the Pension Law was amended in 1994 to raise the eligibility age in order to reduce fiscal expenditures on social security. I use a sharp RDD to estimate the impact of the 2001 reform raising the male eligibility age from 60 to 61, with the month of birth as the running variable, and April 1941 as the cutoff for raising the eligibility age. I estimate the comprehensive impact on the lifestyle of the elderly, in addition to the employment rate. The results present that the pension reform increases employment rates and work hours, but has the effect of decreasing men's housework, leisure for relaxation, and social activities at the same time. I provide

new evidence on the impact of social security reform, which is an important issue in many countries facing aging populations.

For my children, Shinichiro and Yuki

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Chapter 1

The Impact of Intergovernmental Fund Transfers on Local Public Finance: Evidence from Japan

Abstract

Intergovernmental fund transfers play an important role in equalizing public finances among central and local governments in many countries. In Japan, the central government provides unconditional grants to local governments based on a mechanical funding algorithm. I use a fuzzy regression kink design (RKD) to estimate the impact of those grants on the spending, employment, and revenue in municipalities. I observe a significant positive kink in the municipal spending, especially in the general administration department. I also find that the number of employees in this sector and young employers with lower status, although the impact on overall employment is not confirmed. In addition, I apply dynamic RKD and identify the statistically significant positive direct effect of the current unconditional grants on municipal spending and employment, separated from indirect effects via subsequent grant decisions. At the same

time, since the results show a decline in tax rates and collection, I find evidence of both crowding-in and crowding-out of local public spending. The paper comprehensively demonstrates that the crowding-in effect is larger, and provides new evidence of the impact of unconditional grants on local public finances.

1.1 Introduction

Intergovernmental financial transfers are widely used in both developed and developing countries. In general, there is a vertical fiscal gap because the central government is better able to secure tax revenues than local governments and a horizontal fiscal gap in which tax resources are unevenly distributed among local governments. Intergovernmental fund transfers have the role of mitigating these fiscal gaps and guaranteeing the provision of necessary public goods and services for residents by transferring funds from the central government to local governments. Improving local government finances can be critical to the financial sustainability of entire countries. In Japan, local governments spending accounts for more than half of the country's total fiscal spending. About 30% of local government revenues consist of transfers from the central government: unconditional grants (local allocation tax grants, or LATs) and conditional grants (national treasury disbursements). Eligibility for and the amounts of unconditional grants are based on a mechanical funding algorithm; the central government grants to local governments their standard financial needs (SFNs) minus their standard financial revenues (SFRs), with no conditions on how municipalities spend those funds. The unconditional grants do not increase or decrease with local government action.

Bradford and Oates (1971) predict that, theoretically, because grants for local government will be spent on tax reduction, this crowd-out will increase local government expenditure very little.[1] However, many existing studies empirically report that intergovernmental transfers to local governments increase public spending rather than reducing taxation. This crowding-in of public spending is known as the "flypaper effect" because money sticks in the public budget where intergovernmental transfer grants land. Empirical studies of the flypaper effect, starting with Gramlich (1969) and Gramlich et al. (1973), have reported the crowd-in of local public spending by grants in a number of countries, including the United States.[2] However, some recent research has pointed out that the flypaper effect is a consequence of misspecification, such as the neglect of endogeneity. Knight (2002) indicates that the estimated impacts of U.S. federal grants on state spending are biased by endogeneity due to lobbying to increase government spending. He estimates that the Federal Highway Aid Program has a crowding-out effect when controlling for its political endogeneity. Gordon (2004) focuses on grants for compulsory education, which are allocated according to the results of poverty surveys conducted once every 10 years. She finds that discontinuous changes in the grant amount initially increase educational spending but are crowded out within three years. Lutz (2010) estimates the effects of grants introduced in New Hampshire's 1999 education reform and confirms that about 90% of the grants received by municipalities were used to finance tax reductions. Cascio et al. (2013) estimate the effects of the introduction of Title I of the 1965 Elementary and Secondary Education Act, a large U.S. federal grant program. They reported that in the average school district in the

[1] Clemens and Veuger (2023) summarize insights on the role of intergovernmental grants from the points discussed by the classic literature and from the empirical analyses provided by the recent literature.

[2] Hines and Thaler (1995), Bailey and Connolly (1998), and Inman (2008) survey empirical studies of the flypaper effect.

South, Title I increased school spending but by only $0.5 per dollar.

By contrast, several studies report empirical evidence confirming the flypaper effect, even after taking endogeneity into account. Dahlberg et al. (2008) exploit discontinuity in the Swedish grant formula and estimate the impact of the grant on both local expenditures and local tax rates while considering endogeneity. They provide evidence of a crowd-in those federal subsidies led to more local spending but not reduced local taxes. Litschig and Morrison (2013) use a regression discontinuity design (RDD) to provide evidence on the development impact of intergovernmental transfers in Brazil. While additional transfers increased local public spending per capita by about 20% over four years, there is no evidence that they reduced localities' self-generated revenues or other sources of income. Lundqvist et al. (2014) applied a regression kink design (RKD) to Swedish intergovernmental grants to find that employment in administrative departments increased.[3] Lundqvist (2015) uses a difference-in-differences (DID) technique to estimate the impact of grants to municipalities in Finland on local spending and taxes. After the grants increased, a significant positive response to local spending and a significant but small negative effect on local taxes were immediately observed, and Lundqvist regards the grants as having a crowd-in effect. Allers and Vermeulen (2016) report that the fiscal equalization system in the Netherlands has a flypaper effect. Ando (2015) and Ando (2017) apply RKD using panel data for large Japanese municipalities and report that the receipt of the unconditional grants had a positive kink on per capita expenditures.

Thus, it remains unclear whether intergovernmental fiscal transfers lead to crowding-out or crowding-in, and which effect is greater overall. In the present study, I estimate

[3]However, they also report that administrative employees accounted for a small share of total employment in communes and were not effective in stimulating overall employment by communes.

the impact of Japan's unconditional grants on municipal spending, revenues, and the scale of the administrative structure in municipalities by using an RKD. It is possible to identify the effects of unconditional grants since they are provided if the fiscal gap of the municipalities is greater than zero and are not provided if it is less than zero. In this empirical analysis, I use municipal spending, revenues, local tax rates, tax collection efforts, and municipal employment as the outcome variables and a large panel dataset at the municipality level from 1991 to 2000.

Thus, I was able to obtain robust results with a clear positive kink in the municipal spending and employment at the point where the fiscal gap is zero, which triggers eligibility for unconditional grants. At the same time, I observed the presence of actions that municipalities that received the unconditional grants reduced local tax rates and increased tax collection shortfalls. Comprehensively, I confirm that the magnitude of the increase in local government spending is the most notable when municipalities receive the unconditional grants. This implies that the receipt of unconditional grants leads to a crowding-in of public spending, rather than crowding-out of reducing tax rate and increasing tax collection shortfall.

The main contributions of my study are as follows. First, I use natural experiments to provide new evidence on the flypaper effects and crowd-out of intergovernmental fiscal transfers. Japan's unconditional grants are suitable for estimating effects by an RKD or RDD, since eligibility for those grants is determined only by municipalities' financial capacity. I rigorously estimate the effect of unconditional grants by focusing on Japan's fiscal transfer system, which uses mechanical calculation. As Dahlberg et al. (2008) point out, there is heterogeneity in grants across programs, so estimated effects will depend on the specifics of different schemes. The present study adds new evidence on

unconditional grants.[4]

Second, I conduct a detailed analysis based on quasi-experiments, which estimates the causal effects of unconditional grants on spending and employment by category and type. My dataset is a balanced panel data set that includes a rich variety of variables such as municipal spending, the number of employees, wage expenses tax rates from 1991 to 2000. The results of my estimates indicate that as the behaviors against the grants receipts, there exists both crowd-in, through increased spending and employments. In particular, there are a limited number of quasi-experimental studies that have been considered for unconditional grants.[5] Specifically, most research has focused on the amount of spending. To my knowledge, the number of studies estimating impacts on employment is quite limited (e.g., Bergström et al. (2004); Lundqvist et al. (2014)). In addition, my research estimates the effect on spending in the same category as the employment departments and confirms whether wages or non-wages are the primary source of the impact. As a result, I report that the increases in spending are due more to spending other than wages.

Third, my paper succeeds in providing a comprehensive assessment of the effect

[4]In related Japanese intergovernmental grants, various previous literature has reported the impact of unconditional grants on spending and tax collection efforts, although most of them are not based on causal inference (Yamashita et al. (2002); Nishikawa and Yokoyama (2004); Mochida (2006); Nishikawa (2006); Tajika and Miyazaki (2008); Ishida (2012); Ando (2017); Miyazaki (2020)). This paper is most relevant to Ando (2015), which also investigates the relationship between grants of Japanese local governments and their performance. This paper is different from that paper in the following respects: (1) Ando (2015) covers two years when exceptions to the grant calculation rules were applied in many municipalities (2003 and 2004), whereas this paper covers 10 years when the grant calculation rules were strictly and mechanically applied (from 1991 to 2000); (2) The outcomes in my paper include not only spending, but also the number of employees, wage expenditures, revenue, tax rates, tax collection efforts, and provide a comprehensive evaluation of the grants; (3) This research analyzes expenditures in more detail than Ando (2015), using RK estimates by department, such as general administration and welfare.

[5]In the United States, there have been no unconditional intergovernmental transfers since the repeal of General Revenue Sharing in 1987. Hence, most recent U.S. studies estimate effects related to conditional grants.

of Japan's unconditional grants on both crowd-in and crowd-out. Specifically, since my data set also includes revenues, local tax rates, and local collection shortfalls, I estimate the crowding-out effect of the grant and compare it to the crowding-in effect.[6] Overall, the study makes a meaningful contribution to the series of controversies about intergovernmental grants by finding that the crowding-in effect is more significant than crowding-out. The present study adds an important perspective to the analysis of crowd-out in local public finance.

Fourth, I use "dynamic RKD"—the RKD version of "one-step approach" or "dynamic RDD" proposed by Cellini et al. (2010)—to estimate the long-term effect on the municipal spending and employments by using large panel data. Dynamic RDD has been used to estimate the effects of school bond elections in California, Texas, and Wisconsin, and it has been empirically reported that the long-run effects on educational investment exists (Cellini et al. (2010); Martorell et al. (2016); Baron (2022)). In Japan, the central government mechanically calculates the eligibility and amount of unconditional grants annually. Therefore, since a municipality that does not receive a grant in a given year may receive a grant in subsequent years, the estimates based on the normal RKD represents an intention to treat (ITT) that includes both the direct effect of the current grant decision and the indirect effect via subsequent grant decisions. I apply this dynamic method to RKD in order to identify the direct effects while holding the subsequent grant decision constant. The results show that the receipt of unconditional grants has a statistically significant effect on spending and employment when the central

[6] In particular, by focusing on collection shortfall rates, I provide empirical evidence of a new field of crowd-out that the previous literature has not paid attention to. As far as I know, this is the first attempt to estimate the effect of transfer grants on tax collection based on a quasi-experiment. While changes in tax rates may involve local politicians, local legislators, and the central government, the tax collection shortfall rate is controlled internally of municipalities' administrative departments.

government's decisions are made. In addition, the spending for the general administration department increases mainly in the first year - when the unconditional grants are received -whereas for ordinary expenditure and employment, which have relatively low flexibility over the years, positive effects are observed after the second year. By simply using standard RKD, there still exists a possibility that municipalities will reduce municipal spending in subsequent fiscal years (crowding-out) to offset the increase of receiving unconditional grants (crowding-in). The results show that the signs of the statistically significant coefficients are positive, indicating that there are no observed such crowding-out in subsequent periods. To my knowledge, the present study is the first attempt to estimate the long-term effects of unconditional intergovernmental grants.

Finally, this paper empirically examines policymakers' concerns about the moral hazard of the unconditional grants. Among that group, there is a criticism that unconditional grants create moral hazard because local governments have a disincentive to carry out rigorous tax collection efforts or reduce ordinary costs due to guaranteed revenues, they do not have to finance themselves.[7] Japan's unconditional grants are not designed to encourage local bureaucracy and spending bloat or discourage tax collection efforts or reduce costs, since the central government determines them independent of actual local government actions. Therefore, when significant effects on ordinary spending or tax collection efforts are estimated, it can be interpreted as showing the presence of moral hazard.

The remaining part of this paper is organized as follows. The next section presents the institutional background. Section 3 describes the theoretical framework, and section 4

[7]The expert committee of the Japanese Ministry of Finance (MOF) criticizes "the financial guarantee role" of unconditional grants as creating a moral hazard in the management of local government finances (MOF (2003), p.6).

explains the identification method. Section 5 presents the data and descriptive statistics. Section 6 shows the empirical results, and section 7 summarizes the main points and provides conclusions.

1.2 Institutional Background

1.2.1 Intergovernmental Transfers in Japan

In 2000, Japan had a central government, 47 prefectures, and 3,235 municipalities (cities, towns, and villages).[8] Table 1.1 shows the fiscal structure in the G7 countries. In Japan, the central government accounts for about 40% of expenditures and local governments for about 60%, while central government tax revenues are about 60%, leaving 40% for local governments. This implies that the gap between local revenues and local expenditures is larger in Japan than in other developed countries. Panel A of Appendix Figure 1.A.1 shows that in FY 2000, about 36.1% of local government revenue came from fiscal transfers from the central government, of which 21.7% was unconditional and 14.3% conditional.[9] The central government allocated 54.1% of unconditional grants to prefectures and 45.9% to municipalities.

Japan's conditional grants are known as "National Treasury Disbursements." Local governments can only spend them in areas designated by the central government, such as construction projects, compulsory school education, early childhood education, and public welfare. In contrast, Japan's unconditional grants, known as "Local Alloca-

[8] In order to rationalize through scale merits, the central government encouraged municipal mergers between 2000 and 2010. As a result, the number of municipalities decreased from 3,235 in 2000 to 1,790 in 2010.

[9] In addition, local taxes and municipal bonds account for 39.9% and 10.5% of the total, respectively.

tion Tax (LAT) Grants", have no restrictions on their use. The unconditional grants are expected to play a role in reducing the gap between local governments' revenues and expenditure needs, both vertically and horizontally. The unconditional grants are determined mechanically according to the following formula:

$$Unconditional\ Grants = \begin{cases} SFN - SFR & if\ SFN > SFR \\ 0 & if\ otherwise, \end{cases}$$

The central government (the Ministry of Internal Affairs and Communications, MIC) mechanically calculates both SFN and SFR for each local government. The central government computes SFN as a reasonable demand for "standard local government," according to indicators such as population, number of households, number of school teachers and staff, area, and total length of roads. Therefore, as I discuss in detail at Appendix D, local governments cannot manipulate SFN, because they are not based on actual or budgeted expenditures that those governments control. The central government defines SFR as 75% of local tax revenues based on a uniform national "standard tax rate" and "standard tax collection rate". Thus, local governments cannot manipulate SFR by adjusting their tax collection rate. The MIC of the central government must determine the amount to be allocated to each municipality by August 31 of each year (Article 10 of the Local Allocation Tax Law).

1.2.2 Local Government Spending and Employment

As Panel B of Appendix Figure 1.A.1 illustrates, in municipalities, 59.9% of revenues are "general revenue sources" that can be used freely by municipalities, while 40.1% are "specific revenue sources" whose use is limited to specific areas. The revenue from the

unconditional grants is classified in the former category, while the conditional grants are in the latter. Therefore, for the analysis of municipal spending, I focus on spending financed by general revenue sources.

In FY 2000, the central government spent 23.79 trillion JPY (19.6% of expenditures), the social security fund spent 29.31 trillion JPY (24.1%), and local governments spent 68.44 trillion JPY (56.3%). Local government expenditures were further divided into 51.1% by prefectures and 48.9% by municipalities.[10] Panel A of Appendix Figure 1.A.2 reports that general administration accounted for 41.2% of municipal spending, and welfare for 30.3%. Panel B indicates that 46.0% of general administration spending were used for civil engineers, 30.9% for general service or taxation, and 19.8% for industrial policy. In addition, Panel C presents that the ordinary expenses accounted for 62.8% of total municipal expenditures, and Panel D shows that 34.5% of ordinary expenses were personnel costs.

Panel A of Appendix Figure 1.A.3 shows that, according to OECD (2011a), the number of government employees in Japan accounts for 7.7% of the workforce, which is lower than the other G7 countries and the OECD average (15.2%). The number of government employees in Japan was 4.35 million in FY2000, with the central government employing 1.13 million (26.0%) and local governments 3.22 million (74.0%). Prefectures accounted for 1.67 million (52.0%) and municipalities for 1.54 million (48.0%) of the total local government employees. As shown in Panel B, the number of employees in the municipalities by department is the largest in general administration, at 37.6%. Panel C indicates that 59.1% of employees in the general administration department were assigned to secretariat of council, general services or taxation, 26.1% to civil engi-

[10]This does not coincide with local government totals since the figure does not exclude overlapping elements like fiscal transfers from prefectures to municipalities.

neers, and 14.0% to industrial policy. Panel D reports that for employee wages, as well as the number of employees, general administration is the largest, accounting for 36.5% of the total. In many administrative areas of municipalities, the central government has established placement criteria for officials. I focus on the number of employees in the general administrative department, which municipalities are relatively free to determine (MIC (2006)).[11]

1.2.3 Local Government Revenues and Taxations

The main revenues of local governments come from local taxes and municipal bonds, as well as grants from the central government. Panel A of Appendix Figure 1.A.1 shows the amount of local taxes and bonds in FY 2000 account for 35.4% and 11.1% of the total, respectively. As noted above, the amount of the unconditional grant is determined by the central government regardless of the actual other revenues of the municipalities, so there is no institutional relationship between the unconditional grant and the other revenues. The amount of local tax revenue is determined by (1) the tax bases, (2) the tax rates, and (3) the tax collection rates. First, there exist two types of local taxes: legal taxes, which are set by national law, and extra-legal taxes, which the local government council can set on its own. As shown in Panel C of Appendix Figure 1.A.1, the major municipal tax revenues are legal taxes, such as property tax (45.3%), individual income tax (30.3%), corporate income tax (10.9%), and city planning tax (6.6%), while extra-legal taxes account for only 0.002% of total. Thus, the setting of

[11]The Japanese MIC defines municipal departments as general administration, welfare, and other (education, firefighting, and police), in descending order of degree of municipal discretion. The general administration consists of the secretariat of council, general service, tax, labor, industry, and civil engineering.

own tax bases by municipalities is quite limited.[12]

Second, even though the setting of local tax rates belongs to local councils, "the reference tax rates" are suggested by the central government for many legal taxes. Appendix Figure 1.A.4 illustrates that most municipalities have set tax rates for property tax and individual income tax at the exact same rate as the reference rates.[13] Therefore, in analyzing tax rates, I focus on the corporate income tax, where 44.2% of municipalities have set their own tax rates, and the city planning tax, where no reference tax rate exists. Third, Appendix Figure 1.A.5 shows the amount of local tax shortfalls in Japan. That amount continued to increase and amounted to 2,345 billion JPY in FY 2000. This amount roughly equals other local taxes such as consumption tax (i.e., value added tax at 2,479 billion JPY) and is larger than the automobile transaction tax (1,751 billion JPY). In municipalities, local tax shortfalls came to 83.85 billion JPY (48.5%) for property tax and 58.73 billion JPY (34.0%) for individual inhabitant tax; these two taxes accounted for more than 80% of total shortfalls.

1.3 Theoretical Frameworks

Before the empirical analysis, I suggest a simple model for municipalities' public spending. Specifically, I assume that local government i set tax rate or collection rate (θ_i)[14]in order to maximize the utility of representative households in the following quasilinear

[12]Until April 2000, the imposition of extra-legal taxes required approval of the central government in advance.

[13]In addition, municipalities are directly restricted in setting tax rates by a regulation that prevents municipalities that levy taxes below the reference tax rate from issuing municipal bonds; in 2000, no municipality set a tax rate below the standard tax rate.

[14]Since tax rates and tax collection rates play the same role, these can be represented by a single indicator (θ_i).

form:

$$\max_{\theta_i} u_i = c_i + \upsilon(g_i),$$

where c_i is the private consumption in municipality i, g_i is local public spending, and $\upsilon' > 0$ and $\upsilon'' < 0$.For simplicity, I assume that each municipality has an identical fixed labor supply corresponding to its population, so the output in municipality i (y_i) is produced by using capital (k_i) and one unit of labor. The production function is thus $y_i = f(k_i)$ and is strictly concave ($f' > 0$ and $f'' < 0$). In addition, I consider the household budget constraint

$$c_i = labor\ income_i - \theta_i Z_i,$$

where Z_i the tax base for the municipality i. From the production function, $labor\,income_i$ is equal to output minus capital costs ($labor\ income_i = y_i - k_i f'$). I also assume that the local government budget constraint is

$$g_i = \theta_i Z_i + Unconditional\ Grants_i - Cost_i(\theta_i, Z_i),$$

where $Cost_i(\theta_i, Z_i)$ represents the cost of tax collection and is an increasing function of the tax collection rate, tax rate, and tax base in municipality i. $Unconditional\ Grants_i$ denotes the unconditional grant to municipality i, which is computed by

$$Unconditional\ Grants_i = \begin{cases} x_i - \bar{\theta} Z_i & if\ SFN_i > SFR_i \\ 0 & if\ otherwise, \end{cases}$$

where the first term (x_i) represents SFN for municipality i, and the second term ($\bar{\theta} Z_i$) is SFR for municipality i. To calculate formulas of SFR, the central government sets

the "standard tax rate and tax collection rate, multiplied by a constant in $(0, 1]$" ($\bar{\theta}$) as those of the virtual municipality. $\bar{\theta}$ is exogenous for the local government i, regardless of actual performance. Therefore, when municipality i receives an unconditional grant, its utility function can be expressed as follows:

$$\max_{\theta_i} u_i = f(k_i) - k_i f' - \theta_i Z_i + \upsilon(\theta_i Z_i + x_i - \bar{\theta} Z_i - Cost_i(\theta_i, Z_i)),$$

Then, by taking the first order condition with respect to θ_i, the following equation is obtained:

$$-Z_i + \upsilon'_{with\ grant}[Z_i - (Cost_i(\theta_i, Z_i))'],$$

Here, I suppose that the cost of tax collection has a quadratic form ($Cost_i = \alpha\theta_i Z_i + \beta/2(\theta_i Z_i)^2$, and $\alpha, \beta > 0$); the first order condition then becomes

$$-Z_i + \upsilon'_{with\ grant}[Z_i - \alpha Z_i - \beta\theta_i (Z_i)^2] = 0,$$

By rearranging this equation, the optimal level of tax rate and collection rate ($\theta_i{}^*$) can be obtained as follows:

$$\theta^*_{i,with\ grant} = \frac{\upsilon'_{with\ grant}(1-\alpha) - 1}{\beta\upsilon'_{with\ grant} Z_i} = \frac{(1-\alpha) - 1/\upsilon'_{with\ grant}}{\beta Z_i} \tag{1.1}$$

I also consider the case in which municipality i does not receive an unconditional grant. This utility function can be expressed as follows:

$$\max_{\theta_i} u_i = f(k_i) - k_i f' - \theta_i Z_i + \upsilon(\theta_i Z_i - Cost_i(\theta_i, Z_i)),$$

Then, by taking the first order condition and rearranging it, the optimal rate ($\theta_i{}^*$) is

$$\theta^*_{i,no\ grant} = \frac{\upsilon'_{no\ grant}(1-\alpha)-1}{\beta\upsilon'_{no\ grant}Z_i} = \frac{(1-\alpha)-1/\upsilon'_{no\ grant}}{\beta Z_i} \tag{1.2}$$

Since υ is concave and the local government in equation (1.1) receives more revenue than in equation (1.2) because of receiving the grant, $\upsilon'_{with\ grant}$ is smaller than $\upsilon'_{no\ grant}$.[15] Hence, the optimal tax or collection rates with unconditional grants are lower than those without the grants ($\theta^*_{i,with\ grant} < \theta^*_{i,no\ grant}$).

Next, the level of local public expenditure ($g_i{}^*$) under these optimal tax and collection rate ($\theta_i{}^*$) can be obtained from the local government budget constraint. When municipality i is eligible for an unconditional grant, the level of local public spending becomes

$$\begin{aligned} g^*_{i,with\ grant} &= \theta^*_{i,with\ grant}Z_i + Unconditional\ Grants_i \\ &\quad -(\alpha\theta^*_{i,with\ grant}Z_i + \frac{\beta}{2}(\theta^*_{i,with\ grant}Z_i)^2) \end{aligned} \tag{1.3}$$

Also, when municipality i does not receive an unconditional grant, the level of local public expenditure becomes

$$g^*_{i,no\ grant} = \theta^*_{i,no\ grant}Z_i - (\alpha\theta^*_{i,no\ grant}Z_i + \frac{\beta}{2}(\theta^*_{i,no\ grant}Z_i)^2) \tag{1.4}$$

Therefore, by comparing equation (1.3) and (1.4), the optimal government spending ($g^*_{i,no\ grant}$) increases by the amount of the unconditional grant. In addition, the optimal government spending can also be affected by the optimal tax and collection rate ($\theta_i{}^*$). These imply that the unconditional grant increases public spending in accordance with

[15] Therefore, $(-1/(\upsilon'_{with\ grant}))$is smaller than $(-1/(\upsilon'_{no\ grant}))$.

the grant amount.[16] Depending on the functional form of υ, since the amount of the unconditional grant gradually increases with the running variable (the gap between SFN and SFR), it is suitable for applying an RKD. Whether the primary response should be a decrease in ${\theta_i}^*$ or an increase in ${g_i}^*$ is an important question to be empirically examined. In addition, the largest category of ordinary expenses for local governments is personnel costs, as section 2 notes. Hence, in the analysis of expenditures, I also focus on the number of employees per capita.

1.4 Identification Strategy

1.4.1 Impacts on the Municipal Spending and Employment

1.4.1.1 Regression Kink Design

In order to estimate the impact of unconditional grants on spending and employment by municipalities, I compare municipalities' outcomes just above (treatment group) and just below (control group) the cutoff, which I define as the fiscal gap: the difference between SFN and SFR set by the central government, which makes municipalities eligible for unconditional grants. As noted in Appendix D, the actual amount of the unconditional grants is adjusted to match the size of the tax revenues that finance the grants, so I

[16] In the context of the flypaper effect, Dahlberg et al. (2008) point out that there are four cases that will cause grant endogeneity; (i) political negotiations between central and local politicians, (ii) preferences of central politicians for specific economic or political characteristics associated with their spending priorities, (iii) socio-economic characteristics of a given municipality, and (iv) unobserved characteristics correlated with both local spending and grant allocation.

implement a fuzzy RK estimation, instrumenting the amount of the grants as follows:[17]

$$Grants_{it} = \alpha + \sum_{p=1}^{\bar{p}} [\beta_p Fiscal\ Gap_{it}{}^p + \pi_p Fiscal\ Gap_{it}{}^p \cdot D_{it}] + X_{it}\mu + u_{it} \tag{1.5}$$

$$y_{it} = \delta + \sum_{p=1}^{\bar{p}} [\gamma_p Fiscal\ Gap_{it}{}^p + \omega_p Fiscal\ Gap_{it}{}^p \cdot D_{it}] + X_{it}\eta + \epsilon_{it} \tag{1.6}$$

$$Fiscal\ Gap_{it} = SFN_{it} - SFR_{it}$$

Equation (1.5) is the first stage, and equation (1.6) is the second stage estimation. Here, the outcome variable of the first stage ($Grants_{it}$) represents the unconditional grants and those in the second stage (y_{it}) are the expenditures or the number of employees by municipal government i at time t. In addition, $Fiscal\ Gap_{it}$ indicates the running variable, and $D_{it} = \mathbb{1}[Fiscal\ Gap_{it} > 0]$ is an indicator variable that takes one if $Fiscal\ Gap_{it}$ is positive and zero otherwise. $\bar{p}$ is the order of polynomial and I set this to the first order in the baseline. Therefore, municipalities just below the cutoff will receive unconditional grants from the central government, but municipalities just above the cutoff will not. X_{it} is the vector of the covariates for municipality i.[18] I use year dummies, demography (the population density and share of females), and revenue capacity of municipality i as control variables. From equation (1.5) and (1.6), I can get the following RK estimate of the causal effect of receiving the unconditional grants:

$$\text{RK Estimates} : \frac{\gamma_1}{\beta_1}$$

When this estimate is positive and statistically significant, I can interpret that "crowding-in" effect of the unconditional grants exists.

[17] In all RK regressions, I use the "rdrobust" software package developed and provided by Calonico et al. (2014).

[18] Card et al. (2017) indicates that incorporating covariates may improve the precision of the estimates.

I implement the RKDs for total spending and employment, I then run the regressions separately for those by category and type, such as employment in general administration, welfare, and other departments. Additionally, the general administrative department can be largely determined by the municipality on its own. Since my dataset includes departmental details, I provide RK estimates as an additional outcome. I also estimate wage expenses, including employees indirectly employed, such as mayors, local council members, and temporary staff. In the baseline estimation, the functional form is used in local linear functional form, a triangular kernel, and an optimal bandwidth that minimizes the mean-squared error, suggested by the method of Calonico et al. (2014). As a robustness test, I also estimate the second order polynomial and uniform kernel using several bandwidth sizes. I use clustered standard errors at the municipal level.

1.4.1.2 Dynamic Regression Kink Design

As noted in section 2, the central government provides unconditional grants to municipalities annually, based on the mechanically calculated SFN and SFR of each municipality. Since the SFN and SFR are recalculated annually, it is possible that a municipality that receives an unconditional grant in one year may lose eligibility in another year.[19] That is, the causal effect estimated by standard RKD represents ITT that contains both the direct effect of the grant decision in period t and the indirect effect of the grant decision in period t+1 and later. In order to isolate only the direct effects of the unconditional grants while holding the subsequent grant results constant, I adopt the one-step dynamic RDD proposed by Cellini et al. (2010) for RKD ("dynamic RKD") and estimate the

[19] About 84.3% of municipality observations within the baseline bandwidth used in the RDD estimation are in the same treatment or control group for every year between 1991 through 2000.

"treatment on the treated" (TOT). Specifically, I run the following equation:

$$y_{it} = \sum_{\tau=1}^{10} [\theta_\tau Fiscal\ Gap_{j,t-\tau+1} \cdot \mathbb{1}[Fiscal\ Gap_{j,t-\tau+1} > 0] + f_\tau(Fiscal\ Gap_{j,t-\tau+1})] + \mu_j + \alpha_t + u_{j,t} \quad (1.7)$$

$$\text{for } t = 1991, \cdots, 2000,$$

where outcome variable y_{it} is the municipal spendings or employment per capita in municipality i at time t.$f_\tau(Fiscal\ Gap_{j,t-\tau+1})$ is a polynomial function on either side of the cutoff. I use the specification that allows function to be different below and above the threshold. As to the other elements, μ_j represents the municipality fixed effect, α_t year fixed effects and $u_{j,t}$ the error term. θ_τ are the coefficients of interest, and I can interpret θ_τ as TOT effect of the unconditional grants (the causal effect of the grants receipt in time $t - \tau$ on the outcome in time t). As a baseline, I use a first order polynomial, and I additionally check robustness by using second order polynomials. I use clustered standard errors at the municipal level.

1.4.2 Impacts on Municipal Revenue and Taxation

To estimate the "crowding-out" effect that unconditional grants may have, I run the RK estimations in equation (1.6) with municipal revenues as the outcome. Specifically, I set the major revenues other than unconditional grants as the outcomes of the revenue analysis (y_{it}): local taxes that municipalities collect themselves, local transfer taxes that the central government collects on their behalf, municipal bonds issues, and conditional grants (block grants). In addition, I also conduct estimations by tax type, with tax revenues, tax rates, and collection shortfalls as outcomes. The empirical setting is

basically the same as the RKD regressions for spending and employment.[20]

1.4.3 Validity Tests

In order to estimate effects in the RKD, the assumption of continuity must be satisfied. First, I test whether the running variable is manipulated at the cutoff by using the method suggested by McCrary (2008). Appendix Figure 1.A.6 shows the results of the McCrary density test. This figure graphically shows no signs of discontinuity or change in the slope of the density between the running variable and the number of municipalities at the kink point. Since the p-value is 0.637, the null hypothesis that "density is continuous at the cutoff" cannot be rejected. Therefore, evidence indicating a manipulation of the running variable is not observed.[21] Second, in order to show whether continuity assumption may hold, I conduct a covariate balance test for observable variables predetermined before the spending or employment decision. Appendix Figure 1.A.7 plots covariates along the running variable, indicating that no kink may exist at the kink point. Appendix Table 1.B.1 reports the results of these smoothness tests, and all estimates are not statistically significant in both linear and quadratic functions, which suggests that the research design satisfies internally validity. Third, as placebo tests, I conduct the permutation tests suggested by Ganong and Jäger (2018). Appendix Figure 1.A.8 reports the results of the tests, where I use data that does not include the true threshold, draw 300 placebo thresholds, and estimate local linear RK regressions. The figures plot the cumulative distributions of the placebo robust t-statistics, showing that the actual t-statistics for each outcome is larger in absolute

[20] For the tax collection shortfall, I estimate the RDD regressions as described in Appendix E.
[21] I conduct density tests in all individual years and no evidence of manipulation is found for all.

value than the placebo t-statistics. Hence, there is no evidence that shows a placebo effect exists.

1.5 Data

I construct large-scale municipality-level panel data for the 1991–2000 period from several data sources. The data on local government finances were obtained from the MIC's Survey of Local Government Finance, which offers detailed information on local expenditures, revenues, and employment of all municipalities by year. In addition, MIC provided me with data about the amounts of SFN and SFR and the number of residents at the municipal level. I add the percentage of the female population to the covariates. In the analysis, I exclude the 31 municipalities that merged during the period under analysis, because different criteria are applied to the eligibility for and allocation of unconditional grants to merged municipalities for several years.[22] I exclude the village of Miyake because all residents were evacuated until 2005 due to a volcanic eruption in 2000.

Table 1.2 presents summary statistics for the outcomes, the running variable, and the covariates used in the empirical analysis. My data set contains a total of 31,980 observations from 1991 to 2000.[23] The tax collection shortfall is defined as one minus the amount of the assessment minus the actual amount of collection.[24] I use the

[22] Since the number of municipalities rapidly decreased from 3,235 to 1,790 after 2000, most municipalities would have to be excluded from the analysis if the period after 2000 were included.

[23] Due to missing data on the number of employees in Sapporo city, Sendai city, Chiba city, Yokohama city, Kawasaki city, Nagoya city, Kyoto city, Osaka city, Kobe city, Hiroshima city, Kitakyushu city, Fukuoka city, Ushibori town, and Aimi town, these 14 municipalities are also excluded from the analysis.

[24] Since there are collection shortfall below zero (one observation for income tax and seven observations for other tax), that are replaced by zero. There are no observations below zero for the collection shortfall rate of total taxes and property tax.

collection shortfall for current year taxes, excluding the previous year's delinquencies. I define revenue capacity as a predetermined covariate by dividing SFR by 0.75. The variables are deflated by the MIC's consumer price index, with 2020 as a base. To adjust for municipality size, I divide the running variable, outcomes, and other covariates by the number of residents and express these variables as per capita values.

1.6 Empirical Results

1.6.1 First Stage Result

First in the estimations, I run a first-stage RK regression based on equation (1.5) with the unconditional grant as the outcome. Figure 1.1 plots the unconditional grants revenue per capita. The horizontal axis is the running variable ($Fiscal\ Gap_{it}$). The kink point is set by the running variable of zero, at which point municipalities become eligible for the unconditional grants. This figure presents graphical evidence of the running variable, showing the running variable is clearly related to the grants receipt. Table 1.3 reports the RK estimate of equation (1.5). As explained in section 4, I use a local linear functional form and a triangular kernel in the baseline. The bandwidth for all estimators is set by the two different mean squared-error (MSE)-optimal bandwidth selectors. The RK estimate is statistically significant at the kink point and its magnitude is exactly one. This implies that the first stage result is consistent with the grant scheme.

1.6.2 Impacts on the Municipal Spending and Employment

1.6.2.1 Impacts on the Municipal Spending

1.6.2.1.1 Graphical Evidence

Figure 1.2 presents graphical evidence of the effect on the average municipal spending estimated by equation (1.6). Specifically, Panel A plots the total municipal spending, and the spending for the general administration, from general revenue sources. My analysis for spending focuses mainly on spending from general revenue sources, because the unconditional grants are only allocated to this financial source, as I mentioned in section 3. Also, main outcomes of my estimations for municipal spending and employment are about general administration spending, since municipalities can determine these more freely than other departments (MIC (2006)). A clear kink in both panels can be observed at the cutoff ($Fiscal\ Gap_{it} = 0$). Each panel in Appendix Figure 1.A.9 plots a detailed department of general administration, in addition to the welfare and other spending, respectively. There seems to exist a kink in some categories of general administration, welfare, and other expenditures.

In addition, the present study estimates the causal effects of the grants on each type of municipal spending. Appendix Figure 1.A.10 plots the average spending by type. Panel A shows the ordinary spending. Panel B to G show the detailed type of ordinary spending, and Panel H plots the non-ordinary spending. The ordinary spending is the expenditure spent on a recurring basis each fiscal year, such as personnel cost, aid cost, and bond cost, and is regarded as an indicator of administrative cost efficiency in various previous studies (Yamashita et al. (2002); Tajika and Miyazaki (2008); Sumi (2018)). From the figure, it seems that the average ordinary expenditure has a positive kink in

the cutoff, suggesting that municipalities are becoming less cost-efficient.

1.6.2.1.2 RKD Results for the Municipal Spending by Department

Table 1.4 shows the results of the fuzzy RK estimates (γ_1/β_1) for municipal expenditures per capita from general revenue sources, obtained from equations (1.5) and (1.6). In the baseline, I use local linear functional form, a triangular kernel, and two different MSE-optimal bandwidths. Column 1 reports the effect in total spending, and Column 2 reports the effect in general administration spending; both show a statistically significant positive kink at 1% level. Since the magnitude of the total spending estimate is close to 1, we can interpret the increase in unconditional grants directly leading to an increase in municipal spending. Column 3 to 8 indicate the RK estimates for the detailed departments of general administration, showing that estimates for many departments, such as general service (Column 4)[25], industry (Column 7) and civil engineering (Column 8), are positive and statistically significant. In contrast, it will be natural that labor spending (Column 6), which is small in amount and passively paid to unemployed persons, is statistically insignificant, as well as expenditures for local councils (Column 3). Also, Column 5 reports a positive and slightly significant result on the tax department spending, and interpreting this impact should be careful. Next, Column 9 and 8 shows the effects on expenditures for welfare and other departments, respectively. Welfare spending has a statistically significant at 5% level, and other spending at 1% level. Since these spending is from general revenue sources, welfare spending here may be mainly municipal own support policies that add to the national minimum, such as

[25] General service includes the management of personnel, employee benefits, administrative document, household registry, municipal building, property, accounting, statistics investigation, public relations and communications, and the digitalization installation.

lowering children's healthcare fees and expanding childcare services. Other spending includes expenditure for primary and secondary education, so this result may reflect an increase in municipal own educational support beyond national requirements. In general, I observed that the receipt of unconditional grants had the effect of increasing municipal spending in many departments, including industrial developments, social infrastructure constructions, and additional welfare supports as well as local government managements.

1.6.2.1.3 RKD Results for the Municipal Spending by Type

Appendix Table 1.B.2 reports the fuzzy RK estimates for municipal expenditures by type from general revenue sources. Column 1 reports the impact of the unconditional grants on ordinary spending, and Column 8 on non-ordinary expenses. Both of these estimates are positive and statistically significant at the 1% level, with the former being larger in magnitude. These results implies that the receipt of unconditional grants may lower the cost-effectiveness of local governments. Column 2 to 7 represents the RK estimates on spending for personnel (Column 2), supplies and services (Column 3), maintenance and repairs (Column 4), social assistance (Column 5), subsidy (Column 6), and debt repayment (Column 7). The estimates for supplies and services expenses and subsidy expenses are positive and statistically significant. Supplies and services expenses include wages for temporary staff, specially commissioned work, rents, traveling, and equipment purchases. Subsidy expenses include tax burdens related to the municipalities' purchasing and the payment of insurance premiums, as well as subsidies to the private sector. In contrast, the effects on personnel expenses and social assistance cannot be observed. Hence, we can interpret that municipalities receiving

the unconditional grants tend to increase their spending of a type that is recurring but relatively flexible. In addition, the result in Column 7, indicating — the municipal bond repayment is not statistically significant — implies that the grants directly lead to an increase in spending, not a reduction in future generations' burdens.

1.6.2.1.4 Robustness Checks

As robustness tests, Appendix Table 1.C.1 reports the result of sensitivity analyses. First, I run the fuzzy RKD with several length of bandwidths. Specifically, I use 10 bandwidths longer and 10 bandwidths shorter than two different MSE-optimal bandwidth selectors and two different coverage error rate-optimal bandwidth selectors. Panel A shows that all RK estimates for total spending, general administration spending, and ordinary spending are consistent with baseline estimates. Next, I implement the RK estimation without covariates other than year dummies. Panel B presents the result, and it implies that the RK estimates are also positive and statistically significant. Finally, I run the RK regression with several functional forms and kernels. Panel C reports the RK estimates using a linear function with triangular kernel (baseline), a linear function with uniform kernel, a quadratic function with triangular kernel, a quadratic function with uniform kernel. In all, the estimates are stable and statistically significant, indicating that these fuzzy RK estimates are robust.

In addition, I implement fuzzy RKD regressions with municipal spending from specific revenue sources as the placebo outcome. As considered in the institutional background, the unconditional grants are not included in the specific revenue sources, so no kink should be observed. Appendix Figure 1.A.11 demonstrates graphical evidence that no kink arises at the kink point. In addition, Column 3 and 4 of Appendix Table

1.B.3 reports the RK estimates for total spending and general administration from specific revenue sources. In contrast to these from general revenue sources (Columns 1 and 2), these RK estimates for expenditures from specific revenue sources are not statistically significant, indicating that these placebo estimates are consistent with my assumptions. Overall, my estimates show that the unconditional grants have a causal effect of increasing municipal spending, supporting the existence of "crowd-in" or flypaper effects.

1.6.2.1.5 Dynamic RKD Results for the Municipal Spending

As a first stage estimation, I run a regression of equation (1.7) with unconditional grants as an outcome. If my identification strategy is plausible, the effect on the unconditional grants in time t should have a statistically significant and close to one for TOT in period t (θ_1), while the other coefficients ($\theta_2, \cdots, \theta_{10}$) should be close to zero or non-significant. Column 1 of Table 1.5 shows the results of this first stage regression. The first row here presents that θ_1 is statistically significant and almost 1, indicating that this estimation is valid. Colum 2 of this table reports the cumulative effect of the grant decision from year 1 to year 10. After reaching a value close to one with the current grant decision, the cumulative effect remains constant in magnitude. Panel A of Figure 1.3 plots the dynamic RKD estimates of the unconditional grants ($\theta_1, \cdots, \theta_{10}$) and Panel B the cumulative results of these estimates with upper and lower 95% confidence intervals, respectively. These graphically show that the unconditional grants are responsive only in the period when the grant decisions are made by the central government.

Table 1.6 reports the results of the dynamic RK estimates for municipal spending per capita, estimated by equation (1.7). These are the results of baseline estimation using a

linear polynomial. Column 1 shows the municipal spending for general administration. The coefficient of the current grant receipt in this column's Row 1 is positive and statistically significant, and the magnitude is close to one. In addition, the estimates for 2-10 years later (Row 2 to 10) are basically statistically significant or almost zero. These implies that expenditures in the general administration increase largely and immediately when unconditional grants are provided, and there exists no noticeable effect on this spending after the second year. Column 2 reports the cumulative long-term effects for general administration expenditures, and the accumulated spending in the final year is almost the same level as in the first year. This illustrates that after an increase in the first year, the spending is not affected in the following years. With standard RK estimates alone, there still exists the possibility that municipalities may decrease municipal spending or "crowding-out" in subsequent years, in order to offset the "crowding-in" when they receive the grants. The dynamic RK results above test these possibilities, and we can know that there is no such intertemporal substitution that would offset the treatment effect. Panel A in Figure 1.4 plots the coefficients in Column 1 and 2, respectively. These illustrates that crowding-in occurs primarily in the current grant decision, although not quite as much as in the unconditional grants in the first stage.

In addition, Column 3 of Table 1.6 reports the dynamic RKD results for ordinary spending. Row 1 shows that the coefficient in time t (θ_1) is positive and statistically significant, but the magnitude is smaller than one (0.297). Row 2 to 10 also presents the statistically significant positive effects on the ordinary spending after the second year, although they are smaller than the coefficients in the first row. Column 4 shows the cumulative effects, indicating that the ordinary spending gradually increases over time, and reaches close to one in the 10th year. Panel B in Figure 1.4 presents the graph for

each coefficient, illustrating that the increase in the ordinary expenditures (crowding-in) is gradual and that there is no intertemporal crowding-out. The dynamic estimates of ordinary spending above show different behavior from those of the unconditional grants and general administration spending. One possible explanation for this difference is that it is due to the "stickiness" of ordinary spending. Ordinary spending consists of categories such as personnel, repairs to public facilities, and project outsourcing spending, and MIC, which is responsible for Japan's local administrative system, describes it as rigid expenses that are recurrently spent in each year (MIC (2023)).[26] It is likely that due to this "stickiness", municipalities do not react to the receipt of unconditional grants immediately, but rather increase their ordinary spending over a period of time.

As a robustness check, Appendix Table 1.C.2 report the dynamic RKD results with quadratic polynomials for the unconditional grants (the first stage). Also, Appendix Table 1.C.3 presents the dynamic RK estimates for general administration spending and ordinary spending. All coefficients have consistent results, with magnitude and significance levels similar to those in the baseline, showing the robustness of my estimations.

1.6.2.2 Impacts on the Municipal Employment

1.6.2.2.1 Graphical Evidence

Figure 1.5 provides graphical evidence of the effect on employment by municipal governments. It plots the number of employees in total departments (Panel A) and general administration department (Panel B). A kink in the number of employees seems to exist at the kink point. My analysis focuses largely on employment in the general

[26]The central government in Japan uses the magnitude of ordinary spending as an indicator to judge the flexibility of a municipality's fiscal structure, and utilizes this indicator for policy making in the local administration system.

administration department, because the central government has established placement criteria for employment in other departments. Additionally, Appendix Figure 1.A.12 plots the average number of employees working in detailed department of general administration (Panel A to F), and the welfare or other departments (Panel G and H). Since there seems to exist a kink in some departments, I then run fuzzy RK estimations to check if there exists a "kink" or just a "curve".

In addition, Figure 1.6 plot the average wage expenses in the municipal government per residents. Panel A shows the wage spending for total departments and Panel B for general administration department. Appendix Figure 1.A.13 presents the breakdown of this (Panel A to F), in addition to the welfare, and other sectors (Panel G and H). These have a similar shape to the number of employees, and I also estimate the effect of the unconditional grant by using the RK regression.

1.6.2.2.2 RKD Results for the Number of Employees

Panel A of Table 1.7 presents the fuzzy RK estimates on the number of employees by department, estimated by equation (1.5) and (1.6). In the baseline, I use local linear functional form, a triangular kernel, and two different MSE-optimal bandwidths. Column 1 reports the effect in all departments, and Column 2 reports the effect in general administration department. The estimate on general administration, my main outcome, shows a statistically significant positive kink at the 1% level. However, while employment in all departments has a positive sign, it is not statistically significant. This is due to the fact that the estimates for the welfare department (Column 9) and other sectors (Column 10) are not statistically significant. The statistical significance in welfare and other departments are consistent with the fact that municipalities have

little discretion over employment in these departments. In addition, the finding that employment in all departments is not statistically significant is consistent with the result of previous literature which estimates the causal effect of intergovernmental transfers on local public employment (Lundqvist et al. (2014)).[27]

For the detailed departments of general administration, Column 3 to 8 of Panel A show that RK estimates for departments of general service (Column 4) and industry (Column 7) are statistically significant. In contrast, as well as the secretariat of council (Column 3), taxation (Column 5), and labor (Column 6) departments, where no clear kink was observed in expenditures, the effect on employment for civil engineering (Column 8) is not observed and point estimates for them are close to zero.

1.6.2.2.3 RKD Results for the Wage Expenses

Next, Panel B of Table 1.7 presents the RK results on the wage expenses for municipal employees per resident. Again, I use local linear functional form with a triangular kernel, and two different MSE-optimal bandwidths. Overall, all estimates provide consistent results with the number of employees. Column 2 implies that wages in the general government sector are statistically significant at the 1% level, with an estimated magnitude of 0.094, suggesting that about 10% of the unconditional grant is allocated to wage increases in this sector. As with employment, I obtain statistically significant and positive effects for general service (Column 4) and industry (Column 7) in general administration. The effects on welfare (Column 9) and other sectors (Column 10) are not observed, reflecting the fact that the central government has set strict placement

[27] Lundqvist et al. (2014) applies a RKD to the Swedish grant system and reports that the effect on local public employment is statistically significant only for administrative personnel. This paper notes that no clear effects were found for other sectors, such as traditional welfare, and that the result for total personnel is not statistically significant.

criteria for welfare, education, and firefighting.

1.6.2.2.4 RKD Results for Other Employment Outcomes

In addition to the effects on the number of municipal employees, I also estimate the effects of unconditional grants on other employment outcomes. First, I estimate the effect of wages on persons working in local government except for the municipal employees. Appendix Figure 1.A.14 plots the average wage expenses of mayors, council members, commission members, and temporary-staff per residents, indicating that wages for temporary-staff seems to have a convincing kink at the kink point. Appendix Table 1.B.4 presents the RK results on the wage expenses for non-employees in the municipal governments. The effect on wage expenditures for commission members (Column 3) and temporary-staff (Column 4) are significantly positive, while those for mayors (Column 1) and local council members (Column 2) are unaffected. This may be because mayors and local council members are directly elected by residents so they are conservative in increasing their own wages. In contrast, since commission members typically have shorter tenures than employees, municipalities may be able to decide flexibly to increase the numbers and wage levels for commission members and temporary-staff.

Second, in order to confirm what kind of employees are affected, I estimate the impact on the number of employees by employee's age. Appendix Table 1.B.5 reports the fuzzy RK estimates on them in total department. Column 2 of this table presents a significant positive effect at 5% level for employment in ages 24-31, whereas Panel A of Table 1.7 shows no significant results for employment in all departments. In the Japan's labor market, it is common for graduates of high schools or universities to start working right after their graduation (Genda et al. (2010); OECD (2021a)). This

result suggests that municipalities that receive the unconditional grant will increase the new hiring of college or higher graduates. In addition, this result also implies that the increase in wage expenses is due to the increase in the number of employees, not wage levels because the governments in Japan have adopted a seniority system for salaries and promotions (Passet (2003); OECD (2021a)). Since younger employees are assigned to lower-position, such as assistants, this may reflect the increase in the number of subordinates due to more hierarchical organizations.[28]

1.6.2.2.5 Robustness Checks

As a robustness test, I conduct the sensitivity analysis by using several bandwidths for municipal employment. Panel A in Appendix Table 1.C.4 shows the results of sensitivity analysis by bandwidth, showing that the RKD results are consistent with the main estimates. Panel B reports the RK estimates with no covariates, and Panel C resents local quadratic RK estimates or those with uniform kernels. These are also statistically significant and positive in the general administrative department, so I obtain the same results as in the main estimation. In addition, I implement these robustness checks on municipal wage expenditures as well. Appendix Table 1.C.5 shows the results for several bandwidths (Panel A), no covariates (Panel B), and other functional forms (Panel C). These are all consistent with the main estimates, indicating that my estimates are also robust for wage expenditures.

1.6.2.2.6 Dynamic RKD Results for the Municipal Employment

Table 1.8 reports the results of the dynamic RKD results for municipal employment,

[28]This result is consistent with the findings of a previous study that the Swedish grant system increased the employment of administrative personnel; this increase is attributed to administrative assistants rather than high administrative officials (Lundqvist et al. (2014)).

estimated by equation (1.7) with a linear polynomial. Column 1 of the table presents the number of employees in general administration department. The coefficient of the current grant receipt is positive and largest, and the effects also persist after the following years. Column 2 shows the result of cumulative employment of the general administration department, illustrating that the cumulative effect on the number of employees gradually increases, like ordinary spending. The magnitude of the cumulative effect in year 10 is about 0.01, which is about the same as the magnitude of the main estimate (0.01) in Panel A of Table 1.7. In addition, Column 3 reports the municipal wage expenses in general administration department. Similar to the number of employees, a persistent positive effect after two years is also observed. In Column 4, the cumulative effects continue to increase over time. As with ordinary expenses, this may be due to the rigidities in hiring and setting salaries of employees. The magnitude of the cumulative effect in 10th year is about 0.10, almost identical to the main estimate (0.09) in Panel B of Table 1.7. Figure 1.7 plots the estimates of the dynamic RK estimates in Column 1 to 4 by year relative to the grant decisions of the central government, with upper and lower 95% confidence intervals. There is no evidence of an intertemporal substitution effect that reduces employment or wages when the grant is not received. As a robustness check, Appendix Table 1.C.6 presents the estimates for the number of employees and wage spending in general administration. All coefficients have consistent results, with respect to these magnitude and significance levels, implying the robustness of my results.

As reported above, the dynamic effects on the number of employees and wage expenses in the general administration department differ from those of the unconditional grants and general administration spending reported in Figure 1.3 and Panel A of Figure 1.4. The ordinary spending behavior in Panel B of Figure 1.4 is similar to those of

the employment numbers and wage expenditures. Considering that ordinary spending includes personnel cost, these results are consistent. In particular, the Japan's labor market is characterized by long-term employment practices based on long job tenure and high job-retention rates (Passet (2003); Genda et al. (2010); OECD (2021a)). The existence of this practice requires municipalities to be careful in making a hiring decision, and a time lag needs to exist before a hiring decision. In addition, comparing the panels in Figure 1.7, the positive effect on wages is more persistent while the number of employees rises at a smaller rate over the years. Another feature of the Japanese labor market is the wage-seniority system, where salaries increase not with productivity but with years of service (Passet (2003); OECD (2021a)). This may be due to the fact that Japan has adopted this seniority wage system for local government employees. One interpretation for the more persistent impact of the wage spending increase than the number of employees is that this wage system is also applied to local government employees.

1.6.3 Impacts on the Municipal Revenue and Taxation

1.6.3.1 Impacts on the Municipal Revenue

In the above estimates for municipal spending and employment, I obtain results that support the existence of a "crowding-in" or flypaper effect. As additional analyses, I estimate the causal effect of unconditional grants on municipal revenues per residents, in order to confirm if a "crowding-out" effect exists. Hence, I plot the average municipal revenues except for the unconditional grants by category. Appendix Figure 1.A.15 shows the revenues from local tax (Panel A), local transfer tax (Panel B), block grants or

conditional grants (Panel C), local debt (Panel D), and others (Panel E). In contrast to the unconditional grants, it is not clear that kinks exist at the kink point ($Fiscal\ Gap_{it} = 0$) for all outcomes.

Appendix Table 1.B.6 reports the fuzzy RKD results on municipal revenues by category, estimated by equation (1.5) and (1.6). I use local linear functional form, a triangular kernel, and two different MSE-optimal bandwidths. First, Column 2 to 5 reports that RK estimates have not statistically significant for revenues from local transfer tax (Column 2), block grants (Column 3), local debt (Column 4), and others (Column 5). A local transfer tax is taxes collected and distributed to municipalities by the central government instead of the municipalities.[29] Hence, these outcomes should not be affected by the unconditional grants. All RK estimates reported in these columns are statistically insignificant, indicating that the results are consistent with my assumption.

In addition, I estimate local tax revenues as an outcome to confirm the existence of the "crowd-out" effect. Column 1 indicates that the RK estimate on local tax is negative and statistically significant at 10% level. This implies that there may exist a "crowding-out" effect, but since its magnitude (0.168) is smaller than that of the spending (0.747, for general administration department) and its statistical significance is not clear, meaning that the "crowding-in" effect is more evident. Moreover, I also estimate the impact of the grants on local tax revenue by type. Appendix Table 1.B.7 reports the results, and no taxes are statistically significant except for the city planning tax. As shown in Column 3 of this table, the effect of the grants on city plan tax is negative and significant at 10% level, so the observed effects of local taxes can be interpreted as derived from city plan

[29] Local transfer taxes include local road transfer tax, petroleum gas transfer tax, motor vehicle tonnage transfer tax, and aviation fuel transfer tax.

taxes.

1.6.3.2 Impacts on the Municipal Taxation

In order to understand the mechanism of the impact on tax revenues, it is informative to estimate the related variables as outcomes in addition to the local governments' revenues. As noted in the institutional background, the revenue of local tax is determined by (1) the tax bases, (2) the tax rates, and (3) the tax collection rates. Since Panel C of Appendix Figure 1.A.1 shows that the extra-legal taxes account for only 0.002% of total tax revenue, the setting of own tax bases by municipalities is quite limited. Therefore, I focus on the tax rates setting in this section.[30] Appendix Figure 1.A.16 plots the average tax rates of corporate income tax and city planning tax set by municipalities, respectively. As indicated in the institutional background, about 44.2% of municipalities have corporate income taxes that are not at the national reference rate, and the city planning tax is the only major tax for which no reference rate is given. It is not clear for corporate income tax, but there seems to exist a kink at the cutoff for city planning tax.

Appendix Table 1.B.8 presents the results of fuzzy RK regressions, estimated by equation (1.5) and (1.6). I use local linear functional form with a triangular kernel and two different MSE-optimal bandwidths as well. Column 1 reports the RK estimate on corporate income tax rate, indicating that the estimate is not statistically significant. In contrast, as Column 2 shows, the RK regression results for city plan tax rate is negative and statistically significant at 1% level. Although the magnitude of the estimate (-0.017%) seems to be small, it is not small, taking into account that the average rate is 0.6%.[31] Since municipalities cannot set lower corporate income tax rate due to the

[30] I deal with the tax collection shortfall in Appendix E.

[31] In addition, the tax base for the city plan tax is the price of land and housing. Since real estate prices

central government's regulations, the estimate of city planning tax provides evidence of the "crowd-out" effect. Appendix E also shows that the effects of the unconditional grants on tax collection shortfalls are positive and statistically significant at 1% level, Hence, we can interpret that a "crowding-out" effect occurs through the channels of both a lower tax rate and an increase in the collection shortfall even though the "crowding-in" effect on spending increases is more significant, comprehensively.

1.7 Conclusion

Intergovernmental fiscal transfers have been adopted in many countries and play an important role in equalizing public finances between local and central governments and among local governments. The impact of intergovernmental grants on local public spending is still a controversial issue, with arguments for both "crowd-out" through local tax revenues or "crowd-in" through the flypaper effect.

The first contribution of this paper is the rigorous analysis of both municipal spending and revenues by using the Japanese unconditional grant, under which the country's central government distributes funds to local governments based on a mechanical formula. The results show that the receipt of unconditional grants has a clear kink to increase government spending. This is clear evidence that unconditional grants also crowd in local public spending, as prior studies of the flypaper effect have reported in conditional grants. By exploiting the rich municipal variables in my dataset, I find that the increase is primarily in spending by the general administrative department and in ordinary spending. At the same time, I find evidence that the receipt of the unconditional grants also

are expensive, even if the tax rate appears small, the amount of tax paid is not small.

has a "crowding-out" effect, which arises through both lower tax rates and increased tax collection shortfalls. For these municipal responses, I obtain statistically significant estimates in tax rates through the tax whose rates can be freely set (city plan tax) and in tax collection shortfalls through taxes where municipalities directly collect the tax base (city plan tax and property tax). The paper provides a comprehensive evaluation of the impact on spending and revenues in local governments, showing that the crowding-in effect plays a more significant role.

Second, I examine the effect of unconditional grants on municipal employment. There are only a few estimates of unconditional grants using natural experiments, especially for employment, so this paper adds new evidence. It shows a clear kink in an increase of the number of employees in the general administration department at the cutoff for eligibility of the unconditional grants. In addition, the positive kink cannot be observed for employment in other departments, so total employment is unaffected, and the positive kink is considered to be due to adding low-paid young employers like assistants. I also found clear kink in the wages of commission members and temporary staff, who have shorter terms of service. These results are consistent with the previous literature. Since the total employment and wage expenses are not statistically significant, the crowd-in effect of municipal spending is driven by other types of spending, such as subsidies, rather than personnel costs.

Third, I use a dynamic RKD to estimate the identify the direct effect of the current unconditional grants separate from indirect effects via subsequent grant decisions. The results shows that the unconditional grants have a statistically significant positive effect on municipal spending and employment in the period in which the central government decides the grants. In addition, the general administration spending only increases in the

first year, while ordinary spending and employment also increase after the second year, reflecting relative fixed natures of the ordinary spending and employment. Notably, the signs of the statistically significant coefficients are positive, meaning that there are no observed decreases in spending (crowding-out) in subsequent periods that would offset the increase (crowding-in) when the grants are received. I show empirically that the dynamic effects of the unconditional grants on local public finances.

Fourth, the results of this study have implications for policymakers. Some Japanese policymakers are concerned that unconditional grants have the effect of discouraging spending cut or tax collection efforts in municipalities. The estimates provide empirical support for this concern, although it is not clear whether moral hazard is behind them. The paper thus offers a basis for effective administrative reforms.

As with any research, the present study has certain limitations. First, these RK estimates are limited to the area around the cutoff, and caution should be exercised in generalizing them. Second, intergovernmental grants in each country have different schemes, so care should be taken when applying the results here to other countries. These are issues for further research.

1.8 Figures and Tables of Chapter 1

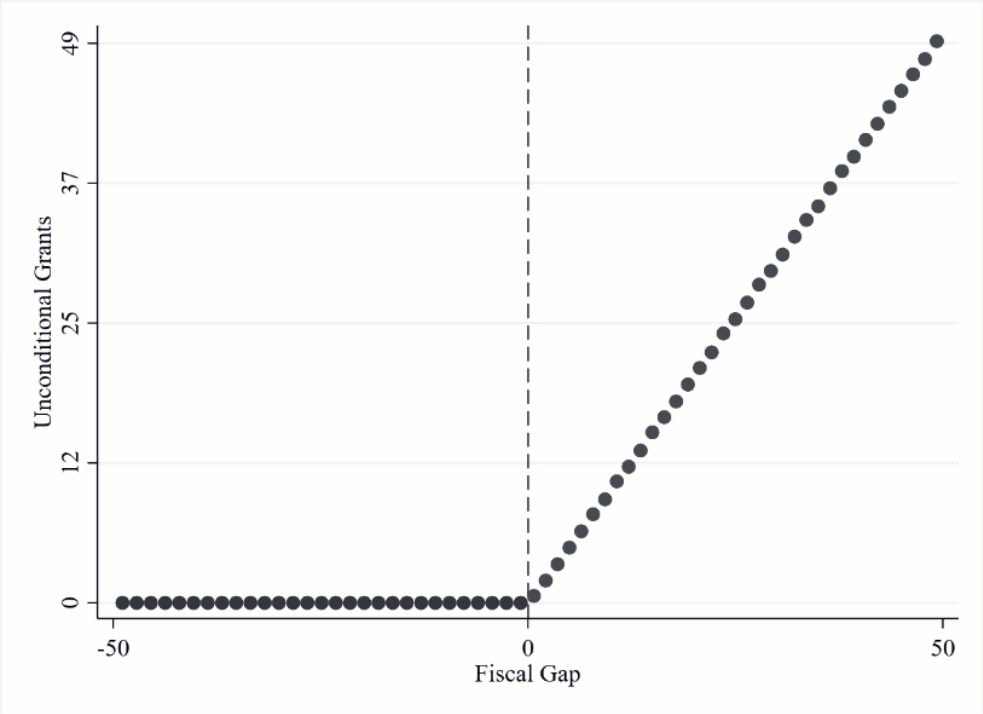
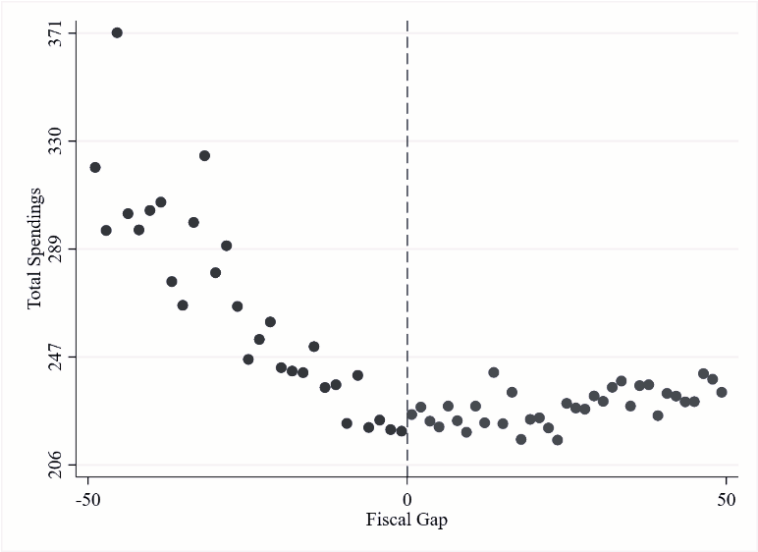


Figure 1.1: RK Estimates on the Unconditional Grants (1st Stage Results)

Notes: This figure plots the unconditional grants revenue per capita. The solid lines on the panels are linear fitted values. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receives the grants.

(a) Total Spending



(b) General Administration Spending

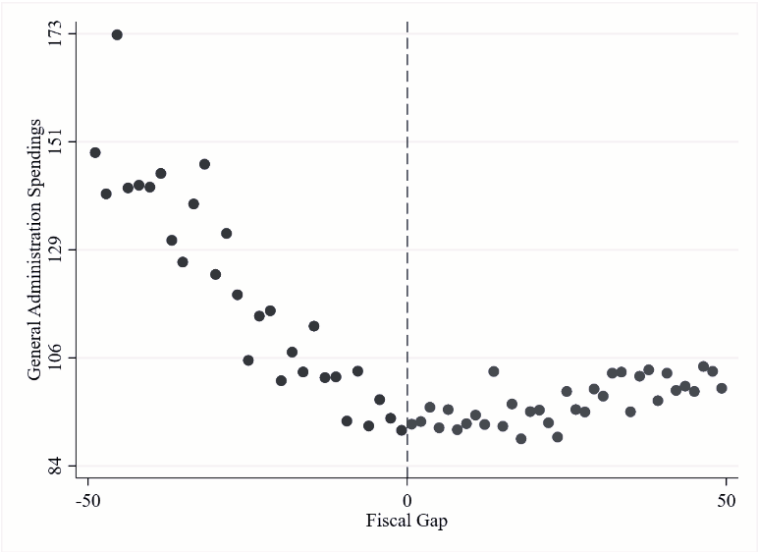
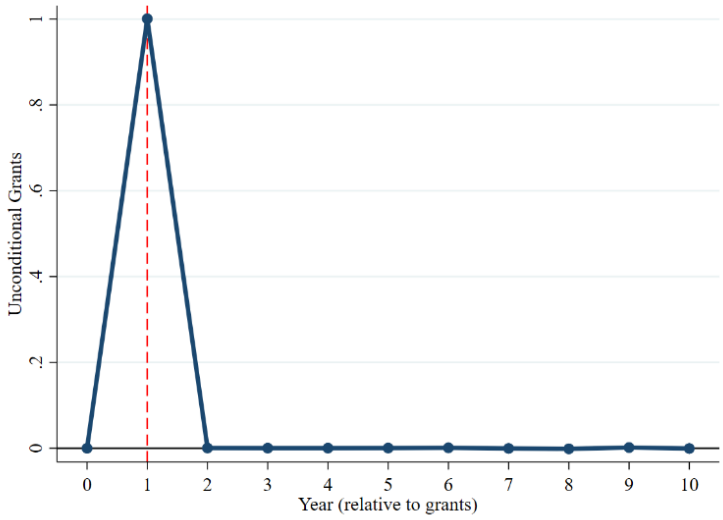


Figure 1.2: RK Estimates on Municipal Spending (1,000 JPY per capita)

Notes: These figures plot the average municipal spending per residents from general revenue sources (1,000 JPY per capita). Panel (a) plots the total spending, and Panel (b) plots the general administration spending. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

(a) Effects by Years



(b) Cumulative Effects

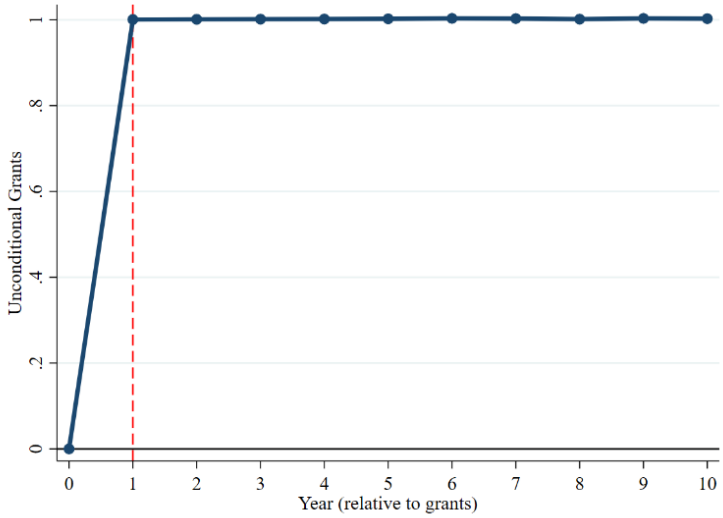


Figure 1.3: Dynamic RK Estimates on the Unconditional Grants (1st Stage Results)

Notes: The figures plot a visual representation of estimates of the θ_τ, while the dashed line shows the corresponding upper- and lower-95 percent confidence intervals for up to 10 years after the unconditional grant decisions. The red dashed vertical line represents the timing ($\tau = 1$) in the current grant decision.

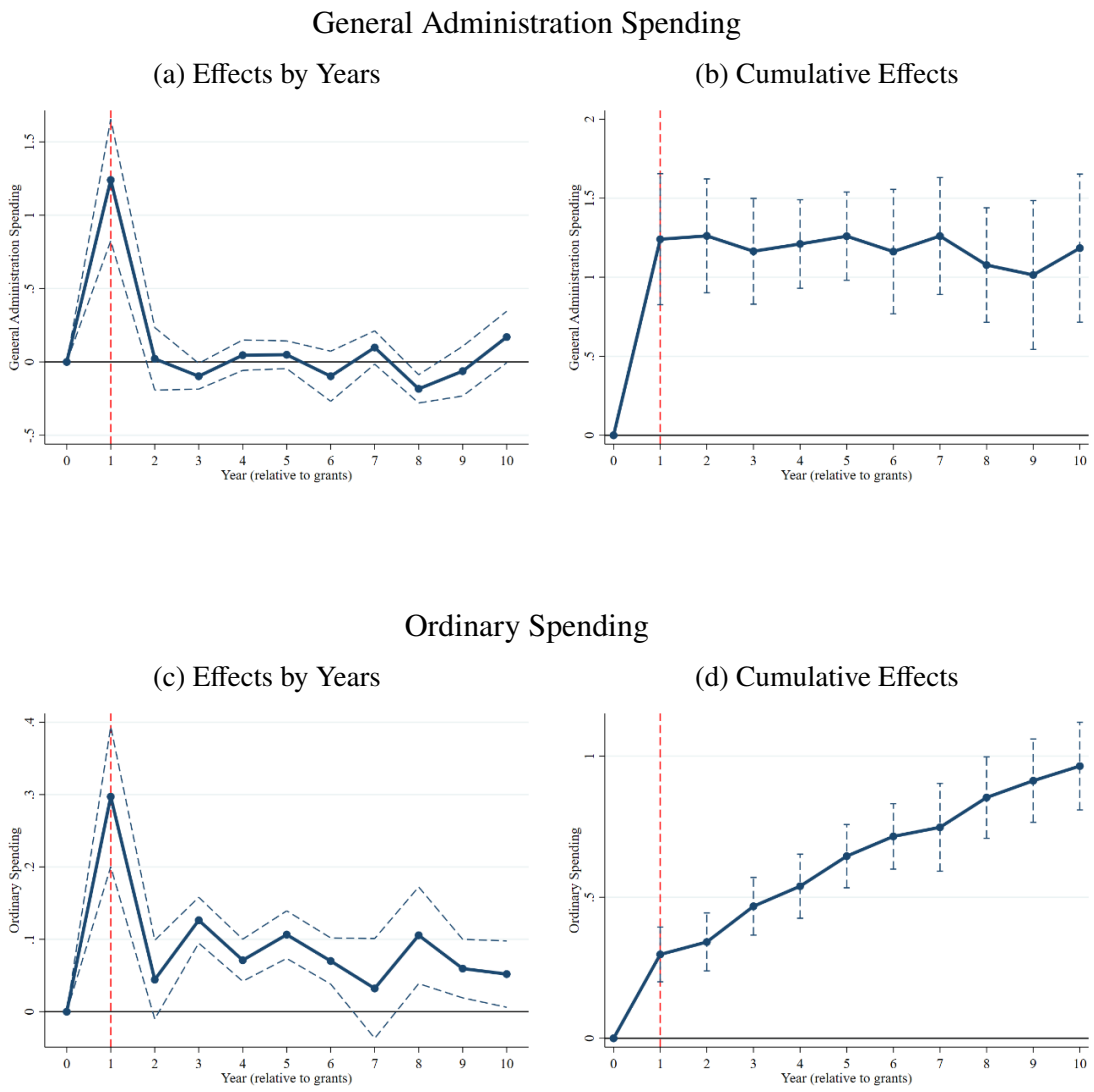
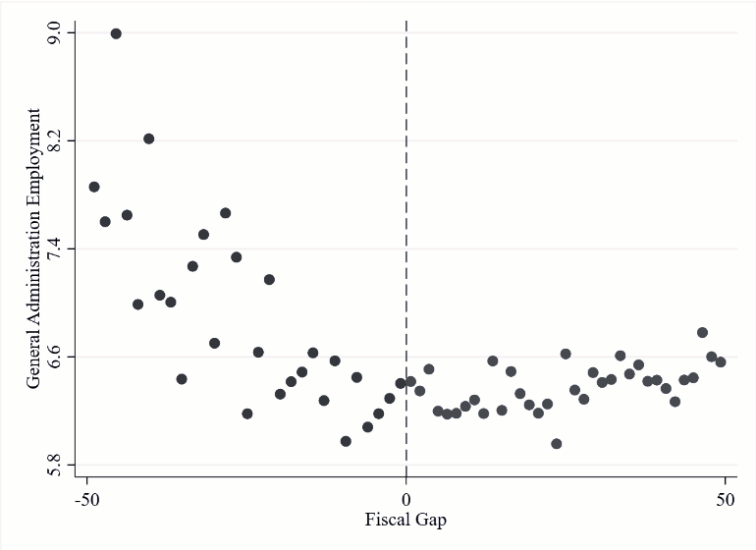


Figure 1.4: Dynamic RK Estimates on Municipal Spending (1,000 JPY per capita)

Notes: These figures plot a visual representation of estimates of the θ_τ, terms, while the dashed line shows the corresponding upper- and lower-95 percent confidence intervals for up to 10 years after the unconditional grant decisions. The red dashed vertical line represents the timing ($\tau = 1$) in the current grant decision.

(a) Total Employment



(b) General Administration Employment

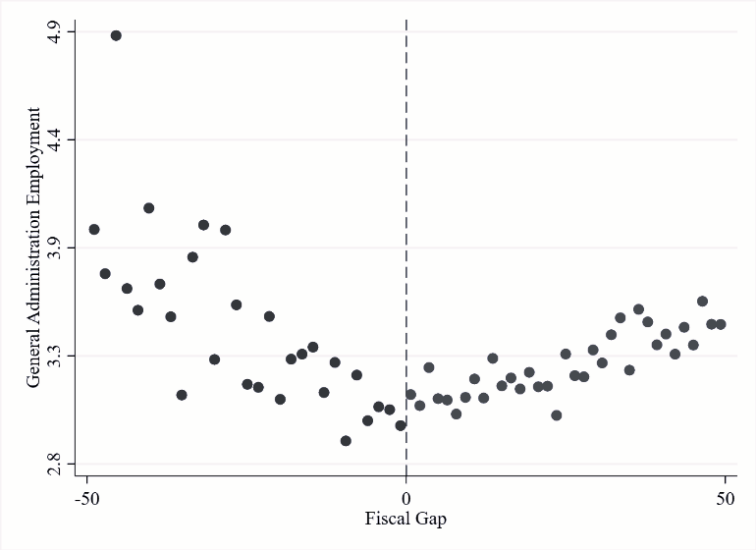
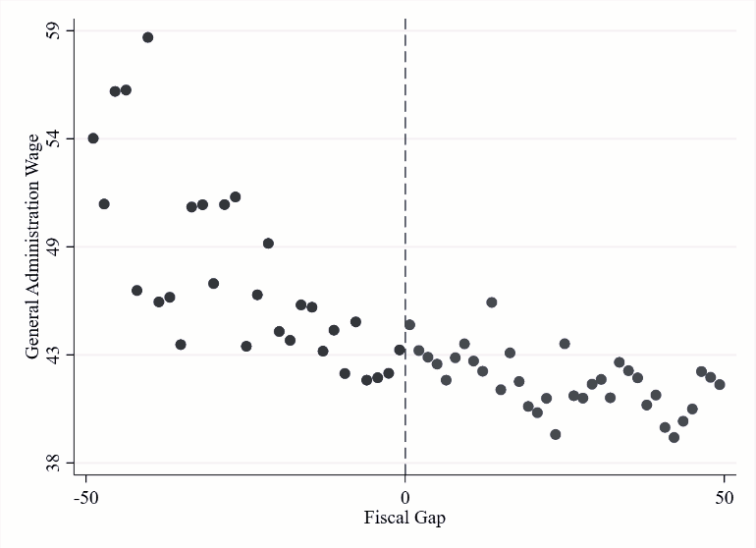


Figure 1.5: RK Estimates on Municipal Employment (persons per 1,000 capita)

Notes: These figures plot the average number of employees in the municipal government per residents (persons per capita). Panel (a) plots the total employment, and Panel (b) plots the general administration employment. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

(a) Total Wage Expenses



(b) General Administration Wage Expenses

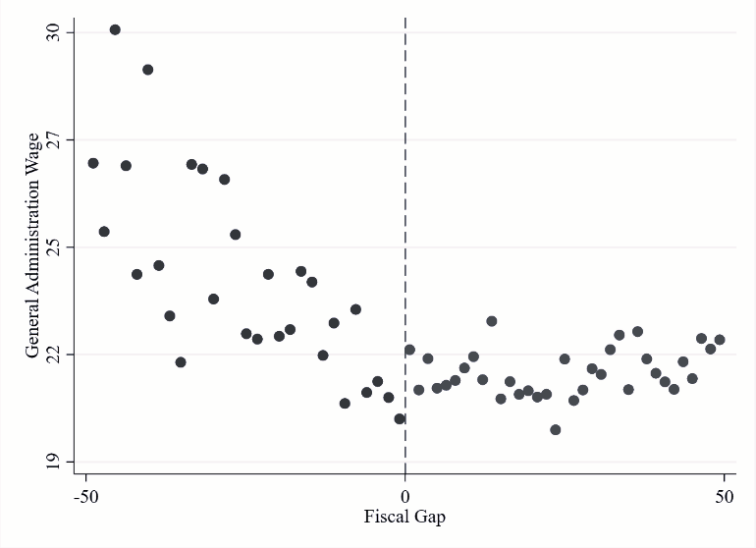


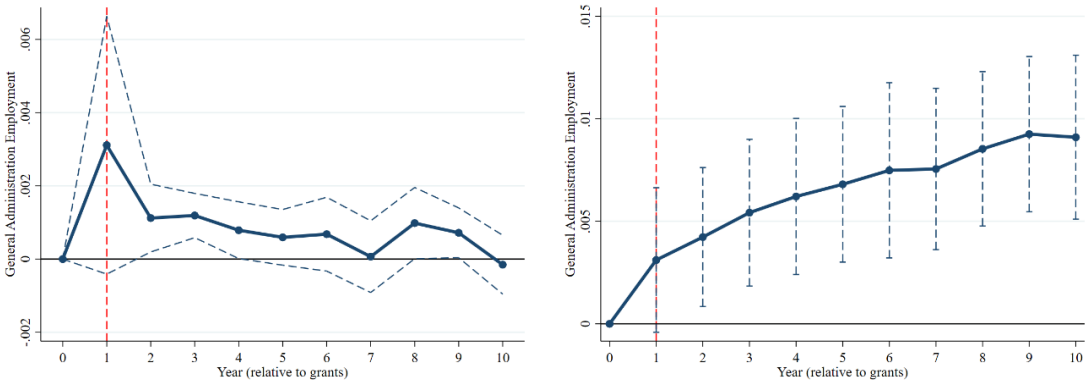
Figure 1.6: RK Estimates on Municipal Wage Expenses (1,000 JPY per capita)

Notes: These figures plot the average wage expenses in the municipal government per residents (persons per capita). Panel (a) plots the total employment, and Panel (b) plots the general administration employment. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

(1) General Administration Employment (persons per 1,000 capita)

(a) Effects by Years

(b) Cumulative Effects



(2) General Administration Wage Expenses (1,000 JPY per capita)

(c) Effects by Years

(d) Cumulative Effects

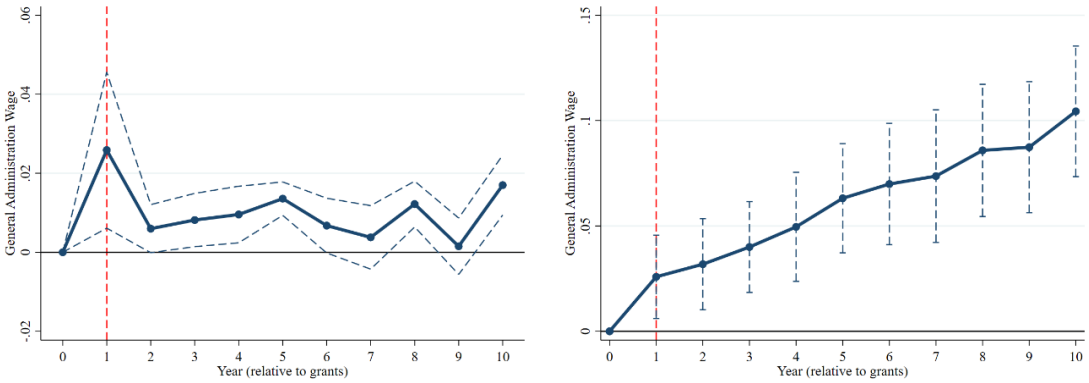


Figure 1.7: Dynamic RK Estimates on Municipal Employment

Notes: These figures plot a visual representation of estimates of the θ_τ terms, while the dashed line shows the corresponding upper- and lower-95 percent confidence intervals for up to 10 years after the unconditional grant decisions. The red dashed vertical line represents the timing ($\tau = 1$) in the current grant decision.

Table 1.1: Financial Structures in G7 countries (in FY 1996)

	Japan	Canada	France	Germany	Italy	United Kingdom	United States
Panel A: Tax Revenue							
Central government	61%	48%	82%	50%	92%	95%	57%
Local government	39%	52%	18%	50%	8%	5%	43%
Panel B: Expenditure							
Central government	41%	38%	66%	41%	70%	74%	49%
Local government	59%	62%	34%	59%	30%	26%	51%

Notes: OECD. Stat, Yamashita et al. (2002).

Table 1.2: Summary Statistics

Variables	Mean	St. Dev	Minimum	Maximum	Observations
Panel A: Main Outcomes					
Municipal Spending, from General Revenue Sources (1,000 JPY per capita)					
Total Spending	412.2	270.5	151.4	4,310.4	31,980
General Administration	186.8	144.3	47.3	2,457.0	31,980
Welfare	81.5	42.0	21.1	781.2	31,980
Others	70.9	40.0	23.6	1,277.7	31,980
Number of Employees (persons per 1,000 capita)					
Total Departments	11.5	7.3	3.1	145.0	31,980
General Administration	6.9	5.0	1.6	105.5	31,980
Welfare	3.7	2.4	0.3	46.9	31,980
Others	1.0	0.9	0.0	13.8	31,980
Panel B: Other Outcomes					
Municipal Spending, from Specific Revenue Sources (1,000 JPY per capita)					
Total Spending	242.0	272.2	21.5	9,067.2	31,980
General Administration	144.5	209.7	3.9	8,318.6	31,980
Municipal Spending by Type, from General Revenue Sources (1,000 JPY per capita)					
Ordinary	222.5	124.2	70.9	1,683.2	31,980
Non-Ordinary	118.9	104.3	19.2	2,387.2	31,980
Wage Expenses for Employees (1,000 JPY per capita)					
Total Departments	66.9	37.9	17.2	660.7	31,980
General Administration	39.2	26.0	9.1	548.2	31,980
Welfare	20.3	12.3	1.8	160.4	31,980
Others	7.4	6.2	0.0	94.2	31,980
Wage Expenses for Non-Employees (1,000 JPY per capita)					
Mayor Wages	6.2	8.9	0.0	203.5	31,980
Council Member	7.5	6.3	0.8	111.7	31,980
Commission Member	4.1	3.3	0.0	67.8	31,980
Temporary-Staff	5.8	7.0	0.0	136.5	31,980
Municipal Revenues (1,000 JPY per capita)					
Unconditional Grants	226.7	217.6	0.0	2,899.0	31,980
Local Tax	107.4	68.1	26.0	1,552.8	31,980
Local Transfer Tax	12.6	5.8	4.5	99.8	31,980
Conditional Grants	51.6	111.5	2.7	5,959.5	31,980
Local Debts	83.2	95.1	0.0	3,305.6	31,980
Others	302.3	207.6	68.8	4,435.0	31,980

Variables	Mean	St. Dev	Minimum	Maximum	Observations
Local Tax Rates (%)					
Corporate Income Tax Rate	4.7	0.6	3.7	5.5	31,980
City Plan Tax Rate	0.6	1.1	0.0	3.0	31,980
Tax collection shortfall (1,000 JPY per capita)					
Total Taxes	1.91	3.48	0.00	255.22	31,980
Individual Income Tax	0.54	0.57	0.00	22.72	31,980
Property Tax Tax	1.11	3.07	0.00	254.26	31,980
City Plan Tax	0.05	0.15	0.00	3.88	31,980
Panel C: Running variable (1,000 JPY per capita)					
Fiscal Gap	225.1	220.5	-737.7	2,906.4	31,980
Panel D: Covariates					
Population Density	583.6	1257.4	1.6	14,131.4	31,980
Share of Female	0.52	0.02	0.34	0.58	31,980
Revenue capacity	130.4	67.1	35.4	1,560.7	31,980

Notes: Spending, wages, fiscal gap, and revenue capacity are per capita values, and employment is per 1,000 capita value (divided by residents or number of employees). Spending, wages, fiscal gap, and revenue capacity are deflated by Consumer Price Index (CPI, the base year is 2020). Population density is persons per km^2.

Table 1.3: RK Estimates on the Unconditional Grants (1st Stage Results)

Variables	Unconditional Grants
RK Estimate	1.000***
	(0.000)
Observations	31,980

Notes: The table reports the impact of receiving the unconditional grants on unconditional grants. The regression uses the local linear RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.4: RK Estimates on Municipal Spending by Department (1,000 JPY per capita)

		General Administration Spending								
Varuables	Total Spending	General Admin Total	Secretariat of Council	General Service	Tax	Labor	Industry	Civil Engineer	Welfare	Others
RK Estimate	1.171***	0.747***	0.012	0.258***	0.023*	0.006	0.149**	0.295***	0.199**	0.324***
	(0.174)	(0.143)	(0.008)	(0.089)	(0.013)	(0.005)	(0.064)	(0.097)	(0.081)	(0.096)
Mean	412.2	186.8	11.1	78.5	6.7	0.6	43.8	46.1	81.5	70.9
Observations	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on municipal spending per residents from general revenue sources. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.5: Dynamic RK Estimates on the Unconditional Grants (1st Stage Results)

	Unconditional Grants	
Variables	Effect	Cumulative Effect
Effect of the decision to grant after		
1 year (granted year)	1.0007***	1.0007***
	(0.0013)	(0.0013)
2 year	0.0005	1.0012***
	(0.0004)	(0.0015)
3 year	0.0003	1.0015***
	(0.0004)	(0.0015)
4 year	0.0003	1.0018***
	(0.0004)	(0.0016)
5 year	0.0005	1.0023***
	(0.0005)	(0.0018)
6 year	0.0010	1.0033***
	(0.0009)	(0.0020)
7 year	-0.0004	1.0029***
	(0.0010)	(0.0019)
8 year	-0.0013	1.0016***
	(0.0013)	(0.0018)
9 year	0.0016	1.0032***
	(0.0011)	(0.0021)
10 year	-0.0005	1.0027***
	(0.0009)	(0.0021)
Observations	31,980	31,980
Order of Polynomial	Liner	Liner

Notes: The table reports the dynamic impact of receiving the unconditional grants on unconditional grants. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.6: Dynamic RK Estimates on Municipal Spending (1,000 JPY per capita)

	General Administration Spending		Ordinary Spending	
Variables	Effect	Cumulative Effect	Effect	Cumulative Effect
Effect of the decision to grant after				
1 year (granted year)	1.2403***	1.2403***	0.2971***	0.2971***
	(0.2115)	(0.2115)	(0.0494)	(0.0494)
2 year	0.0214	1.2617***	0.0443	0.3414***
	(0.1087)	(0.1837)	(0.0277)	(0.0524)
3 year	-0.0974**	1.1643***	0.1264***	0.4678***
	(0.0449)	(0.1707)	(0.0162)	(0.0521)
4 year	0.0462	1.2105***	0.0712***	0.5390***
	(0.0529)	(0.1429)	(0.0148)	(0.0579)
5 year	0.0491	1.2596***	0.1065***	0.6455***
	(0.0481)	(0.1424)	(0.0168)	(0.0571)
6 year	-0.0975	1.1622***	0.0701***	0.7155***
	(0.0871)	(0.2009)	(0.0163)	(0.0592)
7 year	0.0985*	1.2606***	0.0322	0.7477***
	(0.0579)	(0.1886)	(0.0351)	(0.0794)
8 year	-0.1835***	1.0771***	0.1056***	0.8533***
	(0.0491)	(0.1848)	(0.0340)	(0.0736)
9 year	-0.0626	1.0145***	0.0596***	0.9129***
	(0.0863)	(0.2402)	(0.0206)	(0.0753)
10 year	0.1697*	1.1842***	0.0520**	0.9649***
	(0.0896)	(0.2391)	(0.0234)	(0.0793)
Observations	31,980	31,980	31,980	31,980
Order of Polynomial	Liner	Liner	Liner	Liner

*Notes:*The table reports the dynamic impact of receiving the unconditional grants on municipal general administration spending (Column 1 and 2) and ordinary spending (Column 3 and 4) per residents from general revenue sources. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.7: RK Estimates on Municipal Employment by Department

		General Administration Department								
Varuables	Total Department	General Admin Total	Secretariat of Council	General Service	Tax	Labor	Industry	Civil Engineer	Welfare	Others
Panel A: Effect on the Number of Employees in Municipal Government (persons per 1,000 capita)										
RK Estimates	0.003	0.011***	0.000	0.006**	0.001	-0.000	0.005***	-0.000	0.004	-0.008
	(0.010)	(0.004)	(0.000)	(0.003)	(0.001)	(0.000)	(0.001)	(0.001)	(0.005)	(0.006)
Mean	11.55	6.86	0.25	2.95	0.76	0.02	1.72	1.16	3.66	1.03
Panel B: Effect on the Municipal Wage Expenses (1,000 JPY per capita)										
RK Estimates	0.041	0.094***	0.000	0.042**	0.008	-0.002	0.029***	-0.000	0.028	-0.061
	(0.086)	(0.036)	(0.002)	(0.016)	(0.006)	(0.001)	(0.007)	(0.015)	(0.034)	(0.044)
Mean	66.9	39.2	1.7	18.4	4.5	0.1	9.3	5.2	20.3	7.4
Observations	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the number of employees (Panel A), and wage expenses (Panel B) in the municipal governments by department. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.8: Dynamic RK Estimates on Municipal Employment

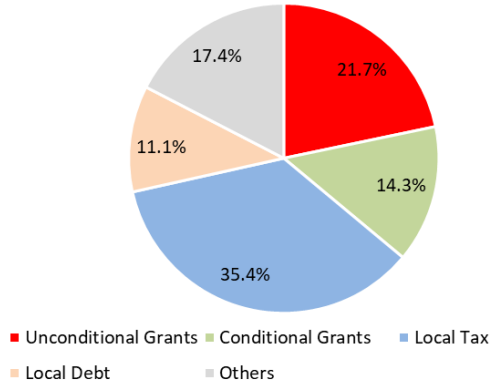
	General Administration Employees (persons per 1,000 capita)		General Administration Wage Expenses (1,000 JPY per capita)	
Variables	Effect	Cumulative Effect	Effect	Cumulative Effect
Effect of the decision to grant after				
1 year (granted year)	0.0031*	0.0031*	0.0259**	0.0259**
	(0.0018)	(0.0018)	(0.0101)	(0.0101)
2 year	0.0011**	0.0042**	0.0060*	0.0318***
	(0.0005)	(0.0017)	(0.0031)	(0.011)
3 year	0.0012***	0.0054***	0.0082**	0.0400***
	(0.0003)	(0.0018)	(0.0034)	(0.011)
4 year	0.0008**	0.0062***	0.0096***	0.0495***
	(0.0004)	(0.0019)	(0.0037)	(0.0132)
5 year	0.0006	0.0068***	0.0136***	0.0631***
	(0.0004)	(0.0019)	(0.0022)	(0.0132)
6 year	0.0007	0.0075***	0.0067*	0.0699***
	(0.0005)	(0.0022)	(0.0035)	(0.0147)
7 year	0.0001	0.0075***	0.0038	0.0736***
	(0.0005)	(0.0020)	(0.0041)	(0.0161)
8 year	0.0010**	0.0085***	0.0122***	0.0858***
	(0.0005)	(0.0019)	(0.0030)	(0.0160)
9 year	0.0007**	0.0092***	0.0015	0.0874***
	(0.0003)	(0.0019)	(0.0036)	(0.0159)
10 year	-0.0002	0.0091***	0.0170***	0.1044***
	(0.0004)	(0.0020)	(0.0039)	(0.0158)
Observations	31,980	31,980	31,980	31,980
Order of Polynomial	Liner	Liner	Liner	Liner

Notes: The table reports the dynamic impact of receiving the unconditional grants on municipal the number of employees (Column 1 and 2), and wage expenses (Column 3 and 4) in general administration. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

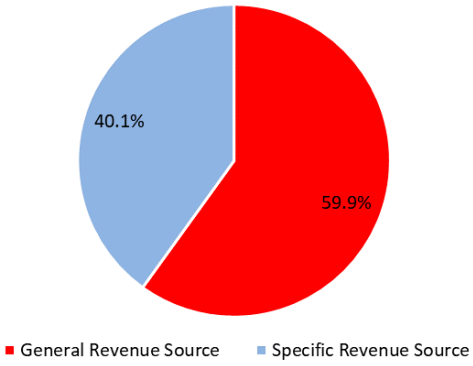
Appendix

Appendix 1.A Figures

(a) the Share of Revenue in Local Government



(b) the Share of Revenue Source in Municipalities



(c) the Share of Tax Revenue in Municipalities

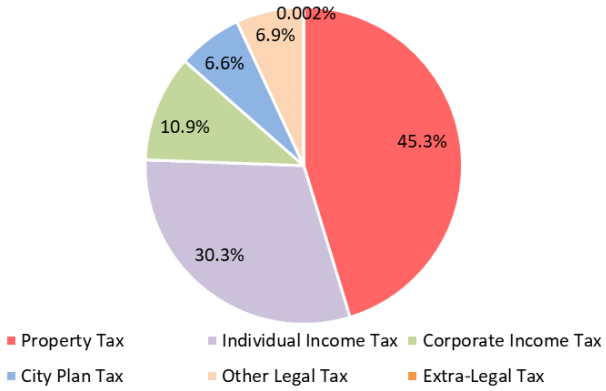


Figure 1.A.1: the Revenue of Local Government (in 2000)

Notes: MIC (2002).

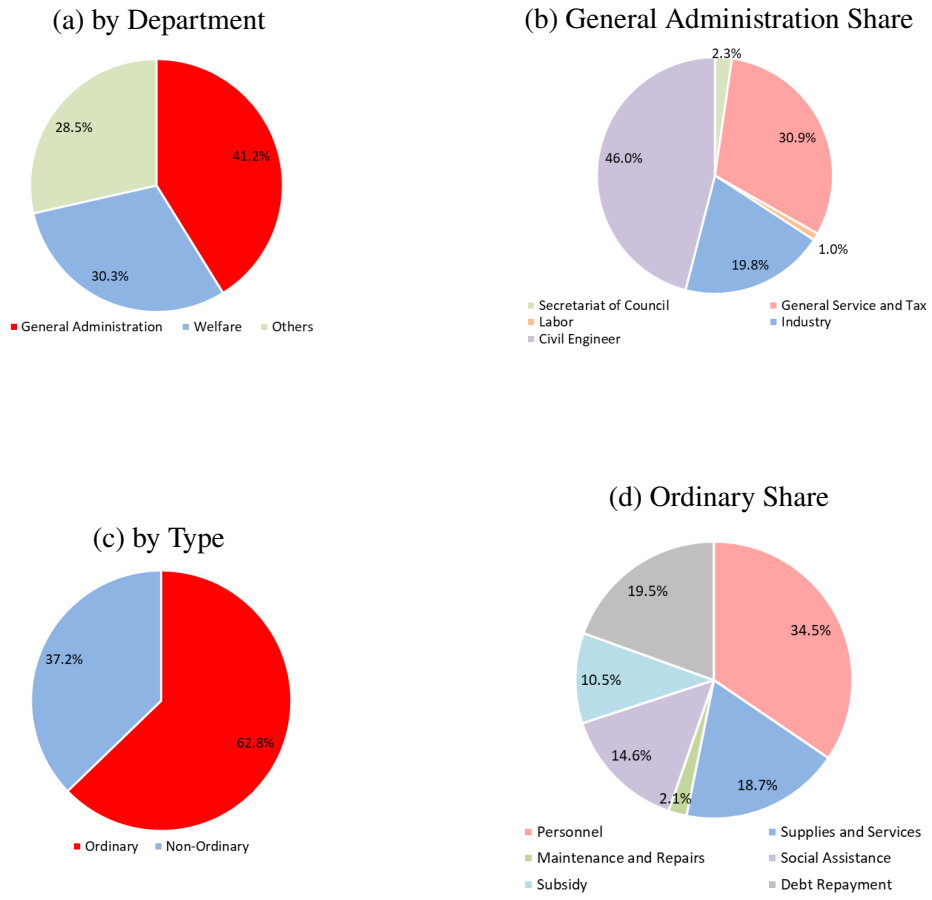
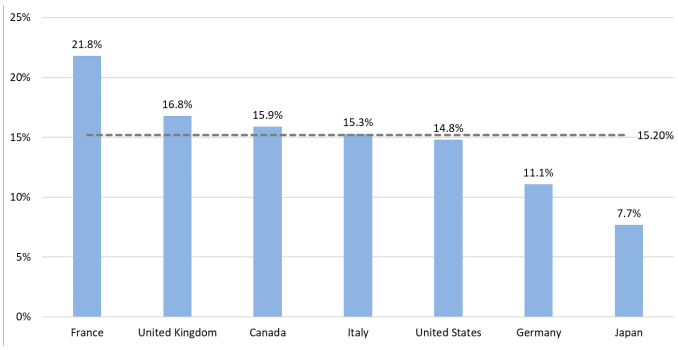


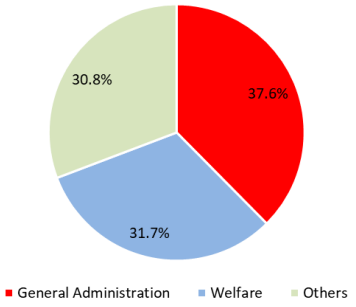
Figure 1.A.2: the Share of Municipal Spending (in 2000)

Notes: MIC (2002).

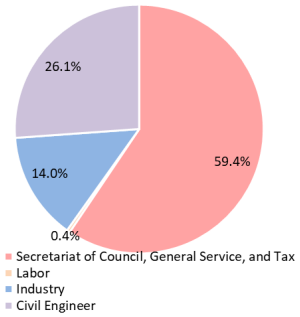
(a) Employment in General Government as a Percentage of Total Employment



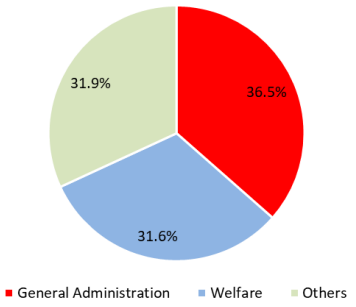
(b) The number of Employees by Department



(c) General Administration Share



(d) Wage Expenses by Department



(e) General Administration Share

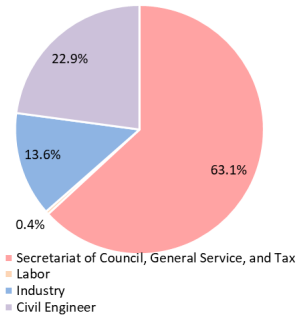
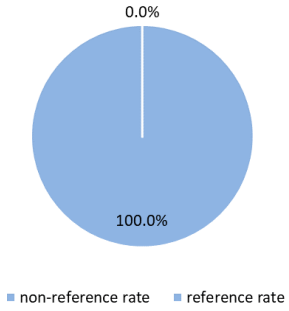


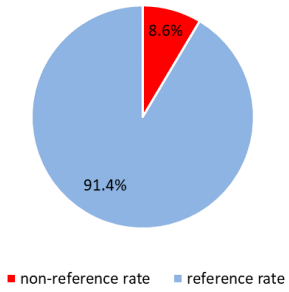
Figure 1.A.3: the Share of Municipal Employment (in 2000)

Notes: Panel (a) is from OECD Stats and the dashed line represents the averages of OECD member countries. Panel (b) to (e) are from MIC (2002).

(a) Individual Income Tax



(b) Property Tax



(c) Corporate Income Tax

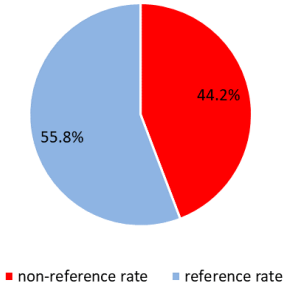


Figure 1.A.4: the percentage of municipalities with the reference tax rate (%, in 2000)

Notes: These figures show the percentage of municipalities (3,235 municipalities) with the reference tax rate set by the central government, or tax rate other than the reference tax rate in 2000. City plan tax is not set a standard tax rate by the central government.

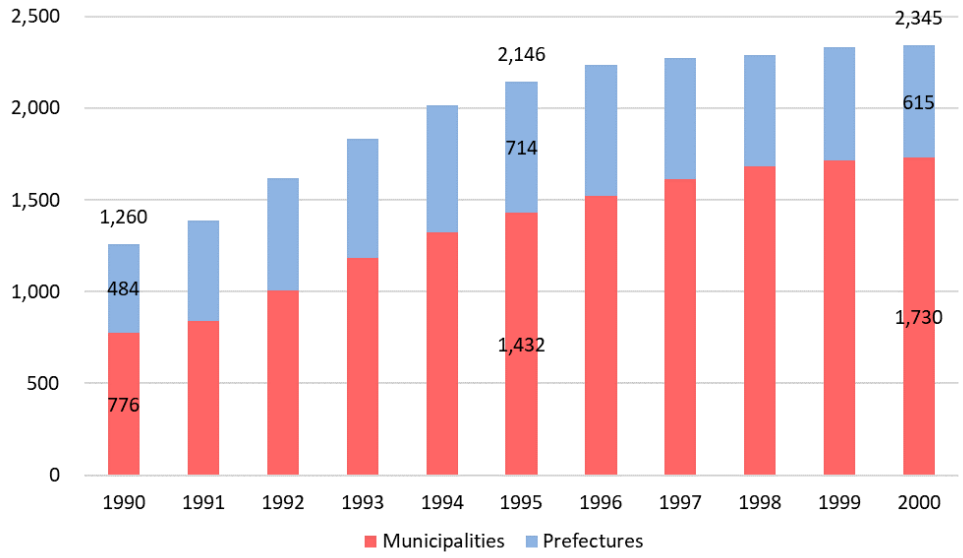


Figure 1.A.5: Local Tax Collection Shortfall (billion JPY)

Notes: MIC (2002). These are the amount of the tax assessment minus the amount of actual tax revenue.

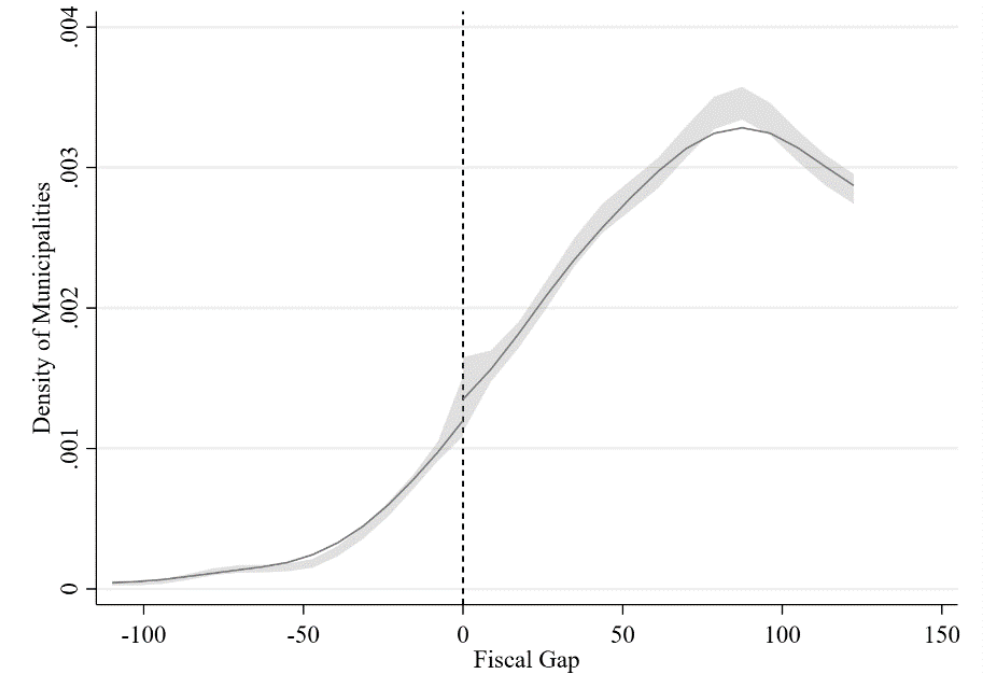
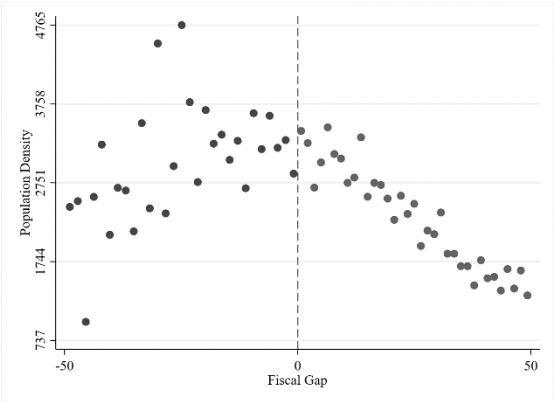


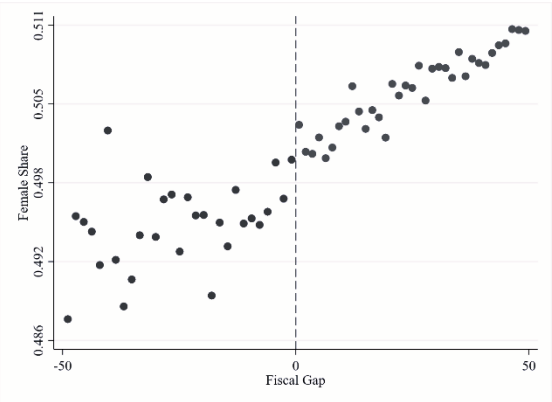
Figure 1.A.6: Density Estimate of Running Variable (Fiscal Gap)

Notes: The figure reports the density of the running variable (Fiscal Gap). The p-value is 0.637. The p-values for the density test for each year are 0.350 for 1991, 0.536 for 1992, 0.989 for 1993, 0.296 for 1994, 0.193 for 1995, 0.593 for 1996, 0.423 for 1997, 0.753 for 1998, 0.965 for 1999, 0.520 in 2000. In addition, no clear kink is seen at the cutoff.

(a) Population Density



(b) Share of females



(c) Revenue capacity

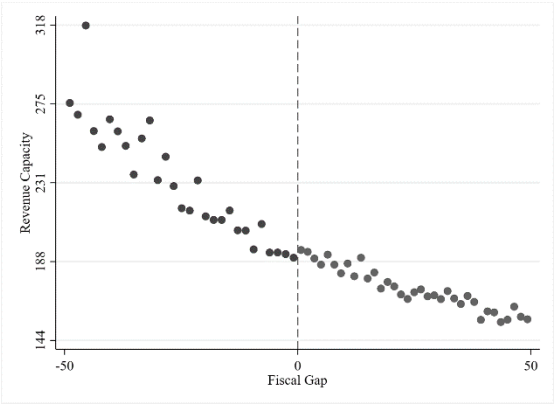
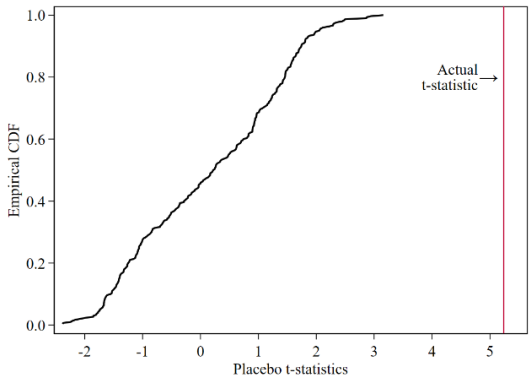


Figure 1.A.7: Smoothness Tests of Predetermined Characteristics

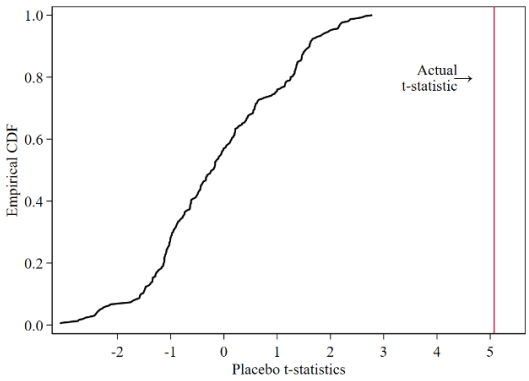
Notes: These figures plot the predetermined characteristics by the running variable (Fiscal Gap). Panel A reports the share of female, Panel B reports the number of residents, and Panel C reports the revenue capacity. The p-value of the smoothness at the cutoff is 0.120 (or 0.553), 0.978 (or 0.565), and 0.173 (or 0.649) respectively (see Appendix Figure B1 for details).

(1) the Municipal Spending

(a) General Administration

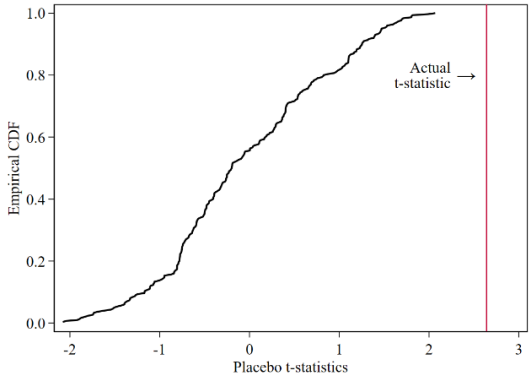


(b) the Ordinary Spending



(2) the Municipal Employment for General Administration

(c) the Number of Employees



(d) the Wage Expenses

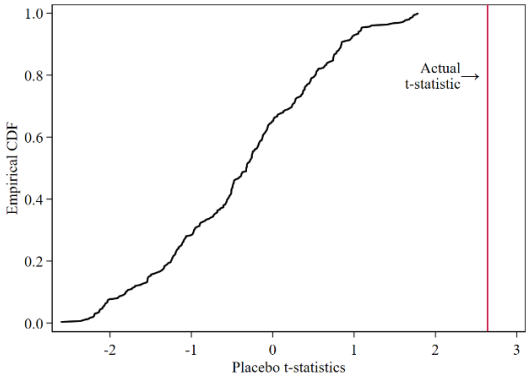
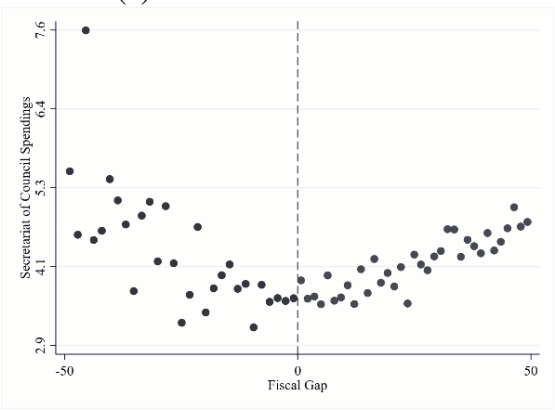


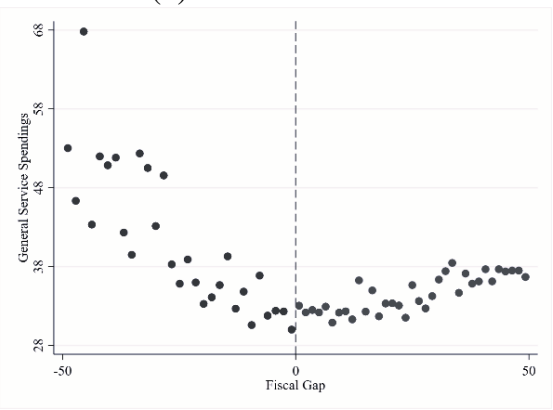
Figure 1.A.8: RK Estimates for Placebo Kink Locations

Notes: These figures plot the results of the Ganong and Jäger (2018) permutation test conducted by following the methodology of Gelber et al. (2023). At the cutoff, I use data that does not include the true threshold, and draw 300 placebo thresholds and estimate local linear RK regressions with robust standard errors. I plot the cumulative distributions of the placebo robust t-statistics, with the vertical line indicating the robust t-statistic for the main estimate.

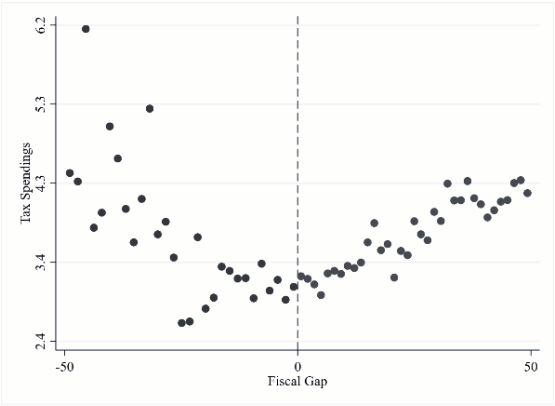
(a) Secretariat of Council



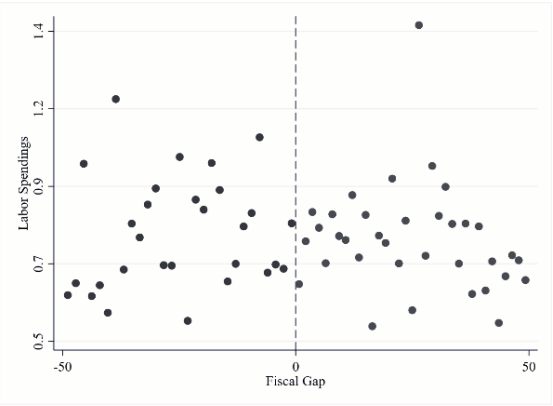
(b) General Service



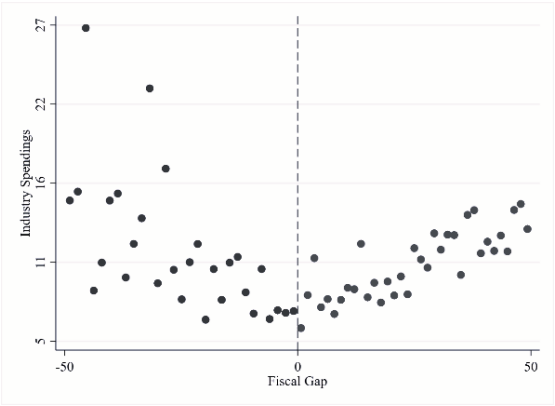
(c) Tax



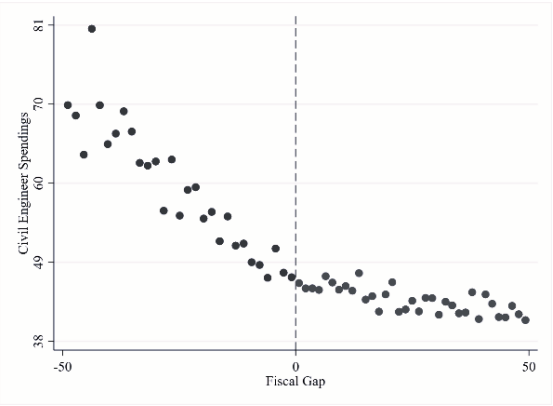
(d) Labor



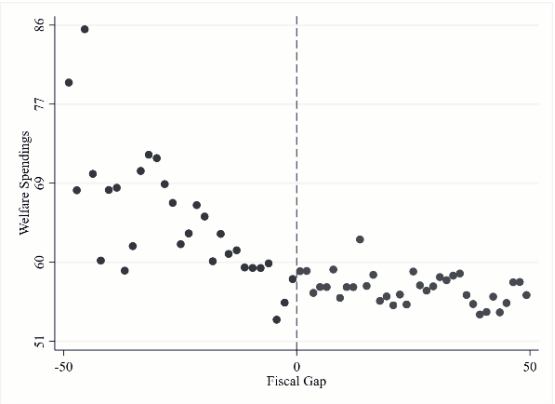
(e) Industry



(f) Civil Engineer



(g) Welfare



(h) Others

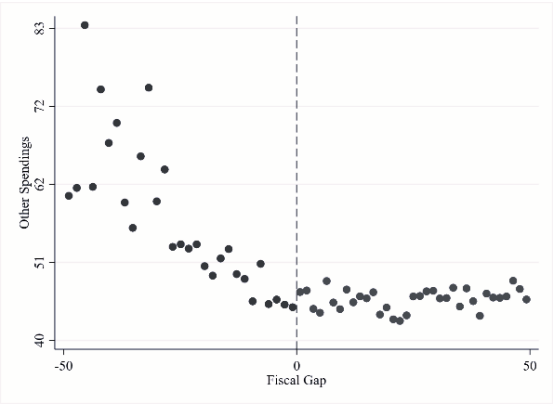
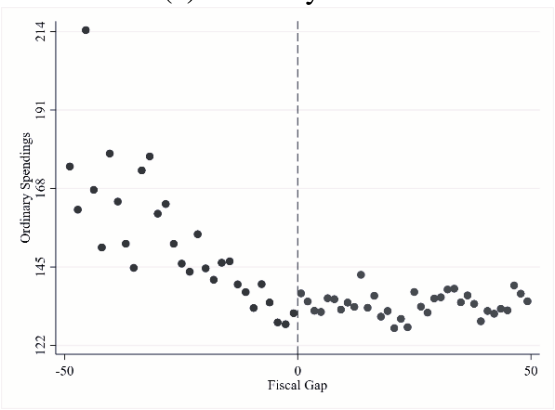


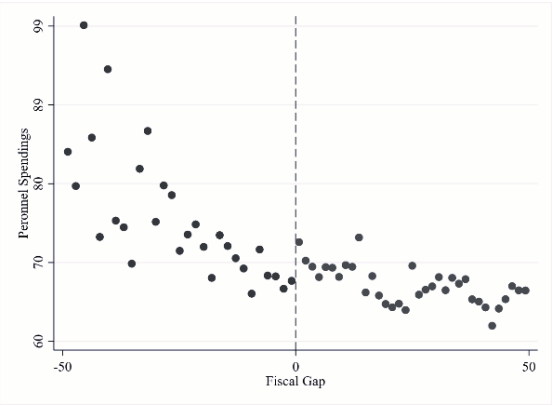
Figure 1.A.9: RK Estimates on Municipal Spending by Department(1,000 JPY per capita)

Notes: These figures plot the average municipal spending per residents from general revenue sources (1,000 JPY per capita). Panel (a) plots the secretariat of council spending, Panel (b) the general service spending, Panel (c) the tax spending, Panel (d) the labor spending, Panel (e) the industry spending, Panel (f) the civil engineering spending, Panel (g) the welfare spending, and Panel (h) the other spending. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

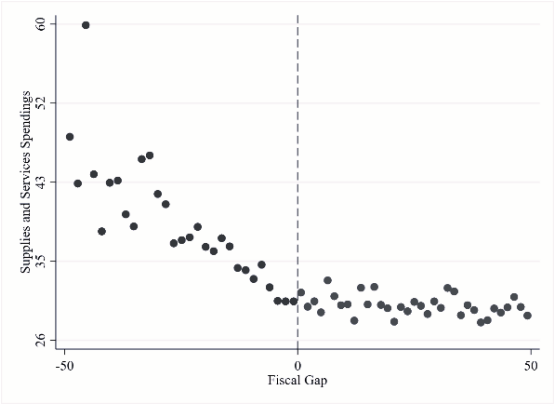
(a) Ordinary Total



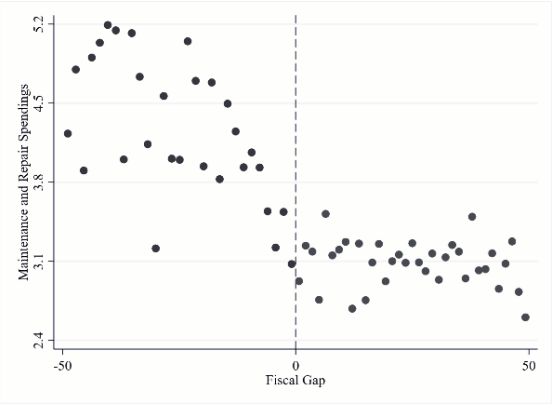
(b) Personnel



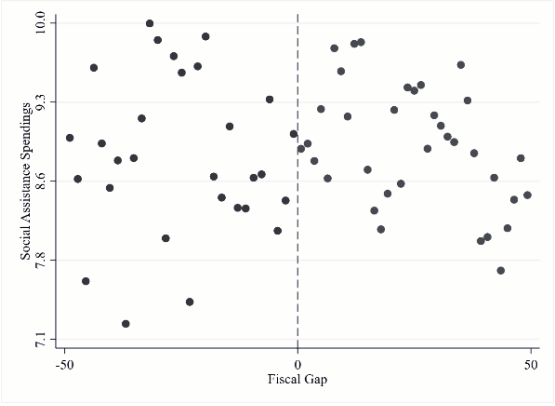
(c) Supplies and Services



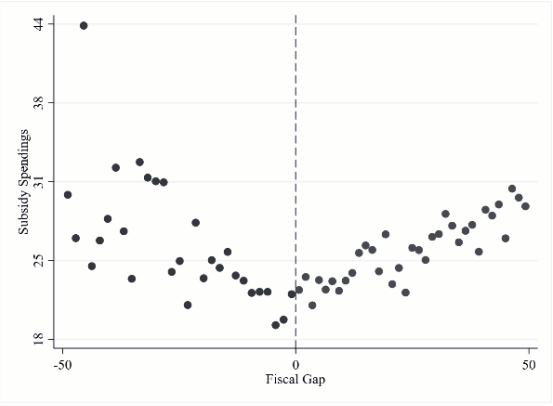
(d) Maintenance and Repairs



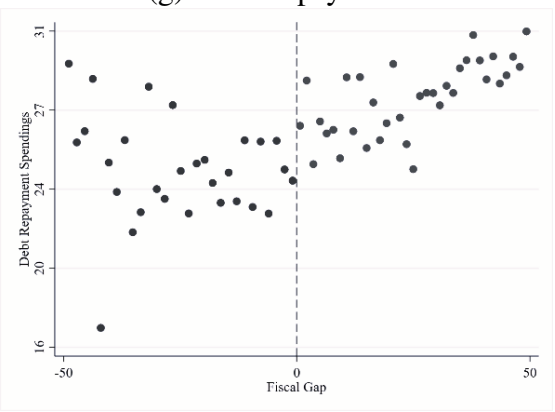
(e) Social Assistance



(f) Subsidy



(g) Debt Repayment



(h) Non-Ordinary Spending

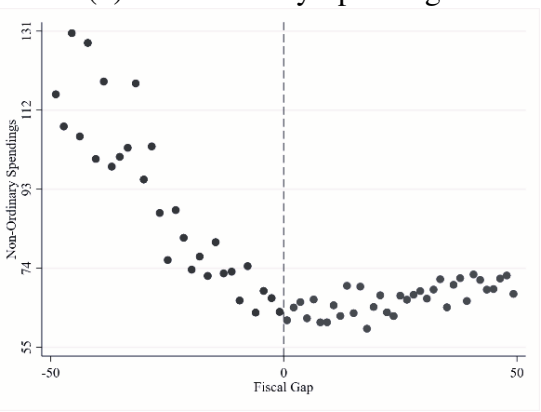
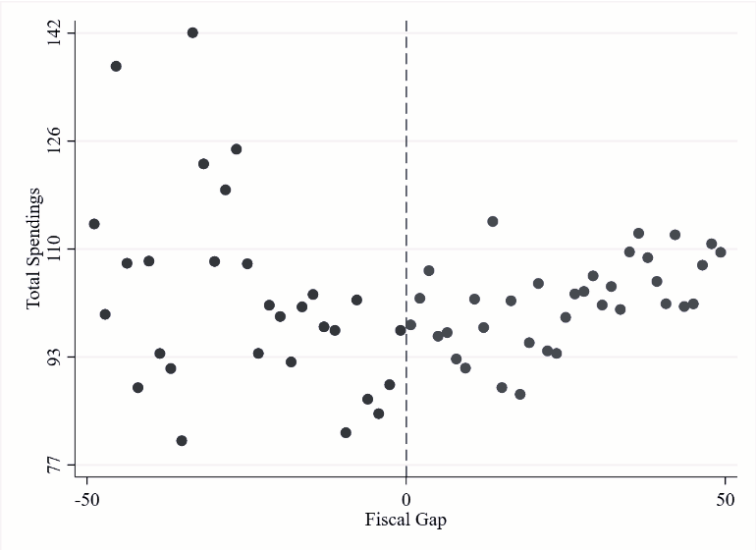


Figure 1.A.10: RK Estimates on Municipal Spending by Type (1,000 JPY per capita)

Notes: These figures plot the average municipal spending per residents from general revenue sources (1,000 JPY per capita). Panel (a) plots the ordinary spending, Panel (b) the personnel spending, Panel (c) the supplies and services spending, Panel (d) the maintenance and repairs spending, Panel (e) the social assistance spending, Panel (f) the subsidy spending, Panel (g) the debt repayment spending, and Panel (h) the non-ordinary spending. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

(a) Total Spending



(b) General Administration Spending

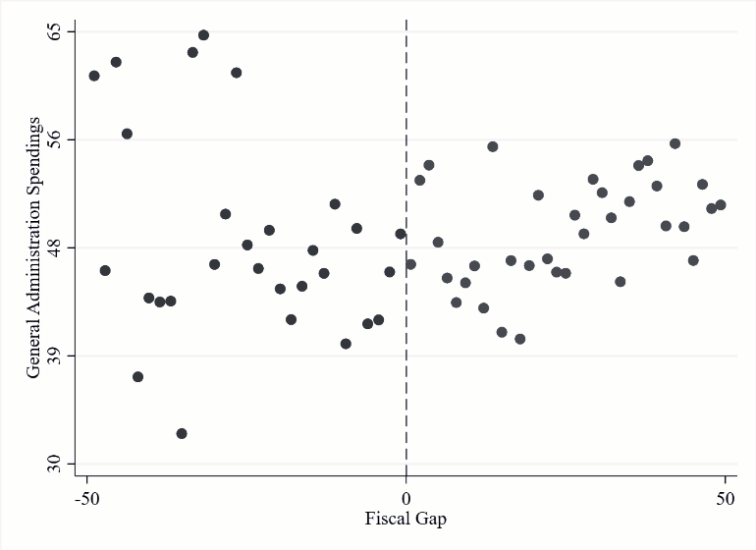
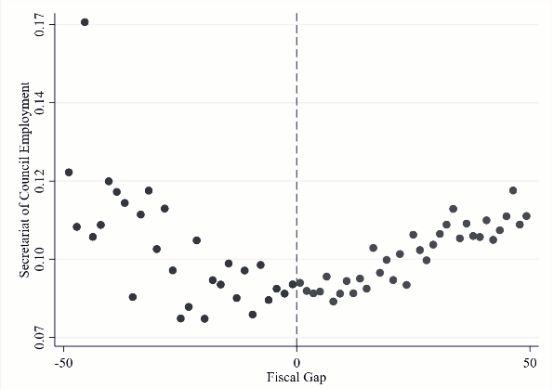


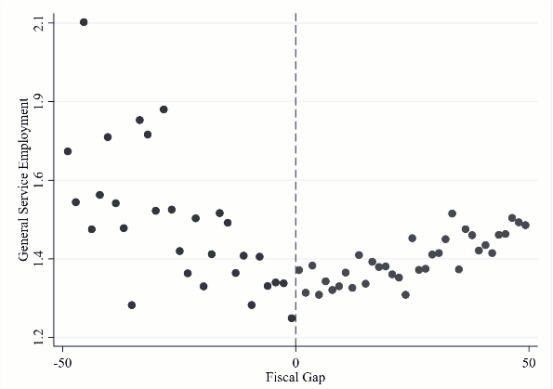
Figure 1.A.11: RK Estimates on Municipal Spending from Specific Revenue Sources (1,000 JPY per capita)

Notes: These figures plot the average municipal spending per residents from specific revenue sources (1,000 JPY per capita). Panel (a) plots the total spending, and Panel (b) plots the general administration spending. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

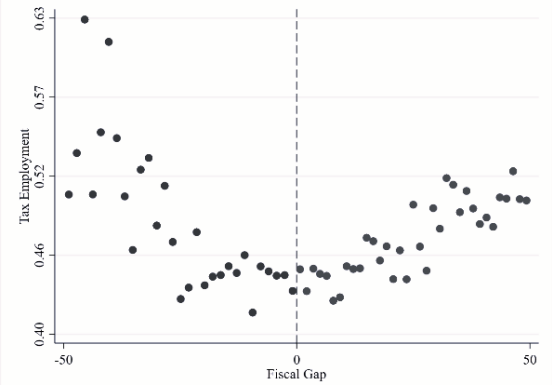
(a) Secretariat of Council



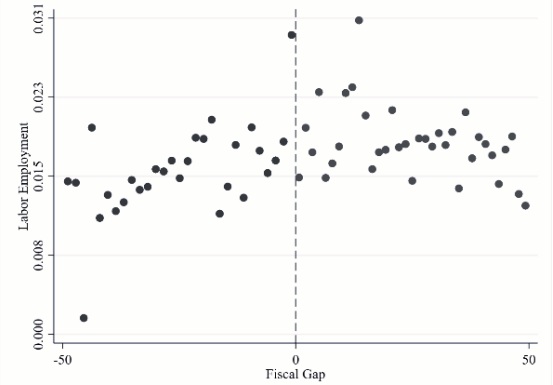
(b) General Service



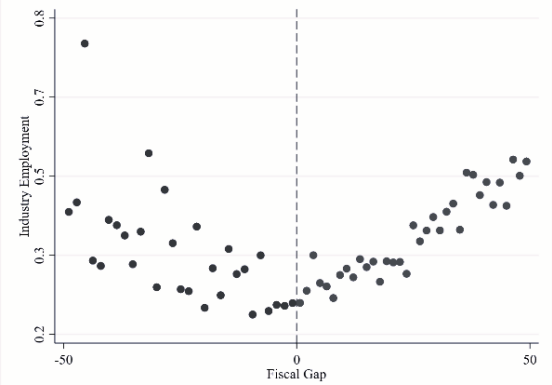
(c) Tax



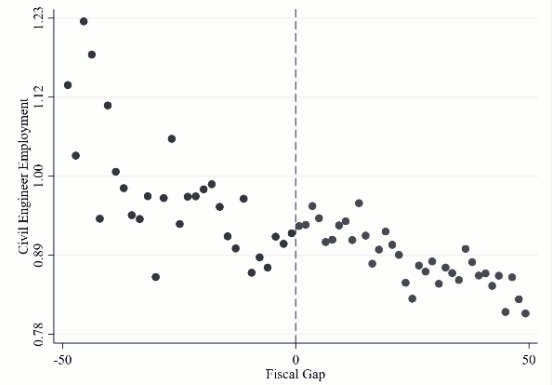
(d) Labor



(e) Industry



(f) Civil Engineer



(g) Welfare (h) Others

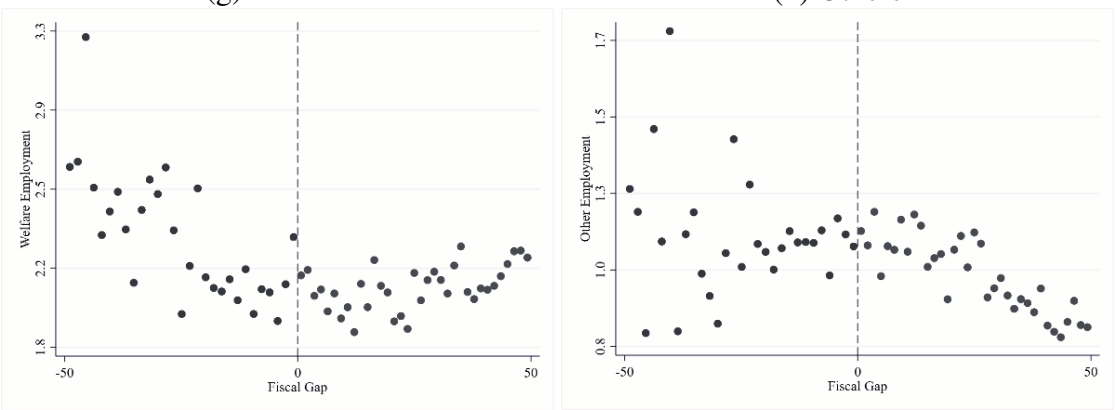
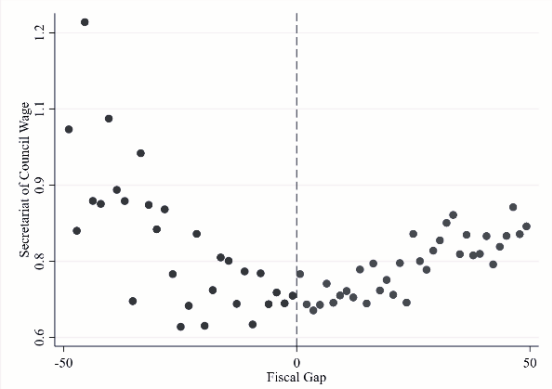


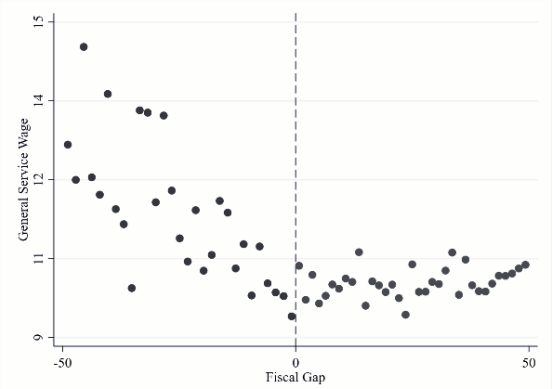
Figure 1.A.12: RK Estimates on Municipal Employment by Department (persons per 1,000 capita)

Notes: These figures plot the average number of employees in the municipal government per residents (persons per capita). Panel (a) plots the secretariat of council employment, Panel (b) the general service employment, Panel (c) the tax spending, Panel (d) the labor employment, Panel (e) the industry employment, Panel (f) the civil engineering employment, Panel (g) the welfare employment, and Panel (h) the other employment. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

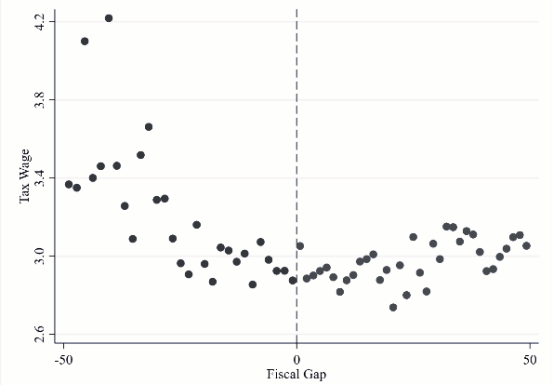
(a) Secretariat of Council



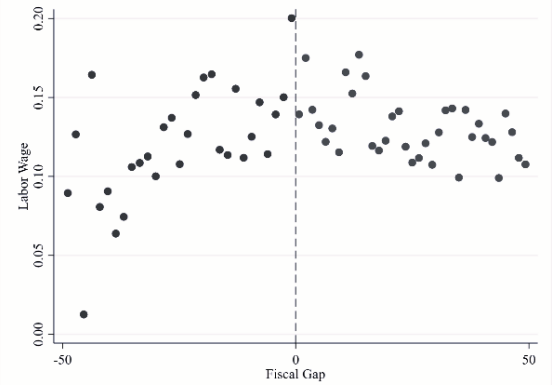
(b) General Service



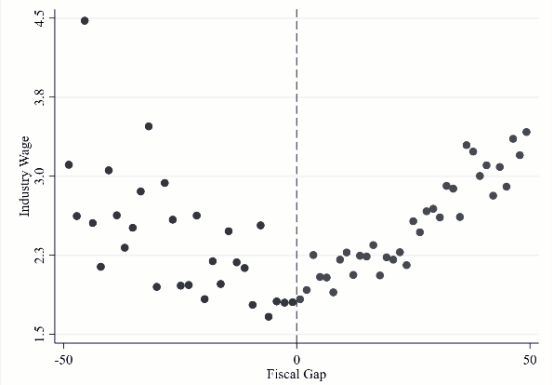
(c) Tax



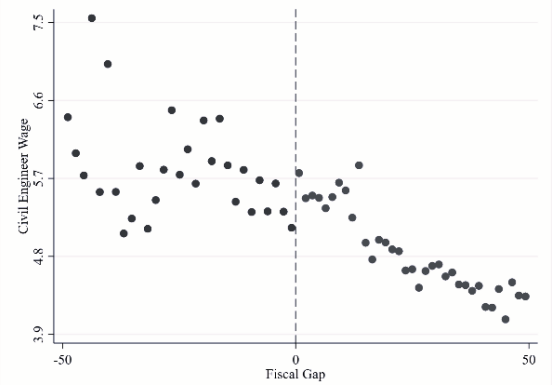
(d) Labor



(e) Industry



(f) Civil Engineer



(g) Welfare (h) Others

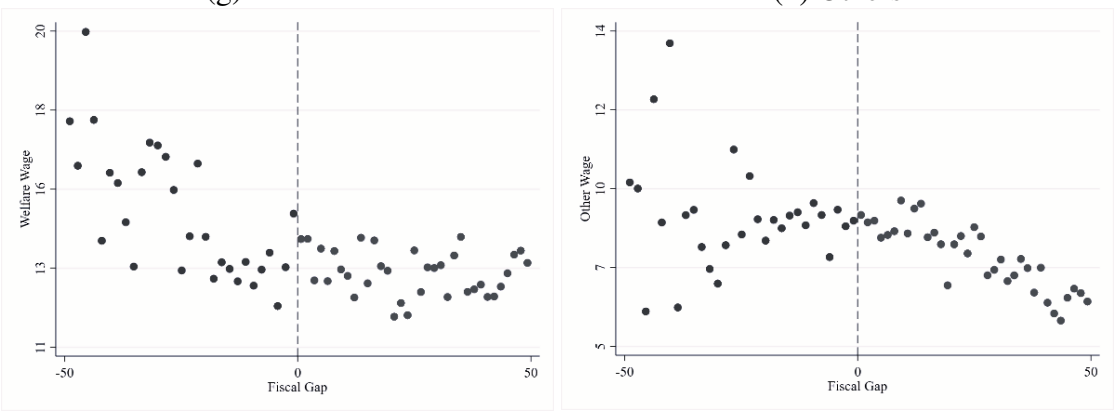
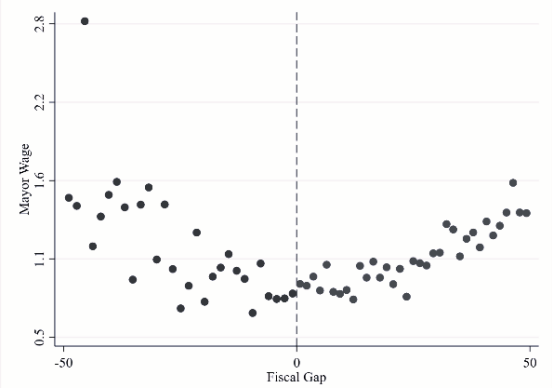


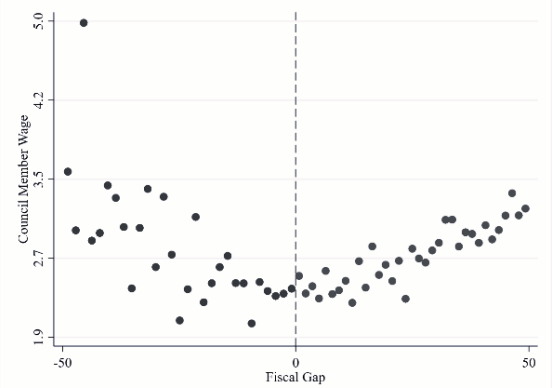
Figure 1.A.13: RK Estimates on Municipal Wage Expenses by Department (1,000 JPY per capita)

Notes: These figures plot the average wage expenses in the municipal government per residents (persons per capita). Panel (a) plots the secretariat of council employment, Panel (b) the general service employment, Panel (c) the tax spending, Panel (d) the labor employment, Panel (e) the industry employment, Panel (f) the civil engineering employment, Panel (g) the welfare employment, and Panel (h) the other employment. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

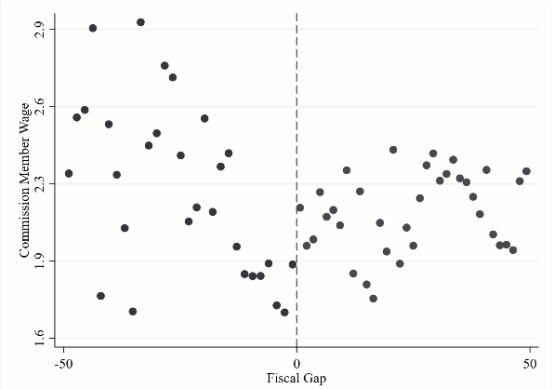
(a) Mayors



(b) Council Members



(c) Commission Members



(d) Temporary-Staffs

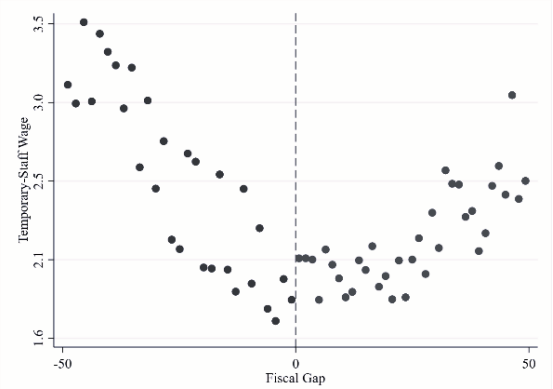


Figure 1.A.14: RK Estimates on Municipal Wage Expenses for Non-Employees (1,000 JPY per capita)

Notes: These figures plot the average wage expenses in the municipal government per residents (persons per capita). Panel (a) plots the wages for mayors, Panel (b) the municipal council members, Panel (c) the municipal commission members, and Panel (d) the temporary staff. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

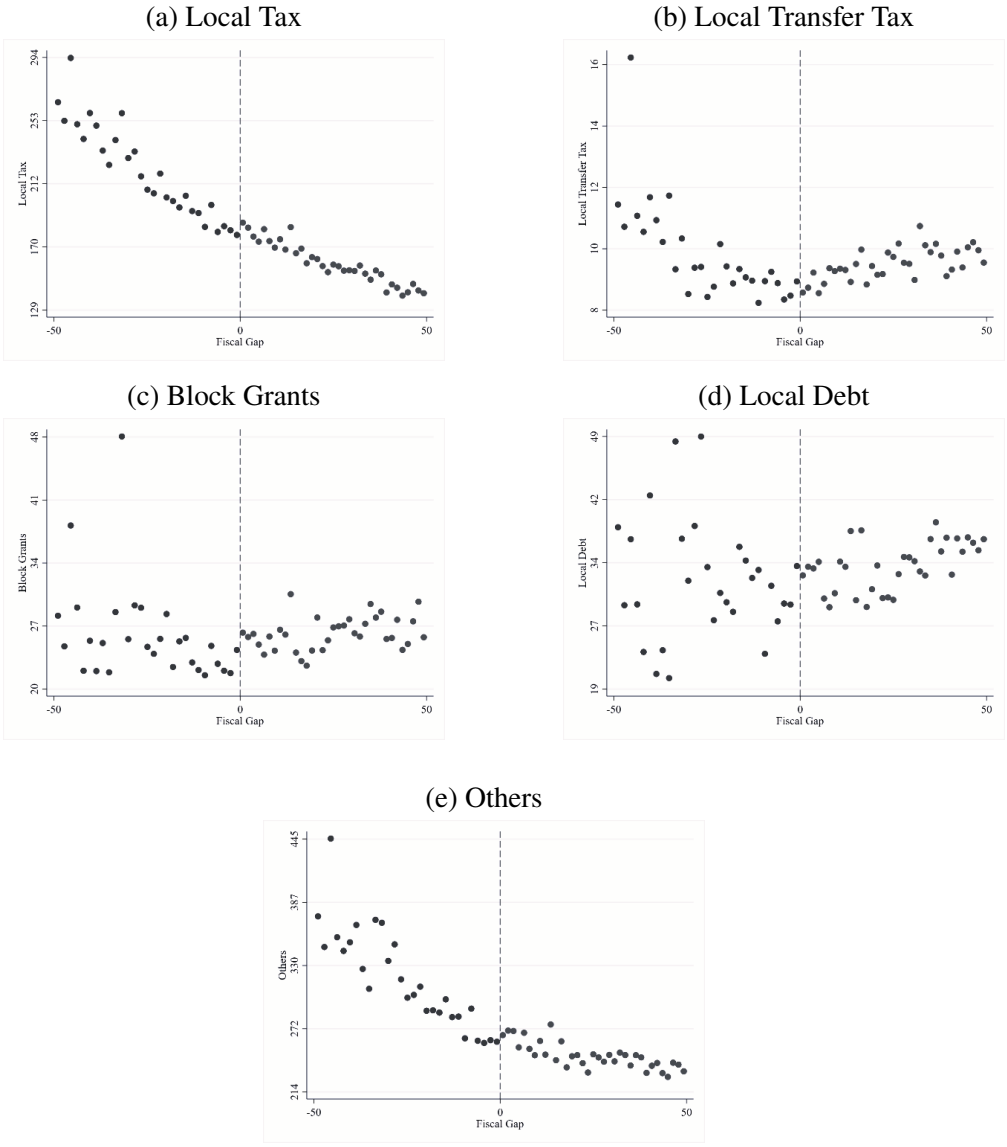
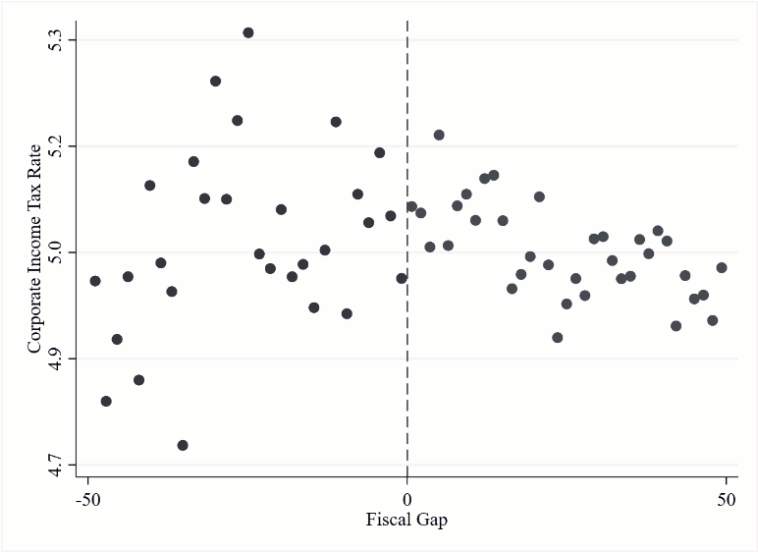


Figure 1.A.15: RK Estimates on Municipal Revenues (1,000 JPY per capita)

Notes: These figures plot the average municipal revenues per residents except for unconditional grants (1,000 JPY per capita). Panel (a) plots the local taxes, Panel (b) the local transfer tax, Panel (c) the block grants from the central government, Panel (d) local debt, and Panel (e) the other revenues. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

(a) Corporate Income Tax Rate



(b) City Plan Tax Rate

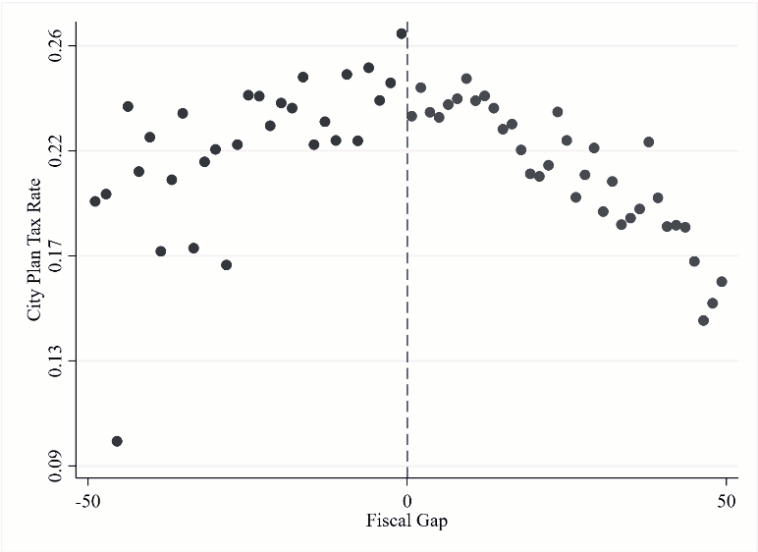


Figure 1.A.16: RK Estimates on Local Tax Rates (%)

Notes: These figures plot the average local tax rate (%). Panel (a) plots the corporate income tax rate, and Panel (b) plots the city plan tax rate. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

Appendix 1.B Tables

Table 1.B.1: Smoothness Tests of Predetermined Characteristics

Variables	Female Share	Population Density	Revenue Capacity	Female Share	Population Density	Revenue Capacity
RK Estimates	-0.000	-38.228	0.415	-0.000	-22.297	0.232
	(0.000)	(24.578)	(0.304)	(0.000)	(37.561)	(0.403)
Mean of the dependent variable	0.517	584	130	0.517	584	130
Polynomial	1	1	1	2	2	2
Observations	31,980	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the estimated kinks in demography (share of female, and the population density), and revenue capacity. The regression uses the fuzzy RK estimate with a triangular kernel. Column 1 to 3 represents the estimate with linear functional form, and Column 4 to 6 with quadratic functional form. The covariates are year dummies. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.2: RK Estimates on Municipal Spending by Type (1,000 JPY per capita)

	Ordinary Spending							
Varuables	Ordinary Total	Personnel	Supplies and Services	Maintenance and Repairs	Social Assistance	Subsidy	Debt Repayment	Non-Ordinary Spending
RK Estimates	0.766***	0.092	0.234***	0.033*	0.025	0.273***	-0.072	0.675***
	(0.147)	(0.113)	(0.065)	(0.019)	(0.029)	(0.089)	(0.076)	(0.188)
Mean	222.5	109.4	47.8	5.5	8.2	51.6	70.8	118.9
Observations	31,980	31,980	31,980	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on municipal spending per residents from general revenue sources. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.3: RK Estimates on Municipal Spending by Source (1,000 JPY per capita)

	General Revenue Sources		Specific Revenue Sources	
Variables	Total Spending	General Administration Spending	Total Spending	General Administration Spending
RK Estimates	1.171***	0.747***	0.348	-0.259
	(0.174)	(0.143)	(0.324)	(0.189)
Mean of the dependent variable	412.2	186.8	242.0	144.5
Observations	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on municipal spending per residents. Column 1 and 2 represents the spending from general revenue sources, and Column 3 and 4 from specific revenue sources. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.4: RK Estimates on Municipal Wage Expenses for Non-Employees (1,000 JPY per capita)

Variables	Mayor Wages	Council Member	Commission Member Wages	Temporary-Staff Wages
RK Estimates	0.005	0.008	0.036***	0.035***
	(0.004)	(0.006)	(0.011)	(0.013)
Mean of the dependent variable	6.2	7.5	4.1	5.8
Observations	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the municipal wage expenses for non-employees. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.5: RK Estimates on Municipal Employment by Employee Ages in Total Department (persons per 1,000 capita)

Variables	Age under 23	Age 24-31	Age 32-39	Age 40-59	Age over 60
RK Estimates	0.001	0.008**	-0.004	0.002	-0.001*
	(0.002)	(0.004)	(0.004)	(0.009)	(0.000)
Mean of the dependent variable	0.9	2.4	2.8	7.6	0.0
Observations	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the number of employees in the municipal governments by employee ages. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.6: RK Estimates on Municipal Revenues (1,000 JPY per capita)

Variables	Local Tax	Local Transfer Tax	Block Grants	Local Debt	Others
RK Estimates	-0.168*	0.005	0.190	0.130	0.440
	(0.100)	(0.015)	(0.144)	(0.168)	(0.278)
Mean of the dependent variable	107.4	12.6	51.6	83.2	302.3
Observations	31,980	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the municipal revenues except for unconditional grants. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.7: RK Estimates on Local Tax Revenues (1,000 JPY per capita)

Variables	Individual Income Taxes	Property Tax	City Plan Tax	Other taxes
RK Estimates	-0.072	0.138	-0.084*	-0.034
	(0.125)	(0.161)	(0.045)	(0.104)
Mean of the dependent variable	34.0	53.3	2.0	17.1
Observations	31,980	31,980	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the municipal local tax revenues. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.B.8: RK Estimates on Local Tax Rates (%)

Variables	Corporate Income Tax Rate	City Plan Tax Rate
RK Estimates	0.001	-0.002***
	(0.003)	(0.001)
Mean of the dependent variable	13.3	0.06
Observations	31,980	31,980

Notes: The table reports the impact of receiving the unconditional grants on the municipal local tax rates. The regression uses the local linear fuzzy RK estimate with a triangular kernel. The covariates are year dummies, demography (share of female, and the population density), and revenue capacity. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix 1.C Robustness Checks

Table 1.C.1: RK Estimates on Municipal Spending (Robustness Tests)

Variables	Total Spending	General Administration Spending	Ordinary Spending
Panel A: Sensitivity Analysis by Length of Bandwidth (1,000 JPY per capita)			
Bandwidth: baseline + 10	1.270***	0.729***	0.791***
	(0.185)	(0.196)	(0.236)
Bandwidth: baseline - 10	1.185***	0.674**	0.485
	(0.296)	(0.328)	(0.373)
Bandwidth: two different CER-optimal	1.156***	0.688***	0.754***
	(0.158)	(0.150)	(0.167)
Panel B: No Covariates (1,000 JPY per capita)			
with No Covariates	2.047***	1.073***	0.920***
	(0.315)	(0.272)	(0.233)
Panel C: Functional Forms and Kernels (1,000 JPY per capita)			
Local Linear with triangular kernel	1.171***	0.747***	0.766***
	(0.174)	(0.143)	(0.147)
Local Linear with uniform kernel	1.106***	0.709***	0.635***
	(0.187)	(0.168)	(0.160)
Local Quadratic with triangular kernel	1.069***	0.648***	0.809***
	(0.210)	(0.191)	(0.199)
Local Quadratic with uniform kernel	1.151***	0.597**	0.901***
	(0.241)	(0.243)	(0.219)
Mean of the dependent variable	412.2	186.8	222.5
Observations	31,980	31,980	31,980

Notes: The table reports the impacts of receiving the unconditional grants on total spending (Column 1), general administration spending (Column 2), and ordinary spending (Column 3), estimated by local linear RK estimates with triangular kernel. Panel A reports the RK estimates with several length of bandwidths. Panel B reports the RK estimates with no covariates other than year dummies. Panel C reports the estimates with several functional forms and kernel. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.C.2: Dynamic RK Estimates on the Unconditional Grants (1st Stage Results, Other Polynomial)

	Unconditional Grants	
Variables	Effect	Cumulative Effect
Effect of the decision to grant after		
1 year (granted year)	1.0038***	1.0038***
	(0.0017)	(0.0017)
2 year	-0.0014**	1.0024***
	(0.0006)	(0.0017)
3 year	0.0021***	1.0045***
	(0.0008)	(0.0019)
4 year	-0.0003	1.0042***
	(0.0007)	(0.0021)
5 year	-0.0007	1.0035***
	(0.0011)	(0.0022)
6 year	0.0025	1.0060***
	(0.0022)	(0.0027)
7 year	-0.0021	1.0039***
	(0.0013)	(0.0023)
8 year	-0.0024*	1.0015***
	(0.0013)	(0.0021)
9 year	0.0031**	1.0046***
	(0.0015)	(0.0025)
10 year	-0.0007	1.0039***
	(0.0013)	(0.0026)
Observations	31,980	31,980
Order of Polynomial	Quadratic	Quadratic

Notes: The table reports the dynamic impact of receiving the unconditional grants on unconditional grants. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.C.3: Dynamic RK Estimates on Municipal Spending (1,000 JPY per capita, Other Polynomial)

	General Administration Spending		Ordinary Spending	
		Cumulative		Cumulative
Variables	Effect	Effect	Effect	Effect
Effect of the decision to grant after				
1 year (granted year)	1.4020***	1.4020***	0.3454***	0.3454***
	(0.1811)	(0.1811)	(0.0777)	(0.0777)
2 year	-0.1155	1.2865***	0.2141***	0.5595***
	(0.1219)	(0.1580)	(0.0480)	(0.0984)
3 year	-0.2357**	1.0508***	0.0155	0.5750***
	(0.1009)	(0.1914)	(0.0422)	(0.0990)
4 year	0.1719*	1.2227***	0.1339***	0.7089***
	(0.0877)	(0.2283)	(0.0211)	(0.1052)
5 year	0.0916	1.3143***	0.1712***	0.8801***
	(0.0687)	(0.2284)	(0.0279)	(0.1091)
6 year	0.2164***	1.5307***	0.0965***	0.9766***
	(0.0711)	(0.2339)	(0.0307)	(0.1145)
7 year	0.2108**	1.7415***	0.0702**	1.0468***
	(0.0884)	(0.2519)	(0.0292)	(0.1248)
8 year	-0.0191	1.7224***	-0.0095	1.0373***
	(0.0857)	(0.2675)	(0.0496)	(0.1176)
9 year	0.1226	1.8450***	0.1127***	1.1500***
	(0.0931)	(0.2916)	(0.0436)	(0.133)
10 year	-0.0254	1.8197***	0.0477	1.1977***
	(0.0866)	(0.2831)	(0.0454)	(0.1547)
Observations	31,980	31,980	31,980	31,980
Order of Polynomial	Quadratic	Quadratic	Quadratic	Quadratic

Notes: The table reports the dynamic impact of receiving the unconditional grants on municipal general administration spending (Column 1 and 2) and ordinary spending (Column 3 and 4) per residents from general revenue sources. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.C.4: RK Estimates on Municipal Employment (Robustness Tests)

Variables	Total Employment	General Administration Employment
Panel A: Sensitivity Analysis by Length of Bandwidth (persons per 1,000 capita)		
Bandwidth: baseline + 10	-0.004	0.016**
	(0.014)	(0.007)
Bandwidth: baseline - 10	-0.004	0.014
	(0.019)	(0.009)
Bandwidth: two different CER-optimal	0.005	0.013***
	(0.011)	(0.005)
Panel B: No Covariates (persons per 1,000 capita)		
with No Covariates	0.018	0.022***
	(0.015)	(0.008)
Panel C: Functional Forms and Kernels (persons per 1,000 capita)		
Local Linear with triangular kernel	0.003	0.011***
	(0.010)	(0.004)
Local Linear with uniform kernel	0.005	0.011***
	(0.012)	(0.004)
Local Quadratic with triangular kernel	-0.010	0.016**
	(0.016)	(0.008)
Local Quadratic with uniform kernel	-0.007	0.017**
	(0.019)	(0.007)
Mean of the dependent variable	11.5	6.9
Observations	31,980	31,980

Notes: The table reports the impacts of receiving the unconditional grants on the number of total employees (Column 1), and employees in general administration (Column 2), estimated by local linear RK estimates with triangular kernel. Panel A reports the RK estimates with several length of bandwidths. Panel B reports the RK estimates with no covariates other than year dummies. Panel C reports the estimates with several functional forms and kernel. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.C.5: RK Estimates on Municipal Wage Expenses (Robustness Tests)

Variables	Total Wage Expenses	General Administration Wage Expenses
Panel A: Sensitivity Analysis by Length of Bandwidth (1,000 JPY per capita)		
Bandwidth: baseline + 10	0.005	0.149**
	(0.115)	(0.059)
Bandwidth: baseline - 10	0.008	0.181**
	(0.155)	(0.087)
Bandwidth: two different CER-optimal	0.055	0.117***
	(0.083)	(0.040)
Panel B: No Covariates (persons per capita)		
with No Covariates	0.083	0.139***
	(0.107)	(0.051)
Panel C: Functional Forms and Kernels (1,000 JPY per capita)		
Local Linear with triangular kernel	0.041	0.094***
	(0.086)	(0.036)
Local Linear with uniform kernel	-0.006	0.108***
	(0.108)	(0.038)
Local Quadratic with triangular kernel	-0.060	0.108*
	(0.126)	(0.055)
Local Quadratic with uniform kernel	-0.002	0.127**
	(0.150)	(0.057)
Mean of the dependent variable	66.9	39.2
Observations	31,980	31,980

Notes: The table reports the impacts of receiving the unconditional grants on the total wage expenses (Column 1), and the wage expenses for general administration (Column 2), estimated by local linear RK estimates with triangular kernel. Panel A reports the RK estimates with several length of bandwidths. Panel B reports the RK estimates with no covariates other than year dummies. Panel C reports the estimates with several functional forms and kernel. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.C.6: Dynamic RK Estimates on Municipal Employment (Other Polynomial)

	General Administration Employees (persons per 1,000 capita)		General Administration Wage Expenses (1,000 JPY per capita)	
Variables	Effect	Cumulative Effect	Effect	Cumulative Effect
Effect of the decision to grant after				
1 year (granted year)	0.0047**	0.0047**	0.0410**	0.0410**
	(0.0023)	(0.0023)	(0.0178)	(0.0178)
2 year	0.0015**	0.0062**	0.0219***	0.0629***
	(0.0008)	(0.0026)	(0.0053)	(0.0188)
3 year	0.0014***	0.0076***	0.0090*	0.0719***
	(0.0005)	(0.0028)	(0.0049)	(0.0205)
4 year	0.0010	0.0086***	0.0244***	0.0964***
	(0.0007)	(0.0031)	(0.0044)	(0.0222)
5 year	0.0008	0.0095***	0.0079*	0.1042***
	(0.0007)	(0.0032)	(0.0044)	(0.0223)
6 year	0.0019***	0.0114***	0.0152***	0.1194***
	(0.0006)	(0.0034)	(0.0057)	(0.0235)
7 year	-0.0006	0.0108***	0.0084*	0.1278***
	(0.0008)	(0.0033)	(0.0046)	(0.0233)
8 year	-0.0002	0.0106***	-0.0088	0.1191***
	(0.0008)	(0.0033)	(0.0056)	(0.0236)
9 year	0.0001	0.0106***	0.0223***	0.1413***
	(0.0008)	(0.0035)	(0.0059)	(0.0256)
10 year	0.0016*	0.0122***	0.0013	0.1427***
	(0.0008)	(0.0036)	(0.0071)	(0.0277)
Observations	31,980	31,980	31,980	31,980
Order of Polynomial	Quadratic	Quadratic	Quadratic	Quadratic

Notes: The table reports the dynamic impact of receiving the unconditional grants on municipal the number of employees (Column 1 and 2), and wage expenses (Column 3 and 4) in general administration. The covariates are municipality fixed effects and time fixed effects. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix 1.D Details of the Unconditional Grants

The central government (MIC) calculates the "Standard Financial Needs (SFN)" and "Standard Financial Revenues (SFR)" for each municipality each year. The unconditional grants are determined mechanically according to the following formula: [32]

$$Unconditional\ Grants = \begin{cases} SFN - SFR & if\ SFN > SFR \\ 0 & if\ otherwise, \end{cases}$$

The unconditional grants are officially called "the Local Allocation Tax (LAT) Grants," which derive from the fact that they are financed by a certain percentage of national tax revenues.[33] Hence, in cases where the required amount above exceeds the tax revenues from these taxes, the actual total amount of grants is adjusted by multiplying by a uniform national rate .[34]

SFN represents the cost required to implement standard public services in a municipality. SFN is calculated at specific budgetary item levels. The formula is

$$SFN = Unit\ of\ measure \times Unit\ cost \times Modification\ coefficient$$

where "unit of measure" is an objective value such as population, share of aged 65 and over, area size of the municipality, and port scale, the number of teachers, port scale, and length of roads. "unit cost" is a uniform value per each item across the entire country, which is computed by dividing the total cost of a "standard municipality" by the number of unite measure. "modification coefficient" is an indicator to adjust fiscal needs

[32] These formulas are defined by the national law (the Local Allocation Tax Law).

[33] In 2000, it was 32% for individual income tax and alcohol tax, 35.8% for corporate income tax, 29.5% for added tax, and 25% for tobacco tax.

[34] In reality, as shown in Figure 1.1, the municipalities can receive the unconditional grants almost equal to the amount determined by the formula.

to reflect the specific regional characteristics, such as colder temperatures, population density, and speed of population change.

In addition, SFR represents the revenue capacity set by the central government as the reasonable financial revenue ability of each municipality, based on the following formula:[35]

$$SFR = Standard\ tax\ revenues \times 0.75$$

The "standard tax revenues" are basically calculated by multiplying each municipality's tax base by the "standard tax rate" and "standard tax collection rate". These are set to a uniform across the entire country, based on the objective values such as the number of persons obligated to pay taxes, housing prices or areas, and are not affected by actual municipal performances. Therefore, in case a municipality sets a different tax rate than the "standard tax rate" or imposes its original tax, the amount of the SFR will not be affected.

Previous studies have pointed out that SFN and SFR are set objectively and mechanically, and municipalities cannot not manipulate them, such as reducing taxation, in order to receive more unconditional grants (Horiba et al. (2003); Mochida (2006); Ando (2015); Ando (2017); Miyazaki (2020)).

[35]Since the remaining 25% of the "standard tax revenues" is not reduced in unconditional grants, municipalities have an incentive to support the local economic growth and increase their tax base (Ando (2017)).

Appendix 1.E Analysis of the Tax Collection Efforts

The purpose of the unconditional grants is to correct the disparity in financial capacities among municipalities for regional equality, and to guarantee the supply of public goods and services by municipalities with weak financial capacities. As noted in Appendix D, the amount of the grants is mechanically determined by objective indicators or "standard tax revenues" that the central government determines, so it cannot be manipulated by the actual municipalities' actions (Mochida (2006)). However, it has been pointed out that (1) "moral hazard" caused by the financial guarantee without collecting their taxes and (2) "hold-up problem" caused by the high implicit marginal tax rate of 75%, which may discourage municipalities' willingness to collect tax revenues (Nishikawa and Yokoyama (2004); Tajika and Miyazaki (2008)).

In order to increase tax revenues, municipalities need to (1) expand their tax base, (2) raise their tax rates, or (3) decrease their tax collection shortfalls. There has been a concern shared by policymakers that the unconditional grants would discourage municipalities to make their tax collection efforts. For example, the expert committee of the Japan's MOF criticizes "the financial guarantee role" of the grants as creating a moral hazard in the local government finances (MOF (2003), p.6). As described in the institutional background, local governments in Japan rarely set their own tax bases or tax rates. Hence, I focus on the tax collection shortfall.[36] Since local tax collection shortfall in FY 2000 roughly equals to local value added tax, the magnitude of the shortfall is not small.

[36]In response to the criticisms, in 2005, the central government started measures that increased the grant amount when the tax collection rate of a municipality was higher than the average for the unconditional grant calculation. This illustrates that the central government has recognized tax collection as a major moral hazard issue.

In the analysis, I treat property tax and city planning tax as my main outcomes, because these two taxes are paid directly to the municipality by the land or property owners, and thus the municipal collection efforts are directly reflected. The municipal administration has tax collection officers, and each officer urges delinquent taxpayers, by phone or in person, to pay their delinquent taxes, seizes their property, and conducts auctions. Appendix Table 1.E.1 shows the results of a survey conducted by a previous study of municipalities, which indicates that collection efforts - sending letters, calling, visiting, and seizing delinquent properties - vary across municipalities (Hayashi (2009)). In contrast, when residents are employees of a company or other organization, their employer must deduct the individual inhabitant tax from their wages and pay that tax to the local government. Since the municipality where establishments are located is in charge of tax collection efforts, the collection shortfall rate for individual inhabitant taxes may not reflect the tax collection efforts of a municipality itself. [37]

1.E.1 Identification Strategy

Figure 1.1 illustrates that the amount of the unconditional grants gradually increases with the running variable if the fiscal gap is greater than zero. However, moral hazard is a psychological effect resulting from a perceived reassurance that fiscal revenues will be guaranteed by the central government. In addition, the hold-up problem arises from the discontinuous increase in the implicit marginal tax rate from 0% to 75%. Therefore, I estimate the impact of Japan's unconditional grants on the tax collection shortfall in municipalities by using an RDD, not RKD. By focusing on collection shortfalls, I

[37] According to the 2000 census, 41.8% (26.35 million) of Japanese employees work in municipalities other than the one in which they reside.

provide empirical evidence of a new field of crowd-out that the previous literature has not paid attention to. As far as I know, this is the first attempt to estimate the effect of transfer grants on tax collection based on a quasi-experiment. While changes in tax rates may involve local politicians, local legislators, and the central government, the tax collection shortfall is controlled internally of municipalities' administrative departments. In the RKD regression, I use a fuzzy design, because the actual grant amount is adjusted to be within the revenue from taxes that will finance the grants. In the RDD regression here, I use the sharp RDD, as it relies on eligibility rather than the amount of the grants.

In order to estimate the impact of the grants on municipal tax collection shortfall, I implement the sharp RDD estimation as follows: [38]

$$y_{it} = \alpha + \beta \cdot \mathbb{1}[Fiscal\ Gap_{it} > 0] + f(Fiscal\ Gap_{it}) + X_{it}\gamma + \epsilon_{it} \tag{1.8}$$

where outcome variable y_{it} is the tax collection shortfall in municipality i at time t, $\mathbb{1}[Fiscal\ Gap_{it} > 0]$ is an indicator variable that takes one if $Fiscal\ Gap_{it}$ is positive and zero otherwise. $f(Fiscal\ Gap_{it})$ is a smooth function on either side of the cutoff. X_{it} are year dummies as control variables. β is the coefficient of interest, which I interpret as the effect of receiving unconditional grants on municipalities' tax collection shortfall rates. When β is positive and statistically significant, I can interpret that the effect that increases tax collection shortfall (or "crowding-out" effect) of the unconditional grants exists.

For validity of the RDD, Appendix Figure 1.A.1 shows that there is no manipulation in the running variable. The P-values estimated by the local linear functions are 0.218 for share of female, 0.599 for the population density, and 0.276 for revenue capacity,

[38] In all RD regressions, I use the "rdrobust" software package developed and provided by Calonico et al. (2014).

while the P-values by the local quadratic functions are 0.320 for share of female, 0.328 for the population density, and 0.346 for revenue capacity. These mean that the RD estimation passes the covariate balance test and continuity assumptions are supported. Appendix Table 1.E.2 reports the placebo RD estimates of the collection shortfalls of property and city plan tax, based on the reduced-form regressions. The results are statistically insignificant, and the signs are unstable. Hence, there is no evidence that shows a placebo effect exists

1.E.2 Empirical Results

1.E.2.1 Graphical Evidence

Appendix Figure 1.E.1 presents graphical evidence of the effect on the average collection effort. The cutoff is set by a $Fiscal\ Gap_{it}$ value of zero, at which point municipalities become eligible for unconditional grants. The sample on the right is municipalities that received unconditional grants, and the sample on the left is municipalities that did not. First, I plot the collection shortfall per capita. Panel 1 (a) represents the property tax shortfall, and Panel 1 (b) the city plan tax shortfall. These figures show a clear discontinuity at the cutoff. Next, I also check the collection shortfall rates. Panel 1 (a) reports the shortfall rate of property tax, and Panel 1 (b) the city plan tax, showing that a discontinuous jump seems to exist at the cutoff.

1.E.2.2 RD Estimation Results for Municipal Tax Collection Shortfalls

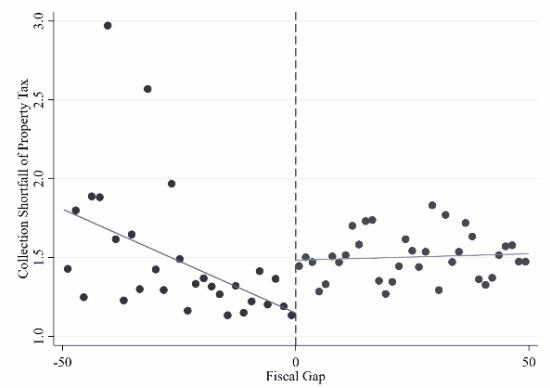
Appendix Table 1.E.3 shows the results of the sharp RD estimates for local tax collection shortfall, estimated by equation (1.8). Same as RK estimates, I use a local linear

functional form with a triangular kernel and the two different mean squared-error (MSE)-optimal bandwidth selectors. Panel A reports the results of tax collection shortfalls per capita, and Panel B represents the shortfall rates. As expected, the RD estimates for property tax (Column 3) and city plan tax (Column 4) are positive and statistically significant at the cutoff for unconditional grant eligibility. In contrast, the shortfalls of individual income or other taxes (Column 2 and Column 5) are less statistically significant, and these results may be due to the fact that the existence of employees makes it difficult to observe tax collection efforts on individual income tax. Comparing the results for each panel, the effect on the fixed assets tax is the largest and has the most statistically significant level. This implies that the impact on total tax collection shortfall rate (Column 1) is caused by the effect on fixed assets tax. In summary, these results support the existence of crowd-out effect by the intergovernmental grants.[39]

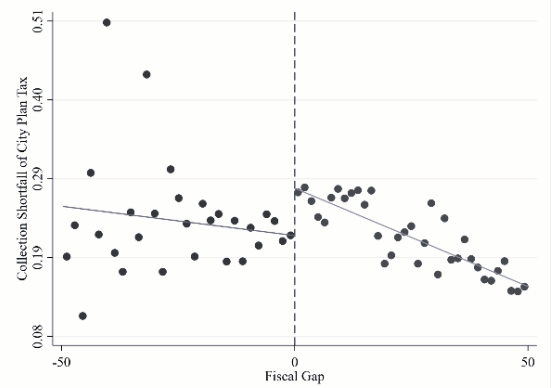
[39] As shown in section 6, Column 5 in Table 1.4 reports that the RK estimates on tax department is positive and statistically significant at 10% level. On the other hand, Ito (2013) points out that an increase in tax collection expenditure does not necessarily increase municipal tax revenues.

(1) Local Tax Collection Shortfalls (1,000 JPY per capita)

(a) Property Tax

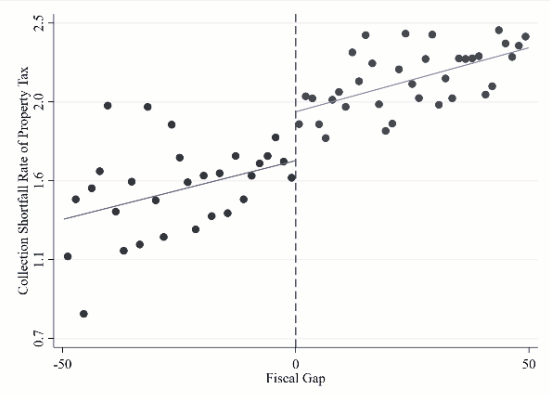


(b) City Plan Tax



(2) Local Tax Collection Shortfall Rates (%)

(c) Property Tax



(d) City Plan Tax

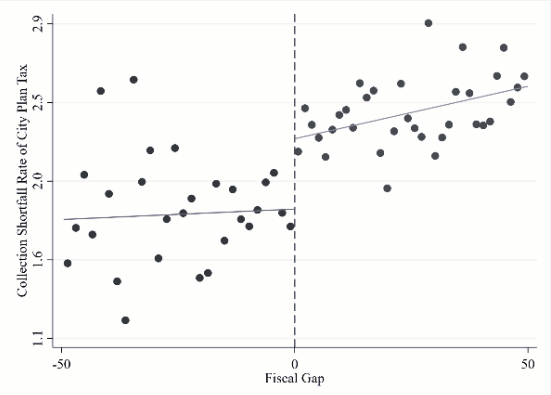


Figure 1.E.1: RD Estimates on Local Tax Collection Shortfalls

Notes: These figures plot (1) the average local tax collection shortfall per capita, and (2) the average tax collection shortfall rates, respectively. Panel (a) and (c) plot the property tax shortfall, and Panel (b) and (d) plot the city plan tax shortfall. The sample on the left side does not receive the unconditional grants, whereas the sample on the right side receive the grants.

Table 1.E.1: Tax Collection Efforts in the Municipalities (in FY 2005)

Variables	Mean	Maximum	Minimum
Sending Letters	45,435	920,000	100
Telephone Call	6,981	54,000	50
Unannounced Visits	7,370	108,712	0
Property Seizure	600	24,000	0

Notes: Hayashi (2009).

Table 1.E.2: Placebo Tests for RD Estimates

	Local Tax Collection Shortfalls (1,000JPY per capita)		Local Tax Collection Shortfall Rates (%)	
Property Tax	Variables	City Plan Tax	Property Tax	City Plan Tax
Fiscal Gap = -60	-0.140	0.152	-0.192	-0.352
	(0.313)	(0.095)	(0.300)	(0.614)
Fiscal Gap = -20	0.030	0.053	-0.041	0.036
	(0.140)	(0.035)	(0.150)	(0.207)
Fiscal Gap = +20	0.006	-0.007	-0.075	0.048
	(0.110)	(0.021)	(0.120)	(0.319)
Fiscal Gap = +60	-0.008	-0.013	0.050	-0.008
	(0.089)	(0.014)	(0.131)	(0.210)
Observations	31,980	31,980	31,980	7,663

Notes: The table reports the impact of receiving the unconditional grants on the municipal local tax collection shortfalls (Column 1 and 2) and shortfall rates (Column 3 and 4). The regression uses the local linear RD estimate of equation (1.8) with a triangular kernel. The covariates are year dummies. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 1.E.3: RD Estimates on Tax Collection Shortfalls (1,000 JPY per capita)

Variables	Total Taxes	Individual Income Tax	Property Tax	City Plan Tax	Other Taxes
Panel A: Tax Collection Shortfall (1,000JPY per capita)					
RD Estimates	0.517**	0.080	0.288***	0.071***	0.059
	(0.216)	(0.072)	(0.092)	(0.022)	(0.102)
Mean of the dependent variable	1.914	0.544	1.115	0.052	0.204
Panel B: Tax Collection Shortfall Rate (%)					
RD Estimates	0.201*	0.154*	0.249**	0.360**	0.102
	(0.121)	(0.093)	(0.111)	(0.143)	(0.331)
Mean of the dependent variable	1.715	1.435	2.120	2.477	1.030
Observations	31,980	31,980	31,980	31,980	31,980

Notes: table reports the impact of receiving the unconditional grants on the municipal local tax collection shortfalls (Panel A) and shortfall rates (Panel B). The observations of city plan tax shortfall rate are 7,663. The regression uses the local linear sharp RD estimate with a triangular kernel. The covariates are year dummies. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Chapter 2

Effects of Shrinking Population on Local Government and Housing Markets: Evidence from Japan[1]

Abstract

Many countries—both developed and emerging—face the prospect of shrinking populations. This demographic trend has become an economic and social problem affecting economic growth and generational and regional inequality. However, since population declines proceed steadily, they are not a shock, and it is difficult to estimate their effects because they are endogenous to each context. I use a unique event—the publication of a list of municipalities at risk of extinction by 2040 in Japan—to estimate the impacts of declining populations on municipalities and housing markets using difference-in-differences models. Because this information shock conveys the significance of shrinking populations in certain areas, I can identify the causal effects of population decline.

[1]This study was supported by Joint Research Program No. 1228 at CSIS, UTokyo (Real Estate Database by At Home Co., Ltd.).

The results show that the designation of future "extinction" has the following effects: an increase in regional revitalization and child-oriented spending and a decrease in home prices. The study's insights provide new evidence of the impact of population decline on local governments and housing markets.

2.1 Introduction

Many developed and emerging countries face the prospect of shrinking populations and population aging because of rising life expectancy and declining fertility. This demographic trend has become an economic and social problem affecting economic growth, inter- and intra-generational inequality, and fiscal sustainability, although severity varies by country (Gramlich (1969); Rouzet et al. (2019)). Figure 2.1 shows population projections for G20 member countries (based on 2020 levels) in the United Nations Population Projections (the United Nations (2022)). As the figure shows, the population of the G20 member countries will begin a downward trend in the late 2040s, and by about 2070 the total population will become smaller than the 2020 population. The figure also clearly shows that Japan faces the steepest decline in population: Japan's population is predicted to be 17.0% and 30.9% below its 2020 level in 2050 and 2080, respectively.[2]

A decline in a given locality's population leads to a reduction in social services and infrastructure due to a smaller labor force, directly affecting the continuity of that community. The declining confidence in sustainability may lead to an outflow of working-age people, especially those with higher levels of education and families with children, to large cities, further reducing the attractiveness of smaller areas. Regional

[2] Appendix Table 2.B.1 shows that the rate of population growth relative to 2020 is also negative in other G20 member countries, such as Italy, Germany, France, South Korea, China, and Russia.

decline is highly persistent and affects the level of education and incomes in adulthood among children in the area (Glaeser and Gyourko (2005); Chetty and Hendren (2018a); Chetty and Hendren (2018b)). Policymakers have concerns about inequality in income, health, and education due to declining sales at local businesses and the deterioration of the living environment.[3]

In Japan, a large share of total spending by central and local governments is allocated to social security for the elderly; conversely, it has a very small share of family-related expenditures, including maternity and childcare support. Although municipalities are responsible for supporting childcare, municipal expenditures for regional revitalization and child-related policies are limited. The share of people over 65 is about 30% in Japan; in some areas, they constitute more than half the population. This may reflect that older people, who are more likely to vote, are apt to support generous pension and health care policies (Rouzet et al. (2019)).

Despite many stakeholders, including policymakers, being concerned about the effects of population decline, it is difficult to identify its impacts clearly because populations shrink steadily over time for reasons that are endogenous to local activities. The present study exploits a unique exogenous event that took place in Japan in 2014 to estimate the impact of population decline on a region's future using the local government policies and housing markets. In May 2014, the Japan Policy Council (JPC) published a list that identified 896 municipalities (cities, towns, villages, and wards), that will be extinct in the future; this amounted to half of all Japanese municipalities The JPC definition of "extinction" was based on a mechanically calculated index that used municipal population projections for 2040. Although the JPC is a private organization,

[3] Combes et al. (2012) argue that high productivity in large cities is due to agglomeration effects, in which larger cities promote exchanges that increase productivity, rather than firm selection.

its chair is a former minister of internal affairs and communications whose mandate included local government. Since many JPC members are high-ranking officials from government, industry, and academia, it is considered quasi-public. The list was received with great shock by citizens and policymakers. Figure 2.2 presents the Google Trend search counts for the term "extinct municipalities" (*Shometsu Toshi*, in Japanese). Those counts increased sharply in May 2014, peaked in December 2014, and have continued to interest people to this day. In response to the publication of this list, Japan's central government promulgated the "Long-Term Vision for Overcoming Population Decline and Vitalizing Local Economy" in December 2014, with the participation of the chair of the JPC. This vison proposes that local policies should be focused on increasing support for childcare and revitalizing local economies.

In the present study, I implement difference-in-differences (DID) models mainly by using detailed panel data on about 1,700 municipalities in Japan over a 13-year period. This "extinction" information effectively serves as an unanticipated exogenous shock that conveys the significance of population shrinkage in some areas.[5] Hence, I can use this information shock as an empirical identification of the causal effect of population decline on local government policies. As a result, I estimate statistically significant positive effects of increasing regional revitalization spending and child-oriented spending by about 23.5% and 11.5%, respectively, in the municipalities designated as at risk of extinction. By contrast, the impact of elderly-oriented expenditures is not statistically significant. These results imply that population declines have the causal effect of changing a municipality's policies toward supporting local industry and childcare.

[5]I also run DID estimates with donations to municipalities as the outcome; Appendix Figure 2.A.6 shows that the information shock significantly increased donations, which provides evidence that the shock was actually meaningful.

In order to examine the broader impact of these policy changes on local economies, I also estimate the effect on housing rents and prices by using a large real estate dataset of more than 36 million observations, which was provided to me from a real estate information firm (At Home). Although housing price is one indicator of economic conditions, the effect of population declines on the housing market is ambiguous. While policy changes may motivate people to move to smaller areas, there will be a negative demand shock for housing, because property prices would be expected to drop in municipalities that are predicted to disappear. In my estimations, I obtain a clear negative effect for housing prices of 3.67%, while there is no statistically significant effect on rental prices. This implies that negative demand shocks are more evident in housing purchases.

The main contributions of my research are as follows. First, the present study estimates the causal effects of population decline by exploiting an exogenous and unanticipated shock as a natural experiment. Although many people, including policymakers in international organizations and governments, are concerned about the problems of population decline, rigorously estimating its causal effects is difficult because it is not a clear shock but rather a steady, gradual process that varies by region, and economic responses are determined endogenously by local demographics. I use a clear and unique event—the publication of a list of municipalities at risk of extinction in Japan—whose population is shrinking at the fastest rate globally, and provide new evidence of the effects of population decline on local governments and housing markets.

Second, this paper contributes to the research stream on local government policies. A number of papers have examined the effects of place-based policies. In order to revitalize local economic activity, such policies have been implemented in many ways,

mainly targeting low-performing regions. For example, the enterprise zone policies implemented in the United States and Europe provide reduced taxes or block grants to municipalities facing economic problems such as unemployment or poverty (e.g., Papke (1993); Ham et al. (2011); Neumark and Young (2019)). In the United States, the federal empowerment zone program provides communities with tax credits and block grants to incentivize firms to locate in distressed regions (Hanson (2009); Reynolds and Rohlin (2015)). Place-based policies may be justified by agglomeration externalities, network effects, or spatial mismatches. However, evidence on the effects of place-based policies is not clear (Neumark and Simpson (2015)). The event exploited in this paper is notable because it was simply the provision of information about population decline rather than fiscal stimulus. In general, local governments are more informed about preferences and costs than central governments (Oates (1999); Rogger and Somani (2023)). However, local governments might have insufficient information about their demographic futures. The present study adds new evidence that can inform local government policies.

Third, the present study deals with housing prices and rents. It has been reported that housing prices are affected by economic and social factors, such as an area's school quality and test scores (Black (1999); Bayer et al. (2007)), public policies (Cellini et al. (2010)), the minimum wage (Yamagishi (2021)), and neighbors' criminal records (Linden and Rockoff (2008)). I estimate rigorous causal effects on housing prices using a unique intervention (forward-looking information about municipalities) by using a large micro-level dataset. Because it includes both housing sales and rentals, I can identify precise effects on both the rental and purchase markets.

Finally, I present a new aspect to the effect of information provision, which is implemented experimentally, mainly for the purpose of testing economic theory by influencing

beliefs, preferences, and (perceived) constraints. A Swedish experiment finds that information provision about the relative position of individuals' incomes changes their political views, including those about redistribution, and which parties they support (Karadja et al. (2017)). In addition, it has been reported that information provision has important effects on individual behavior, including labor supply (Chetty and Saez (2013)), educational choice (Jensen (2010)), and perceptions of migration (Grigorieff et al. (2020)). To the best of my knowledge, the present study is the first to examine the causal effects of information provision by policy experts about the future extinction of municipalities.[7]

The remainder of the paper is organized as follows. The next section presents the institutional background. Section 3 explains the identification method, section 4 presents the data and descriptive statistics, section 5 shows the empirical results for municipal spending, and section 6 for housing markets. Section 7 summarizes the main points and offers conclusions.

2.2 Institutional Background

2.2.1 Municipal System in Japan

Local government in Japan currently consists of 47 prefectures and about 1,700 municipalities (cities, towns, villages, and wards). In Japan, more than 30% of total government spending by central and local governments is allocated to social security. Appendix

[7] In addition, the results of donations to municipalities contribute to a number of studies on altruism. Previous studies show that natural disasters and wars increase individuals' altruistic behavior (Deryugina and Marx (2021); Scharf et al. (2022)). I estimate a clear increase in donations to municipalities at risk of extinction. This suggests that the risk of disappearance motivated people to be as altruistic as they were in the case of natural disasters, providing new evidence for research on altruism.

Figure 2.A.1 shows that Japan's social security spending is largely directed toward the elderly and that the share of family-related spending, such as support for maternity and childcare, is quite small. Appendix Figure 2.A.2 indicates that local governments in Japan account for a large share of total government spending (46.6% in FY 2014), and family-related spending is a fiscal area for which local governments are responsible. However, expenditures on regional revitalization and child policies accounted for only 5.6% and 7.9% of total expenditures, respectively, in FY 2014.

Expenditures by municipalities in Japan can be divided into broad categories: unsubsidized services and subsidized services. In FY 2014, expenditures on unsubsidized and subsidized services accounted for 67.5% and 32.5% of total expenditures, respectively. Unsubsidized services are public services implemented and paid for with revenues that municipalities can freely decide how to spend, rather than targeted grants from the central government. Therefore, the content of unsubsidized services varies by municipality. The prospect of extinction, as indicated by being on the JPC list will affect unsubsidized services and reflect policy decisions by individual municipalities. In contrast, subsidized services are projects financed by conditional grants that municipalities receive from the central government. Since the purpose of these is to ensure national minimums, the usage is already determined by the central government, and municipalities have no discretion. Hence, the main estimations in the present study are about unsubsidized services, with subsidized services used to check for placebo effects.

I consider the unsubsidized spending on the regional revitalization and child-oriented as the main outcomes, as discussed later. The unconditional spending for regional revitalization is the expenditures to revitalize commerce and industry in the region. The unsubsidized spending varies among municipalities, but the unsubsidized regional

revitalization spending includes expenditures such as support for local businesses (subsidies, loans, management guidance), attracting outside firms, arranging tourism events, promoting local energy investment, consumption and distribution measures, and so on. In addition, child-oriented spending is the expenditures for child welfare, such as expansion of child allowance, subsidization of child-care centers, reduction in fees of child-care centers, operation of child counseling centers and temporary shelters.

2.2.2 Publishing the List of Endangered Municipalities

The May 2014 JPC list of municipalities at risk predicted to be extinct by 2040 ("endangered municipalities") defines "extinction" as having a predicted number of females aged 20–39 in 2040 less than half the number in 2010. These assessments are based on population projections made by the National Institute of Population and Social Security Research of Japan (IPSS) in March 2013, with JPC making minor adjustments to the population change rates. This list includes all municipalities except Fukushima Prefecture, which suffered a nuclear disaster in March 2011. 896 municipalities, about half of the total number in Japan, were designated as endangered. Appendix Figure 2.A.3 shows the geographic distribution of those municipalities.[9]

JPC is not a governmental entity, but it is recognized as a quasi-public organization, since it is chaired by a former Minister of Internal Affairs and Communications, who was in charge of overseeing local government and policy initiatives directed at the municipal level. In addition, JPC includes a current cabinet counselor, a former vice minister of finance, a company CEO, and university professors among its membership. The publication of this list attracted widespread public attention, and policymakers in

[9] I describe the details of the designation of future "extinction" in Appendix C.

central and local governments undertook efforts to gain the public's understanding about this problem (OECD (2016)). In July 2014, the Prefectural Governors' Association, with the chair of JPC, declared that Japan's low birthrate constituted a state of emergency. Then, in December 2014, the central government promulgated the "Long-Term Vision for Overcoming Population Decline and Vitalizing Local Economy," which was crafted with the participation of the JPC chair at a meeting chaired by Prime Minister Shinzo Abe. The main purpose of this vision was to show the Japanese people the current and future pictures of population and raise awareness about related issues, citing the JPC designation for emphasis.[10] This emphasized the importance of promoting support for "local economic vitality" and "childcare" as strategies for the future. Hence, I focus on the unconditional regional revitalization spending and child-oriented spending as the main outcomes.

Accompanying the vision, a new grant category ("Regional Revitalization Promotion Grants") was created. However, it is unlikely to affect my estimates for the following reasons: (1) the amount of such grants is small and account for only about 0.15% of local government spending; (2) such grants are provided regardless of the endangered designation; and (3) my main estimation is for unsubsidized services. In addition, the requirements for other government grants do not include the JPC's designation. Hence, we can interpret this list publication as a simple information provision, not a fiscal stimulus.

[10] However, this vision does not cite the list itself, which includes the names of specific municipalities, as the central government sought to avoid disadvantaging specific localities.

2.3 Identification Strategy

2.3.1 Difference-in-Differences Estimations with the Two-Way Fixed Effects Model

I estimate the effect of being designated an endangered municipality in 2014. More specifically, I use a difference-in-differences (DID) model or two-way fixed effects (TWFE) model to estimate the following equation:

$$y_{it} = \alpha + \beta \cdot Treatment_i \times Post_t + X_{it}\gamma + \lambda_i + T_t + \epsilon_{it}, \tag{2.1}$$

where y_{it} is the outcome for municipality i in year t. $Treatment_i$ is a dummy variable that equals one if municipality i is in the treatment group (i.e., an endangered municipality) and zero otherwise, $Post_t$ is a dummy variable that equals one after 2014 and zero otherwise, X_{it} denotes the vector of control variables of municipality i in year t, λ_i is a municipality fixed effect, and T_t is a year fixed effect. Finally, ϵ_{it} is the error term clustered at the municipal level. The coefficient of interest is β, which I interpret as the causal effect of the endangered designation on the outcome.

As to outcomes, I focus first on a municipality's unsubsidized expenditures and also estimate any placebo effect of subsidized expenditures. If the endangered municipality designation induces a change in municipal policymaking, then it should only have an effect on unsubsidized expenditures. For these estimates, I use demographic variables (share age 14 and under, share age 65 and over, share of females, and population density) and industry shares (primary and tertiary industry shares) as controls. I also control for a municipality's fiscal structure (debt level, share of categorical grants). If municipal policy changes actually have an effect, then statistically significant effects

should be observed in the variables of interest. In addition, I estimate the causal effect of the endangered municipality designation on housing prices; they are expected to rise as economic activity increases, but the prediction of future extinction may create a negative demand shock on asset prices. Hence, the sign of the effect on housing prices is ambiguous. I estimate the following equation to measure causal effects:

$$ln(price)_{ijt} = \alpha + \beta \cdot Treatment_j \times Post_t + X_{ijt}\gamma + \lambda_j + T_t + \epsilon_{ijt}, \tag{2.2}$$

where $ln(price)_{ijt}$ is the price of housing i observed in municipality j in quarter t. $Treatment_j$ is a dummy variable that equals one if municipality i is in the treatment group (i.e., designated as endangered), $Post_t$ is a dummy variable that equals one after 2014, X_{ijt} is the vector of control variables of housing i, and T_t denotes the quarter fixed effect. Since treatment is decided at the municipality level, I use municipality fixed effects (λ_j), with the error term (ϵ_{ijt}) clustered at the municipality level. The coefficient of interest is β, which represents the causal effect of the treatment.

As control variables, I use a home's age, its square footage, the floor that a housing is on (if applicable, made the value above the 10th floor fixed), dummies for housing type (e.g., house or apartment) and the material used in housing i (e.g., steel, wood, or reinforced concrete). I also include the population density of municipality j. There are housing markets for both rentals and purchases, and purchased housing may react differently from rentals because of its role as an individual or familial asset. I therefore estimate equation (2.2) for both rental and purchase markets, respectively, and compare the results.

For robustness checks of both estimates, I restrict the samples and conduct several DID estimations. The JPC list contains round values of scores calculated to check

whether a municipality is likely to become extinct. I use this score to run several DID regressions of the effects on local governments and housing markets, comparing municipalities that are barely over the extinction threshold to municipalities that are barely short of that line. Additionally, I estimate the effects excluding municipalities in Iwate and Miyagi Prefectures, because the March 2011 earthquake not only caused a nuclear disaster in Fukushima Prefecture but also led to massive tsunami damage in those areas. In 2011, the central government decided to allocate funds for reconstruction to these three prefectures. Municipalities in Fukushima Prefecture are excluded from the endangered designation, but Iwate and Miyagi Prefectures are included; there is a concern that estimates might be affected as a result. As described later, the designation by JPC was done at the district level, which is smaller than the municipality, for the 12 largest cities in Japan, so I exclude those municipalities from my dataset. In contrast, JPC designated the Wards of Tokyo, which were established by dividing the former Tokyo City in 1943, as ward units, and these are included in my dataset. In the robustness check, I also exclude Tokyo Wards.

2.3.2 Identifying Assumptions

The primary assumption required in the identification of DID model is the common trend. Therefore, to analyze municipal spending and economic variables, I estimate an event study design with the following equation to check whether this assumption holds:

$$y_{it} = \alpha + \sum_{t \neq 2013} \beta_t \cdot Treatment_{it} + X_{it}\gamma + \lambda_i + T_t + \epsilon_{it}, \tag{2.3}$$

where $Treatment_{it}$ is a dummy variable that equals one when municipality i belongs to the treatment group (i.e., endangered) and zero otherwise. The definitions of the

other variables are the same as in equation (2.1). The coefficient of interest is β_t, which captures differential movement. If β_t prior to 2014 is not statistically different from zero, I interpret the common trend assumption to be plausible.

For the housing market analysis, I estimate the following equation as an event study design:

$$ln(price)_{ijt} = \alpha + \sum_{t \neq 2014Q1} \beta_t \cdot Treatment_{jt} + X_{ijt}\gamma + \lambda_j + T_t + \epsilon_{ijt}, \tag{2.4}$$

where $Treatment_{jt}$ is a dummy variable that equals one when municipality j is in the treatment group. The definitions of the other variables are the same as in equation (2.2), and the coefficient of interest is β_t.

The second assumption required for a DID approach is a lack of anticipation. The search counts for the term "extinct municipalities" (*Shometsu Toshi*, in Japanese) shown in Figure 2.1 are indirect but strong evidence. They clearly indicate that the endangered municipality designation was not anticipated prior to the JPC publishing the list in May 2014.[14] In addition, Appendix Figure 2.A.4 reports the search counts for the term "Japan Policy Council" (*Nihon Sosei Kaigi*, in Japanese). Although the JPC was founded in October 2011, the figure indicates that it received little attention until May 2014 and thus supports the assumption of no anticipation. Importantly, the projections used for the list were computed by a non-governmental organization. Since the members of JPC do not include prefectural governors or municipal mayors, there is no concern that they affected the timing or content of the endangered designation.

Moreover, Figure 2.1 and Appendix Figure 2.A.4 illustrate that this information shock is meaningful, as the publication of the list was reported to have attracted widespread

[14] Although the IPSS published its future population projections for each municipality, which are the basis for the JPC calculations, in March 2013, there was no significant increase in searches in 2013.

public attention in Japan (OECD (2016)). Additionally, Panel A of Appendix Figure 2.A.5 illustrates the trends in the search counts for "population decline" (*Jinko Gensho*, in Japanese). Despite the fact that "population decline" is a much more common word than "extinct municipalities" and "Japan Policy Council", it jumped sharply in May 2014, when the list was published, and has remained high. Unfortunately, Google trend only reports an index of 100 for the most searched count during the period, not the actual search count itself. However, we can compare it to another searched words during the same period; Panel B of Appendix Figure 2.A.5 compares "extinct municipalities" with "population decline". The search count for "extinct municipalities" exceeded the "population decline" in May 2014. Remarkably, this panel shows that the search counts for "extinct municipalities" are much larger than "population decline", which is powerful evidence that the list publication caught public attention. Appendix Figure 2.A.6 shows the event study estimates for the donations to municipalities and illustrates that large donations to municipalities emerged found after the 2014 designation of endangered municipalities. This demonstrates that the publication of the list meaningfully caused people to develop an altruism toward those municipalities.[15]

These indicate that the event provided new and meaningful information for people. Nevertheless, as I discuss in Appendix E, there may be a concern that the municipal policymakers already expect the potential risk of extinction from the IPSS projection because the indicator used to determine extinction is an adjusted version of an indicator already published by the IPSS. Therefore, it is important to check whether the procedures

[15]If a given donations is accompanied by an award, it may not be due to pure altruism. In Japan, there is an honorarium system in which the emperor awards medals to those who donate more than 5 million JPY to public organizations, including local governments. Since the number of recipients of this medal has been stable (554 in 2013, 536 in 2014, and 495 in 2015), these awards do not affect the estimates on donations.

are new and nontrivial information not only for people but also for policymakers. First of all, the concern about newness is not serious because this indicator was uniquely defined by the JPC and not included in the publication by the IPSS. Second, anecdotal stories exist that show that the list publication was surprising and shocking to municipal leaders.[16] Furthermore, Appendix Figure 2.A.7 illustrates the relevant word counts in prefectural councils of "extinct municipalities" (*Shometsu Toshi* or *Shometsu Jichitai*, in Japanese), "Japan Policy Council" (*Nihon Sosei Kaigi*, in Japanese), and "Population decline" (*Jinko Gensho*, in Japanese) by using the database provided by a Japanese research project (Japanese Local Assembly Minutes Corpus Project).[17] The figure presents the sharp increase in 2014. Although this data is not for municipal councils, it is indirect evidence that shows the significance of this information shock for municipal policymakers. For an empirical check, I run DID regressions with two divided treatment municipalities, respectively. As detailed in Appendix E, I conduct DID regressions with the treatment group divided into the following two municipalities; (1) 373 municipalities whose indicator calculated using only the IPSS projection satisfies the definition of "extinction", and (2) 523 municipalities whose indicator satisfies the definition only after adjustment by the JPC. Appendix Table 2.E.1 reports these DID estimates and shows that all of them are identical to the main estimates. Therefore, since these imply that this information shock is not only a shock but also an economically meaningful one in the area of shrinking population, I can interpret the DID results as the causal effects of shrinking populations on responses by local governments and housing markets.

[16]The media in Japan interviewed leaders of the municipalities designated by the JPC, and they openly stated that they were shocked by this information. (Sankei Shimbun (2015); Chuo-Koron (2021); NHK (2024)

[17]Since the Japanese expression Jichitai is also commonly used in prefectural government, *Shometsu Jichitai* is included here in addition to *Shometsu Toshi*. The word counts for *Shometsu Toshi* alone is 0 in 2011, 4 in 2012, 5 in 2013, and 352 in 2014, respectively.

In addition, the potential threat of validity is that the designation by the JPC could cause households to migrate (Moffitt (1992); Deza et al. (2023)). Therefore, I implement a migration test, estimating net migration across municipalities as an outcome. Appendix Figure 2.A.8 reports the event study estimates in equation (2.3) for net migration. The placebo estimates to the left of zero (2014) are not statistically different from zero, and a common trend appears to hold. The coefficients after 2014 are less clear than for municipal spending. Appendix Table 2.B.2 presents the DID estimates. The table presents statistically insignificant results for both all municipalities (Column 1) and those excluding Iwate and Miyagi prefectures that suffered from the 2011 earthquake (Column 2), suggesting that the treatment does not induce real migration. At the same time, these results are consistent with my expectation; notably, the fact that population inflows are not negative provides strong evidence that my main estimates—per capita spending increases—are credible results, not false results caused by decreases in the number of local residents.

Finally, the recent literatures on DID point out that naive TWFE models have serious biases when the treatment take place over multiple time periods (e.g., de Chaisemartin and D'Haultfœuille (2020); Callaway and Sant'Anna (2021); Goodman-Bacon (2021)). However, I have no such concerns because the event I exploit in this paper was a single event in 2014, and the designation has not changed since.

2.4 Data

For the analyses of municipal spending and economic variables, I construct large-scale municipality-level panel data for the 2009–2021 period from several data sources.

First, I obtained data on municipal finances from the Survey of Local Government Finance produced by Japan's Ministry of Internal Affairs and Communications (MIC). This survey includes detailed information on annual expenditures for both subsidized and unsubsidized public services in all municipalities. I add the population density and shares of population by age and gender from the MIC's Counts of Population derived from Basic Resident Registration and the Statistical Report on the Land Area by Municipalities in 2014, which was published by the Geospatial Information Authority of Japan. For industry share, I use the MIC's Census of Population; since the census is undertaken every five years, I conduct linear completion to obtain variables for the missing years. For population inflow, I obtained data from MIC's Internal Migration in Japan Derived from Basic Resident Registration. [19] For Japan's 12 largest cities, because the endangered designation was only assigned to smaller units (districts) than municipalities, I exclude them from my analysis.[20] The number of municipalities decreased from 1,800 in April 2009 to 1,741 in 2021. Hence, I use the converter provided by Kondo (2023) to combine data involving merged municipalities.

For the housing market analysis, I use a large micro-level dataset of real estate information provided by At Home, a leading Japanese housing information firm. I received this dataset from the Center for Spatial Information Science of the University of Tokyo; it contains all information about housing registered in the information network operated by At Home, including monthly rent or sales price, square footage, the floor that an apartment is on (if applicable), the material of which the housing is made, and

[19] Net population inflow includes only the internal movements of Japanese people, not foreign immigrants. However, the share of foreign residents in Japan was 1.5% in 2015, so its impact on the analysis is not substantial.

[20] Sapporo city, Sendai city, Chiba city, Yokohama city, Kawasaki city, Nagoya city, Kyoto city, Osaka city, Kobe city, Hiroshima city, Kita-Kyushu city, and Fukuoka city.

building age. Since the observations are posted prices, housing prices and rents may not necessarily match actual contract prices. However, since price negotiation is not very common in Japan, the posted price plays an important role in determining the contract price and is thus a close proxy to the contract price (Tabuchi (2019); Kuroda (2022); Yamagishi (2021)). This data includes housing registered between January 2013 and December 2016. I conduct the analysis in quarterly units to ensure a sufficient pre-trend period.

Table 2.1 reports the summary statistics for the outcomes and covariates used in the empirical analysis. Panel A shows that the dataset of municipalities contains a total of 21,710 observations from 2009 to 2021; there are 884 municipalities in the treatment group of endangered municipalities and 786 in the control group. Panel B represents the datasets for housing market, which contain contains 2,733,019 observations for sales and 33,269,825 observations for rentals. To adjust for municipality size, I divide the outcomes by the number of residents and express these per capita values. All variables in JPY are deflated by the consumer price index as calculated by the MIC, with 2020 as a base.

2.5 Empirical Results on Local Governments

2.5.1 Impacts on Unsubsidized Municipal Expenditures

2.5.1.1 Regional Revitalization Expenditures

I first conduct the event study estimates of equation (2.3). The outcomes are expenditures freely determined by a municipality without subsidies from the central governments and

indicate whether the treatment had an impact on municipal policy decisions. Figure 2.3 shows the results of the regional revitalization expenditures of greatest interest. It plots the estimates of β_t and their 95% confidence intervals for each year before and after the treatment year of 2014. The coefficients to the left of zero are placebo estimates. Since they are not statistically significantly different from zero, the common trend assumption is supported. This figure visually demonstrates that municipalities significantly increased their regional revitalization spending after the 2014 designation. Column 1 of Table 2.2 shows the DID results of estimated regional revitalization spending as determined by equation (2.1). As in the event studies shown in Figure 2.3, the estimate of the regional revitalization spending is positive and statistically significant at the 1% level. Since the mean of the dependent variables is 23.22 thousand JPY, the impact of the treatment on municipal spending is about 23.5%. This result means that the specter of the effects of population decline encouraged municipalities to modify their policies.

2.5.1.2 Child-Oriented Expenditures

Figure 2.4 reports the estimates on child-oriented spending per child age 19 or below and illustrates the presence of the common trend before the treatment and the statistically significant positive effect after the designation.[23] Column 2 of Table 2.2 shows the DID estimates based on equation (2.1). Consistent with the event study result, the estimate of child-oriented spending is positive and statistically significant at the 1% level. The mean of the dependent variables is 148.53 thousand JPY, so the impact

[23] Under Japanese law, a legal child (or minor) was defined as "under 20 years old" until March 2022. In April 2022, the definition was changed to "under 18 years old." I also run DID regression by using the child-oriented spending per children age 14 or below, and the results are consistent.

of the designation on municipal spending is about 11.5%. These results show that municipalities designated as at risk of extinction increase spending on child care in addition to regional revitalization efforts.

2.5.1.3 Other Expenditures and Revenues

Unlike community local revitalization and child-oriented spending, elderly-oriented spending may not be affected by the JPC list's information shock, at least in the short term. Therefore, as a first placebo test, I estimate the DID regression on elderly-oriented expenditures. Appendix Figure 2.A.9 reports the event study estimates and illustrates that there is no evidence that municipalities in the treatment group increased their elderly-oriented spending. Appendix Table 2.B.3 shows that expenditures for the elderly were not statistically significant, as expected.

In addition, I run DID regressions for other spending categories to check the broader effects of this shock. Specifically, I estimate impacts on education, health, and environmental unsubsidized spending. Since compulsory education at the primary and secondary levels belongs to subsidized spending, education unsubsidized spending includes additional support such as expanded educational content, school lunches, and scholarship. For health, medical assistance for the elderly is already covered by social insurance, and unsubsidized spending includes reduced co-payments for children's medical expenses.[24] Environmental expenses include waste cleanup and collection of recyclable waste. These expenditures will support long-term sustainability for the regional society or community. Appendix Figure 2.A.10 shows the event study results, and there seems to exist a pre-treatment time trend in education and environment, but

[24] Iizuka and Shigeoka (2022) indicate that most municipalities have reduced the coinsurance rate to zero (i.e., free care) from the national 30 percent set by the central government.

the effects are generally positive. Appendix Table 2.B.4 presents the DID estimates respectively, and they are all positive and statistically significant at the 1% level.[25]

The above estimates imply that the treatment by the list publication has the effect of increases unsubsidized municipal spending, mainly for community revitalization and child-oriented. Since designation by JPC is just an information shock, as discussed in the institutional background, it is informative to estimate the effect on municipal revenues. Appendix Table 2.B.5 reports the results of equation (2.1) with major municipal revenues as outcomes. Column 5 of this table shows that the DID estimate on the intergovernmental grants is not statistically significant, which is consistent with that noted in the institutional background. Notably, the effects on revenue through municipal bond issuance (Column 2) and donations (Column 3), not from local taxes or rents, are statistically significant and positive. The magnitudes of these estimates are almost identical, clearly indicating that the list publication stimulated public altruism, considering the fact that the magnitude of the donations is very small in the pre-treatment average.

2.5.2 Placebo Estimates

Next, in order to obtain another placebo estimate, I run regressions with equation (2.1) and (2.3) for subsidized services. As noted in the institutional background section, because the spending on services subsidized by the national levels of government do not reflect the intentions of the municipality, no effects of the treatment should be

[25] What caused these policy changes may be an important question. To check the impact of the treatment on this political outcome, I additionally estimate the effect on the probability of reelection for mayoral elections from 2010 to 2019. Mayors in Japanese municipalities serve four-year terms. I conduct the estimation with the outcomes in equations (2.1) and (2.3) as a dummy variable on a mayor's reelection. Appendix Figure 2.A.15 and Appendix Table 2.B.10 report the event study and DID estimates. Since those estimates are not statistically significant, the change of mayors by election is not the main driver of these policy changes.

observed. Appendix Figure 2.A.11 shows the results of the event study design for subsidized services spending. Although a common trend appears to hold in all cases, there may not be a statistically significant effect after the publication of the JPC list. Appendix Table 2.B.6 reports the DID estimates for each outcome, with none of the coefficients statistically different from zero. This implies that treatment did not affect central government grants for municipalities and that the effect on unsubsidized services was due to the information shock. I also estimate subsidized spending in education, health, and environment. For these outcomes, any effects should not be observed as well. Both the event study results reported by Appendix Figure 2.A.12 and the DID estimates presented by Appendix Table 2.B.7 support that list publication has no significant effect.

2.5.3 Robustness Checks

2.5.3.1 DID Estimates with Restricted Samples

In order to check robustness, I first conduct DID estimations with a restricted sample. Since the JPC list also reports round values of the scores calculated to determine whether municipalities are likely to become extinct, I can use those scores to identify both municipalities that are barely over the extinction threshold and those that are barely under that line. I focus on three cases: those with scores between 0.2 and 0.8, between 0.3 and 0.7, and between 0.4 and 0.6. Appendix Figure 2.C.1 and Panel A of Appendix Table 2.D.1 show the event studies and DID results of regional revitalization expenditures. The figure illustrates that the common trend assumption appears to hold when restricting samples in this way; the table reports the estimated effects on regional revitalization spending, with all estimates positive and significant at the 1% level.

Appendix Figure 2.C.2 and Panel B of Appendix Table 2.D.1 report the event studies and DID results of child-oriented expenditures. These results are also statistically significant and consistent with the main result. In addition, Panel C of the table shows that the DID estimates on elderly-oriented spending is also consistent. Also, each panel of Appendix Table 2.D.2 presents the results for unsubsidized education, health, and environment spending, and Appendix Table 2.D.3 for the subsidized spending (placebo estimates). Although statistical significance is reduced for unsubsidized spending on education and the environment, the results are generally identical to the main results, providing evidence of robustness.

2.5.3.2 Excluding Iwate and Miyagi Prefectures and Tokyo wards

As a second check, I estimate the effects excluding municipalities in Iwate and Miyagi Prefectures. As noted above, there are concerns that donations in those areas may have been affected by the March 2011 earthquake and tsunami. In addition, I also exclude wards in Tokyo. The wards in Tokyo are municipalities established in 1943 by dividing Tokyo city, which represents one of Japan's major metropolises. As noted in section 4, because my sample already excludes 12 largest cities, I can eliminate all of Japan's major metropolises from the sample. Appendix Figure 2.C.3 and Appendix Table 2.D.4 report the event study and DID estimates for my main outcomes. This figure shows that my estimates are robust to the effects of the 2011 earthquake or characteristics specific to the largest cities. The table shows that all of these are statistically significant at 1% level, indicating these are consistent with the main estimates. In addition, Appendix Figure 2.C.4 and Appendix Table 2.D.5 present the results for education, health, and environment spending. All results are consistent with the main estimates, indicating

that the estimates are robust.

2.5.3.3 Synthetic Difference-in-Differences Estimations

As an additional robustness check, I implement the synthetic difference-in-differences (SDID) method, proposed by Arkhangelsky et al. (2021). Looking at the event study figures for some outcomes, such as child-oriented and education spending, it appears that a time trend exists. SDID incorporates the strengths of both DID and the Synthetic Control methods to construct synthetic counterfactuals by weighting both pre-treatment time periods and cross-sectional units. Consequently, the parallel trend assumption can be weakened so that the causal effects can be identified with large panel data sets.

Appendix Figure 2.C.5 presents the event study results on municipal unsubsidized spending for regional revitalization, child-oriented, and elderly-oriented.[28] In Panel B, we find no pre-treatment time trend, including for child orientation, indicating the robustness of the estimates. Appendix Table 2.D.6 reports SDID estimates for these outcomes, using 50 iterations based on the bootstrap procedure. Column 1 presents SDID estimates without covariates, while Columns 2 and 3 report estimates that include covariates. In controlling for covariates, Column 2 employs the optimized method, and Column 3 the method of Kranz (2022). SDID estimates for all methods are consistent with the main estimates in statistical significance, sign, and magnitude. Additionally, I run SDID regressions of unsubsidized spending on the other categories (education, health, and environment). Appendix Figure 2.C.6 presents the event study and Appendix Table 2.D.7 the SDID estimation results, respectively. The pretreatment time trends in spending for education and environment, which are a concern in the main estimates, are

[28] In all SDID regressions, I use the "sdid" software package developed and provided by Clarke et al. (2023).

not observed. All are consistent with the main estimates, reinforcing the robustness of the estimates.

Next, I perform SDID estimation of subsidized spending as a placebo estimation. Since these spending levels are controlled by the central governments, the results are expected to be statistically insignificant. Appendix Figure 2.C.7 shows subsidized spending for regional revitalization, child-oriented, and elderly-oriented, and there seems to be no clear effect even after the treatment. Appendix Table 2.D.8 provides the SDID regression results for subsidized spending, including other categories, which are not statistically significant regardless of the estimation method employed. This indicates that the placebo checks are successful.

2.6 Empirical Results on Housing Markets

2.6.1 Impacts on the Purchasing Prices

Next, I estimate the impact of the publication of the JPC list on local housing markets. A negative demand shock may exist because pessimistic information about the future suggests a future decline in asset prices. On the other hand, when municipal governments increase local spending for regional revitalization and children, housing prices may rise in part as a result. In addition, within each housing market, purchases and rentals may react differently to the information shock about population shrinkage. I focus primarily on sales prices because dwellings owned by individuals or families are more directly affected by negative demand shocks due to population decline. Figure 2.5 reports the event study estimates in equation (2.4) for home purchase prices. Since the placebo estimates prior to the second quarter of 2014 are not statistically different from zero,

the common trend appears to be supported, and a clear negative effect is estimated later than the treatment in the second quarter of 2014. Table 2.3 presents the DID results estimated by equation (2.2) and indicates statistically significant negative effects at the 1% level; the purchase prices of housing located in the treated municipalities decreased by 3.67%. These may be due to revisions in expectations of property values caused by information shocks related to future "extinction". Besides, municipalities finance their increased spending through greater municipal debt, so concerns about future rises in taxes may push down the expected returns on housing.

2.6.2 Placebo Estimates

I estimate the impact on housing rents as a placebo. Appendix Figure 2.A.13 shows the event study estimates for rents. In contrast to purchase prices, no negative effect is observed for rents, except in the second and third quarters of 2014. Appendix Table 2.B.8 presents the DID result; the effect is small and not statistically significant. These results imply that while the treatment may have had a negligible impact on current residents while no clear effect on rental prices is observed, it may raise concerns about future property values and lower their purchase prices. In addition, since my dataset includes rents for offices and stores, I can estimate the impact on commercial rents. Appendix Figure 2.A.14 and Appendix Table 2.B.9 indicate that there is no evidence that the effect of the treatment was significantly different from zero. This indirectly suggests that the endangered municipality designation did not negatively affect businesses.

2.6.3 Robustness Checks

2.6.3.1 DID Estimates with Restricted Samples

As a robustness check, I run DID regressions with a restricted sample. Since the JPC list also reports round values of the scores calculated to determine whether municipalities are likely to become extinct, I can use those scores to check the robustness of the estimation results by comparing municipalities barely over the extinction threshold to those that are just short of that line. I focus on three cases: those with scores between 0.2 and 0.8, between 0.3 and 0.7, and between 0.4 and 0.6. Appendix Figure 2.C.8 and Panel A of Appendix Table 2.D.9 report the event studies and DID results. The figure shows that the common trend assumption appears to be supported in each case. Columns 1 and 2 of the panel report the DID estimates when the samples are restricted to scores between 0.2 and 0.8 and between 0.3 and 0.7, respectively; the results are negative and statistically significant. Column 3 reports estimates for the most restricted sample, and they are negative but not statistically significant. Panel C of the figure shows that the estimates become significant over time, which is consistent with the main estimate, but this needs to be interpreted with caution. Panel B and C of the table presents the DID results for housing rents and business office rents. Since these are not statistically significant, these results imply that my estimation results are reasonable.

2.6.3.2 Excluding Iwate and Miyagi Prefectures and Tokyo wards

Appendix Figure 2.C.9 and Appendix Table 2.D.10 report event study and DID estimates for the housing market when Iwate and Miyagi prefectures, and Tokyo 23 wards are excluded. The robustness of the estimates needs to be checked because the earthquake

and subsequent reconstruction could have had a profound impact on the housing market. The figure and table show that the estimates are consistent with the main estimates, even after these prefectures are excluded.

2.7 Conclusion

Population decline is a potential challenge for many developed and emerging countries, and it is important to address concerns of inequality across generations and regions. I use a unique event—the publication of a list of municipalities at risk of extinction by 2040 in Japan—to estimate its causal impacts on local governments and housing markets. I estimate these effects by using a DID model or TWFE model, based on large micro-level datasets of municipalities and housing prices.

The first contribution of this paper is presenting new evidence on the effects of population shrinkage. In spite of widespread concern about declining populations, rigorously estimating its effects is difficult because any population changes gradually; it is not a clear shock, and the demographics of a given area are endogenous to local activities. The event I exploited in this paper is unique because it is a meaningful exogenous shock related to population decline. I found that municipalities identified as endangered increased their spending on regional revitalization and childcare, which implies that the information shock about population decline in municipalities actually changed their behavior.

In addition, the present study illustrates that information on the future of municipalities influences current housing prices. If local economies are actually revitalized by municipal policy changes, housing prices should rise correspondingly. However, infor-

mation indicating a risk of extinction by 2040 may reduce the expectations of future asset prices. Hence, the impact on the housing market is not clear. Therefore, I use a large micro-level dataset to estimate the causal effects of information provision on housing purchase prices and rents, respectively. The effect was negative and statistically significant for purchase prices and not significantly different from zero for rents. This implies that for individuals and families holding residential assets, information about future extinction generates a large negative demand shock.

As with all research, the present study has certain limitations. The results might differ depending on a country's situations, including the scale and pace of its population decline, its openness to immigration, and its regional and local government system.

2.8 Figures and Tables of Chapter 2

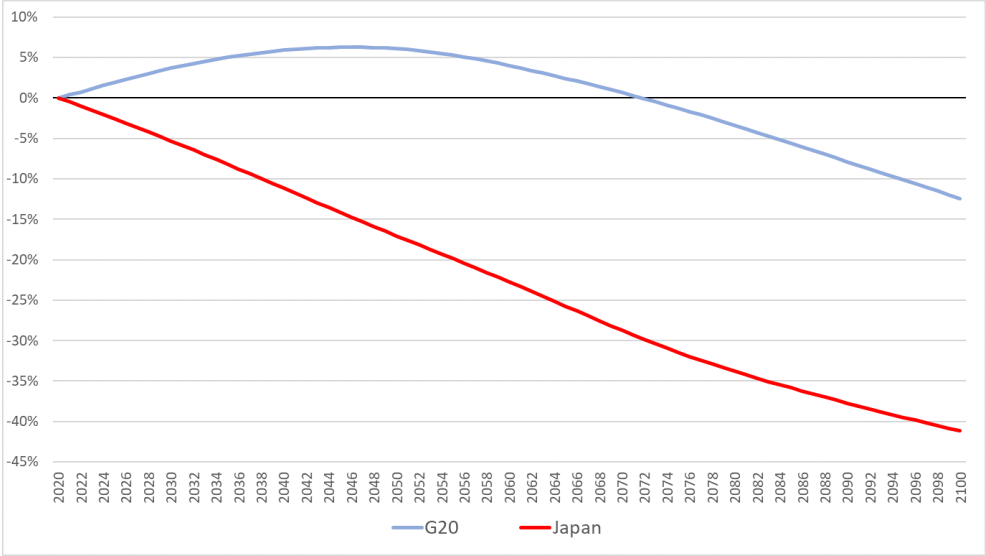


Figure 2.1: Future Population Projections for G20 Member Countries (Baseline: 2020)

Notes: the United Nations (2022)

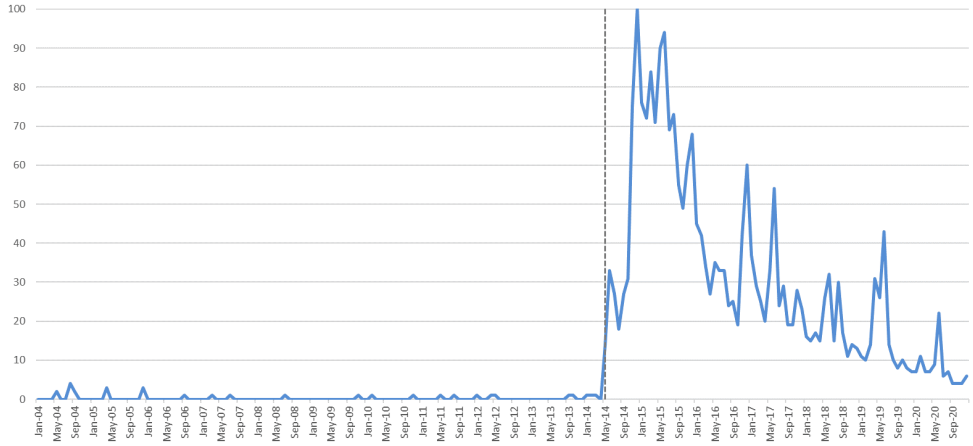


Figure 2.2: The Search Counts for the Word "Extinct Municipalities" ("*Shometsu Toshi*", in Japanese)

Notes: Google Trends. The highest level of searches during the period is standardized to 100. Dashed line indicates when the JPC list was published (May 2014).

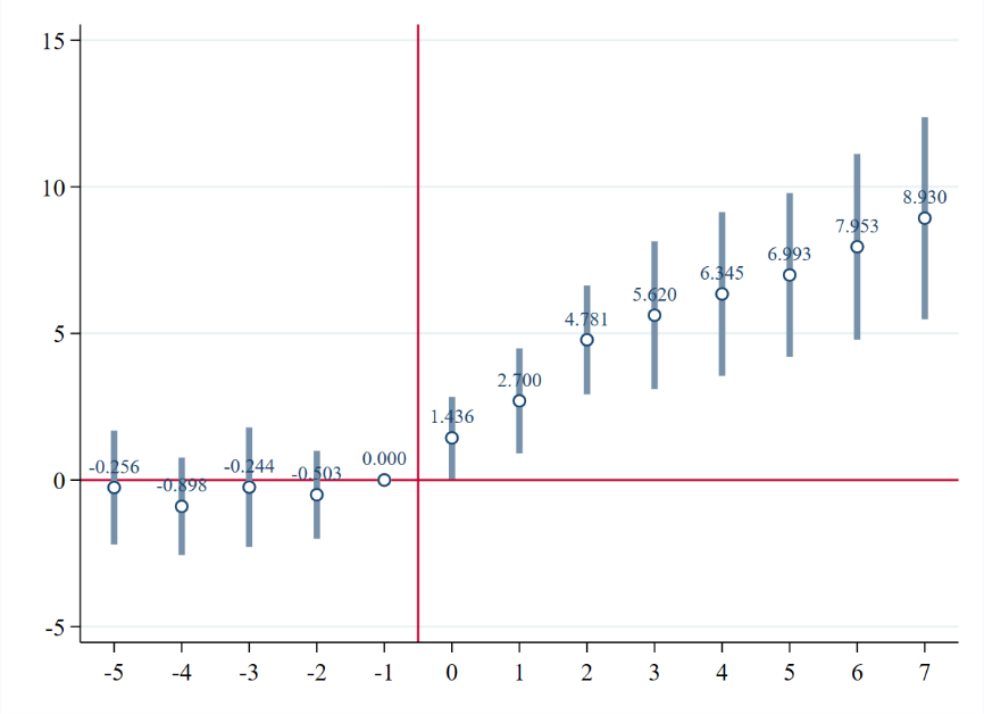


Figure 2.3: the Event Study on Unsubsidized Regional Revitalization Spending (1,000 JPY, per Residents)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3), on unsubsidized expenditures during 2009-2021. This reports the coefficients of regional revitalization spending per residents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

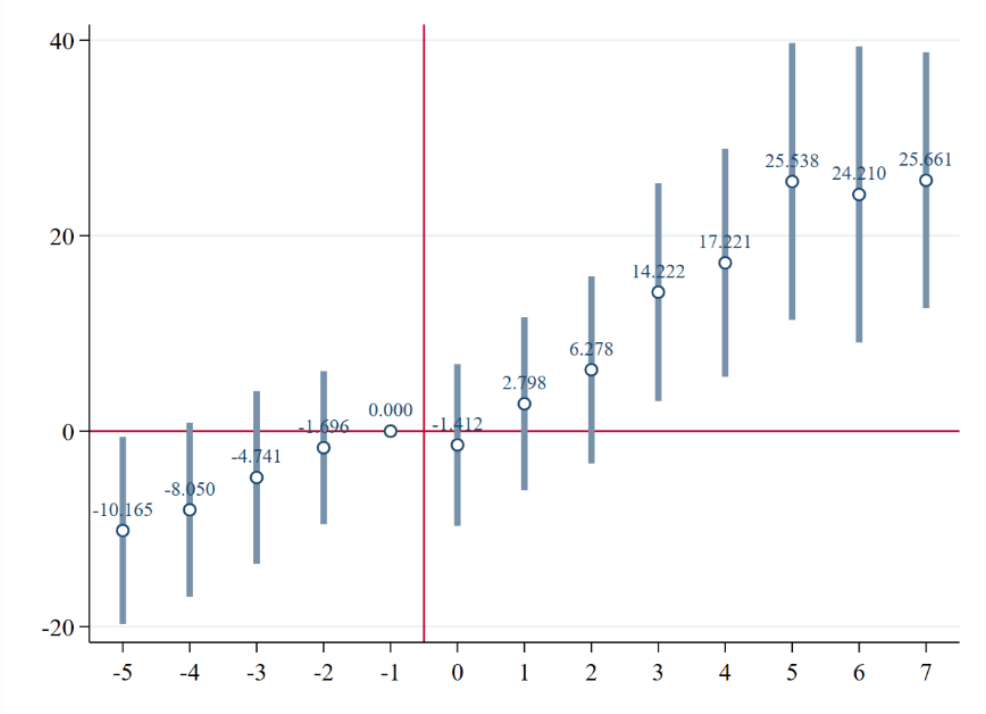


Figure 2.4: the Event Study on Unsubsidized Child-Oriented Spending per Children below 20 (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on unsubsidized expenditures during 2009-2021. This reports the coefficients of child-oriented spending per children below 20. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Figure 2.5: the Event Study on the Housing Market (log of Purchasing Prices)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4) during January 2013-December 2016. This reports the coefficients of log purchasing prices. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Table 2.1: Summary Statistics

Variables	Mean	Standard Deviation	Observations
Panel A: Expenditures and Economic Activities			
Expenditures for Unsubsidized Services (1,000 JPY per Residents)			
Regional revitalization	21.09	36.06	21,710
Child-oriented per children below 20	23.14	16.04	21,710
Elderly-oriented per adults over 65	23.57	24.93	21,710
Expenditures for Services (1,000 JPY per Residents)			
Regional revitalization	2.57	15.40	21,710
Child-oriented per children below 20	33.19	17.91	21,710
Elderly-oriented per adults over 65	19.04	13.34	21,710
Economic Activities (per Residents)			
Net population inflow (persons)	-0.67	8.24	20,028
Donations to municipalities (1,000 JPY)	10.08	69.75	21,710
Covariates)			
Share of ages below 15	0.119	0.025	21,710
Share of ages over 65	0.310	0.075	21,710
Share of female	0.514	0.015	21,710
Population density	1,064	2,492	21,710
Share of primary industry	0.112	0.104	21,710
Share of third industry	0.632	0.100	21,710
Debt level (1,000 JPY per Residents)	669	586	21,710
Share of categorical grants	0.134	0.068	21,710
Panel B: Housing Market			
Housing Price and Rent)			
Purchase price (million JPY)	23.45	21.91	2,733,019
Monthly rent (JPY)	72,956	53,975	33,269,825
Covariates			
Housing ages for purchase	21.21	14.70	2,733,019
Square footage for purchase (m^2)	91.54	367.72	2,733,019
Located floor for purchase	2.37	3.89	2,733,019
Housing ages for rent	18.93	10.43	33,269,825
Square footage for rent (m^2)	40.07	153.66	33,269,825
Located floor for rent	2.45	2.33	33,269,825

Notes: The expenditures, donations, and debt level are per capita values (divided by number of residents). The expenditures, donations, debt level, housing prices and rents are deflated by Consumer Price Index (CPI, the base year is 2020). In the estimations for the housing market, I also controlled the covariates of dummies of its housing-type (e.g., house or apartment), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. For purchasing prices, I also control for new house dummy.

Table 2.2: the DID Estimates on Unsubsidized Service Spending (1,000 JPY)

Variables	Regional revitalization	Child-oriented
DID Estimates	5.4681***	17.0338***
	(0.8370)	(3.1812)
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Control covariates	Yes	Yes
Mean in treatment group pre-2014	23.22	148.53
Number of municipalities	1,670	1,670
Observations	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Column 1), the child-oriented spending per children below 20 (Column 2). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.3: the DID Estimates on Housing Market (Log of Purchasing Prices)

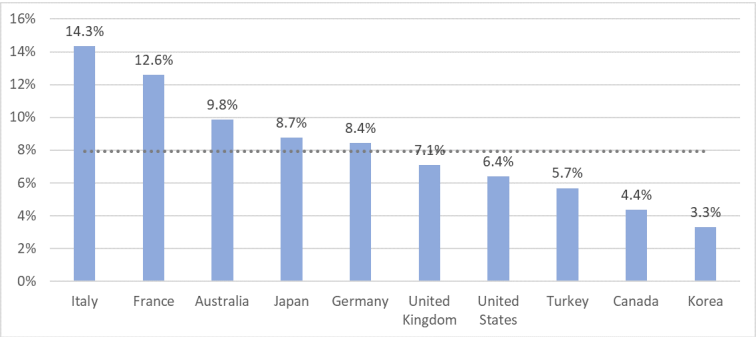
Variables	Log of Purchasing Prices
DID Estimates	-0.0367***
	(0.0123)
Municipality fixed effects	Yes
Quarter fixed effects	Yes
Control covariates	Yes
Observations	2,733,019

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the log of purchasing house price. The estimate is control by covariates of housing age, its square footage, floor that the housing room is located on, and dummies of its housing-type (e.g., house or apartment), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. For purchasing prices, I also control for new house dummy. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix

Appendix 2.A Figures

(a) For Old Ages



(b) For Family

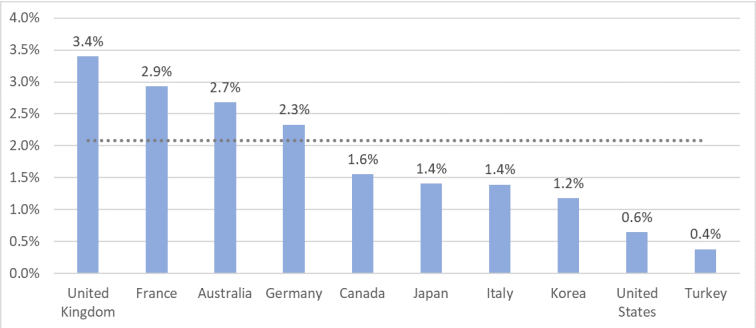
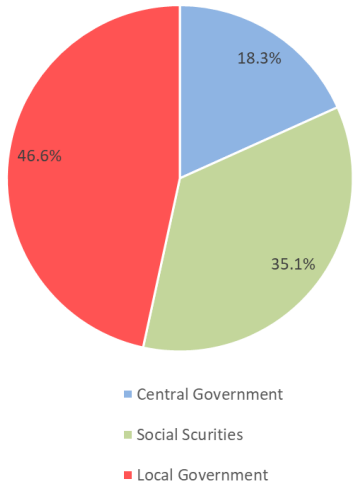


Figure 2.A.1: Social Security Expenditure in 2015 (share of GDP)

Notes: OECD Stats. The dashed lines represent the averages of OECD member countries.

(a) Expenditure by governments



(b) Expenditures by components (of local governments)

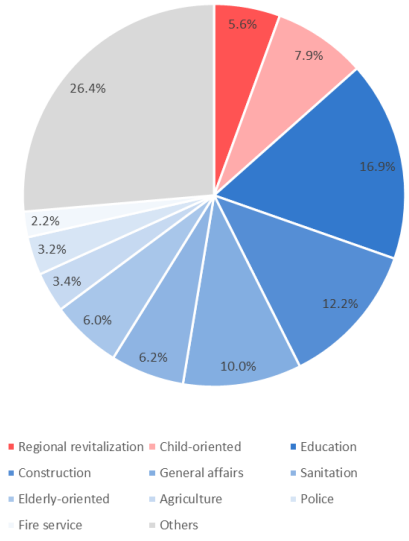


Figure 2.A.2: Expenditure Share in FY 2014

Notes: Japanese MIC.

Figure 2.A.3: Municipalities at Risk of "Extinction" by 2040

Notes: The figure shows the Japanese municipalities designated as one at the risk of "extinction" by 2040 (filled areas). Fukushima prefecture is excluded from the designation due to the 2011 nuclear disaster.

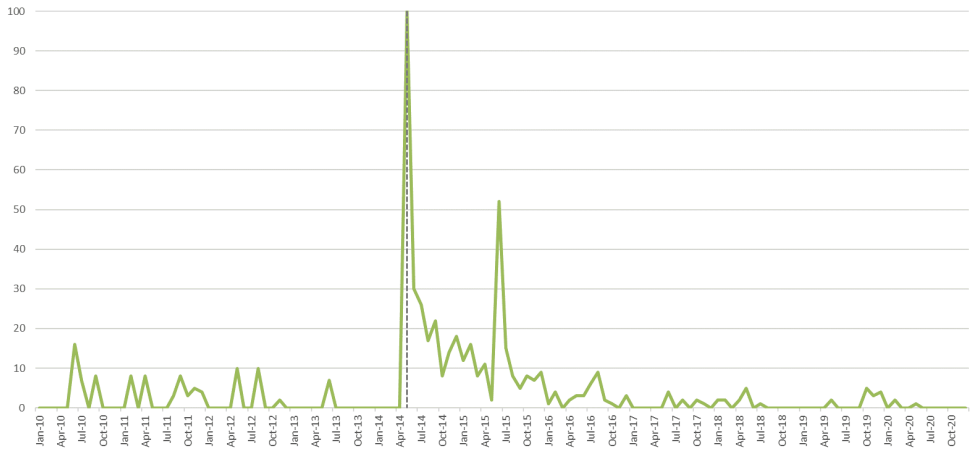
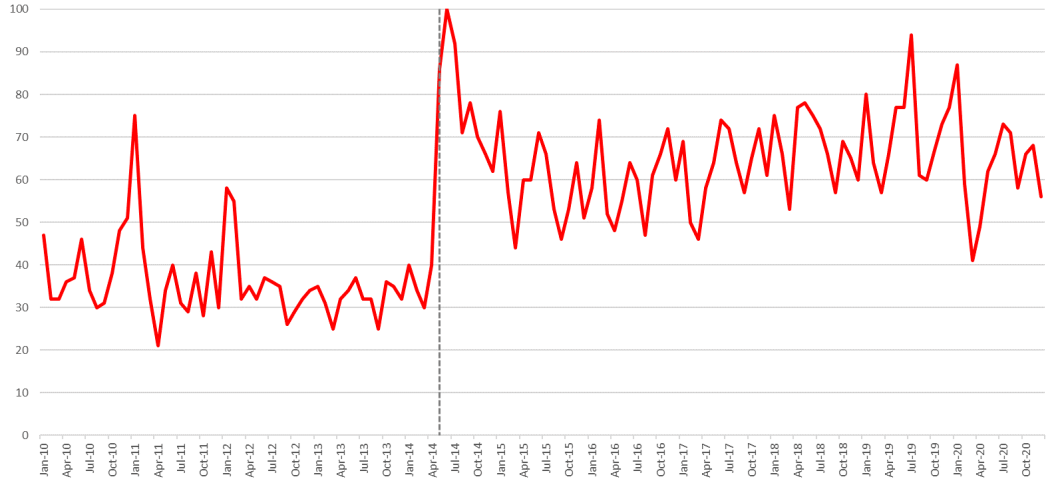


Figure 2.A.4: The Search Counts for the Word "Japan Policy Council" ("*Nihon Sosei Kaigi*", in Japanese)

Notes: Google Trends. The highest level of searches during the period is standardized to 100. Japan Policy Council was established in March 2011. Dashed line indicates when the JPC list was published (May 2014).

(a) "Population Decline"



(b) "Population Decline", compared with "Extinct Municipalities"

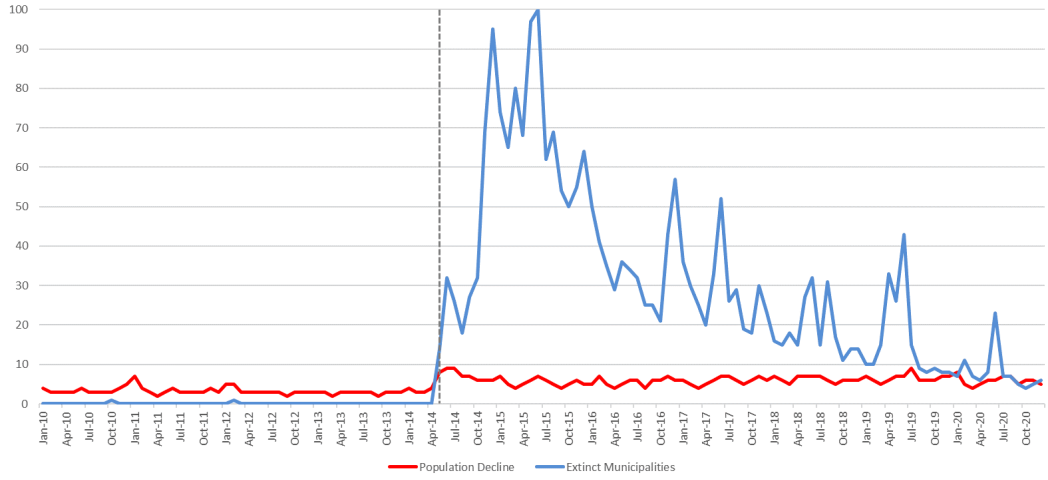


Figure 2.A.5: The Search Counts for the Word "Population Decline" ("*Jinko Gensho*", in Japanese)

Notes: Google Trends. The highest level of searches during the period is standardized to 100. The blue line shows the search counts for "extinct municipalities" ("*Shometsu Toshi*", in Japanese), the red line for "Population Decline" ("*Jinko Gensho*", in Japanese). Dashed line indicates when the JPC list was published (May 2014).

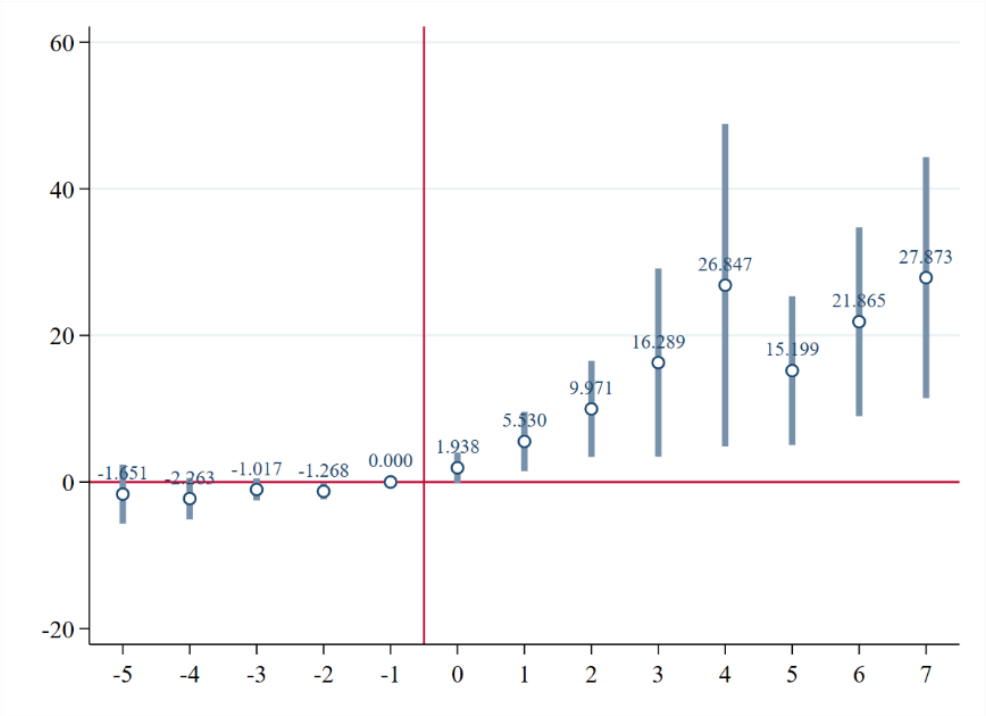
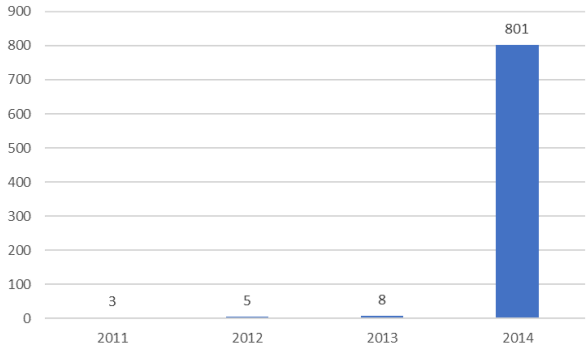


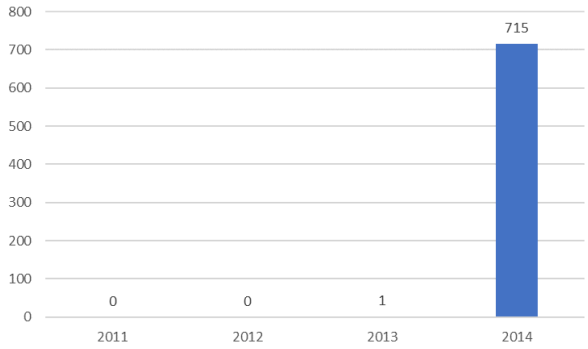
Figure 2.A.6: the Event Study on the Donations to Municipalities (1,000 JPY, per Residents)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3). This figure reports the coefficients of donations to municipalities per residents during 2009-2021. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) "Extinct Municipalities" (*Shometsu Toshi* or *Shometsu Jichitai* in Japanese)



(b) "Japan Policy Council" (*Nihon Sosei Kaigi* in Japanese)



(c) "Population Decline" (*Jinko Gensho* in Japanese)

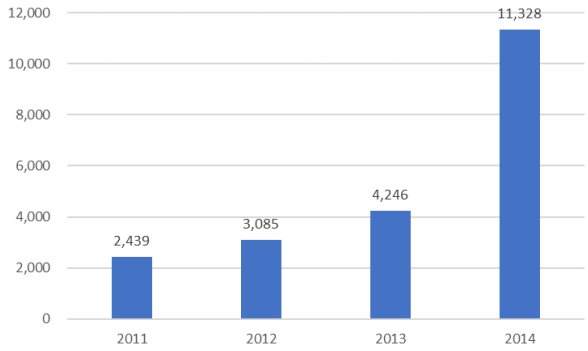


Figure 2.A.7: the Word counts in the Prefectural Councils

Notes: Japanese Local Assembly Minutes Corpus Project. Each year represents a fiscal year (from April of the year to March of the next year).

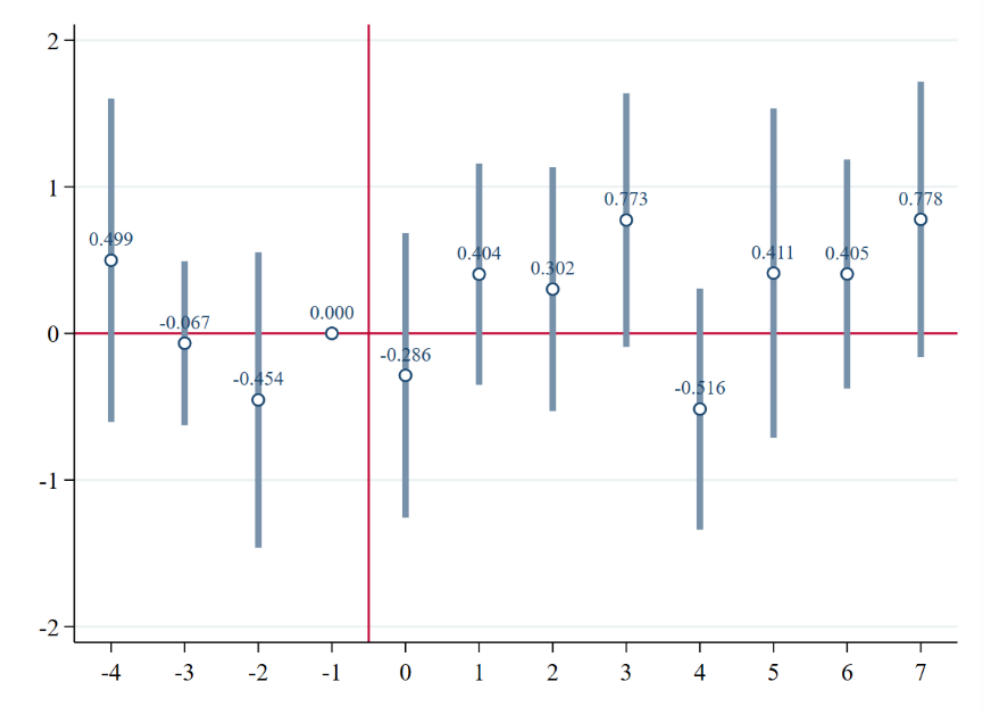


Figure 2.A.8: the Event Study on Net Migration (per Residents in last year, Migration Test)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3). This figure reports the coefficients of net migration across municipalities to municipalities per residents during 2009-2021. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

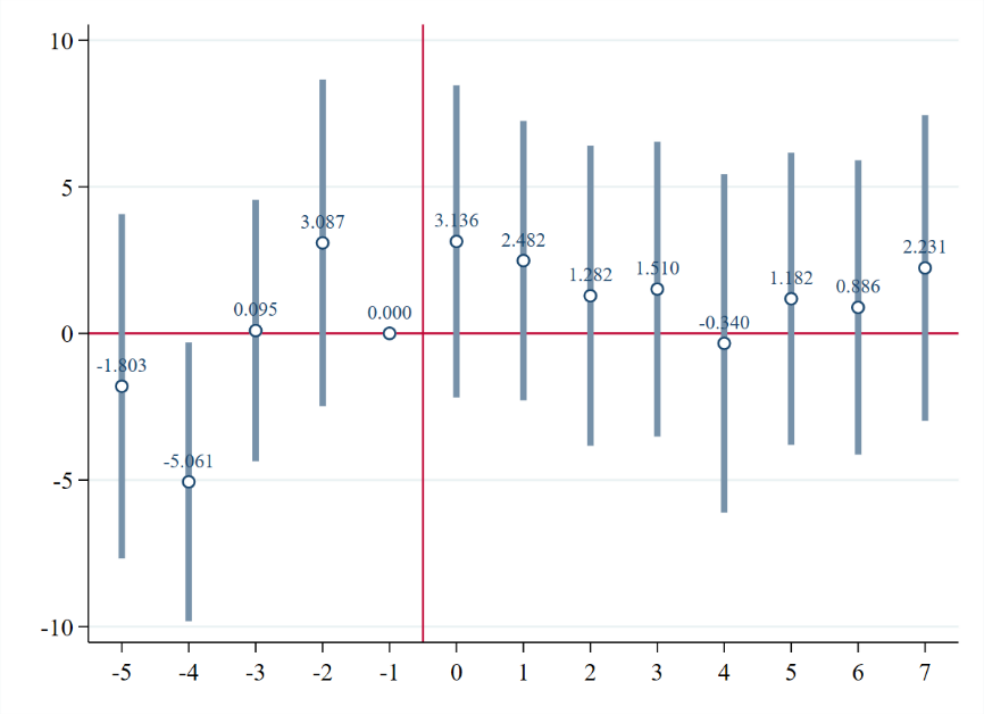
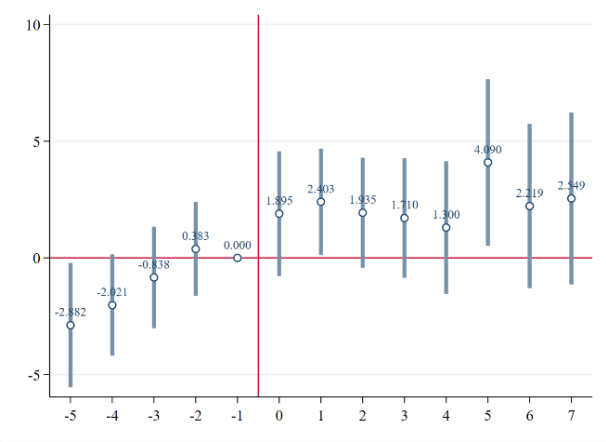


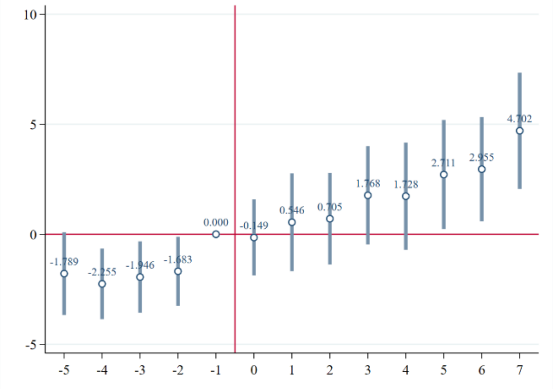
Figure 2.A.9: the Event Study on Unsubsidized Elderly-Oriented Spending per Adults over 65 (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on unsubsidized expenditures during 2009-2021. This reports the coefficients of elderly-oriented spending per adults over 65. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Education Spending



(b) Health Spending



(c) Environment Spending

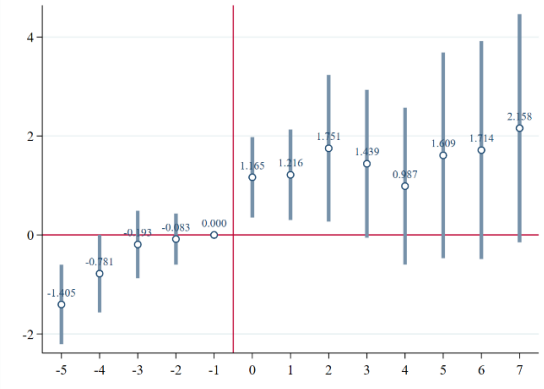
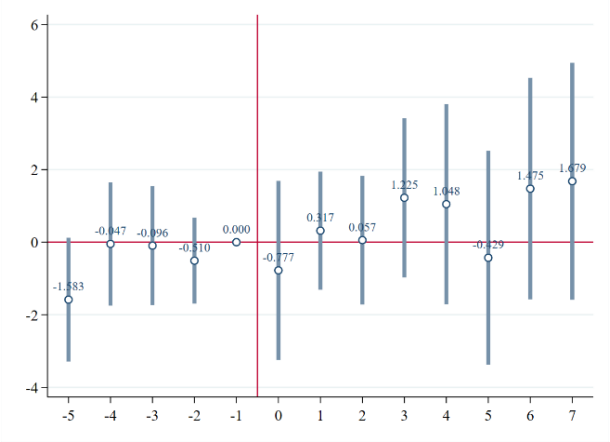


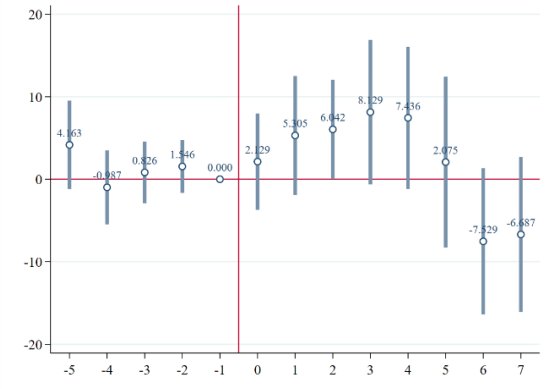
Figure 2.A.10: the Event Study on Unsubsidized Other Spending (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on unsubsidized expenditures during 2009-2021. Panel A reports the coefficients of education spending per residents, Panel B health spending per residents, and Panel C environment spending per residents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Regional Revitalization Spending



(b) Child-oriented Spending



(c) Elderly-Oriented Spending

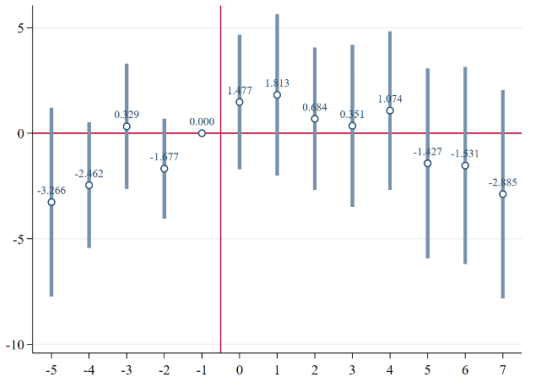
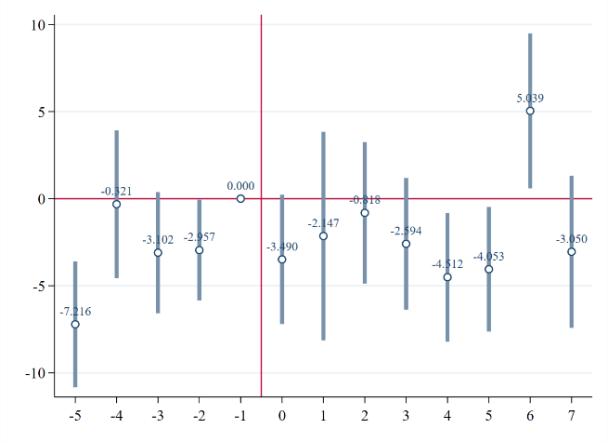


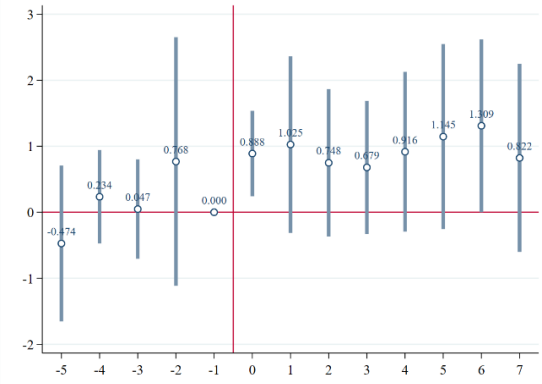
Figure 2.A.11: the Event Study on Subsidized Spending (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on expenditures during 2009-2021. Panel A reports the coefficients of regional revitalization spending per residents, Panel B children-oriented spending per children below 20, Panel C elderly-oriented spending per adults over 65. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Education Spending



(b) Health Spending



(c) Environment Spending

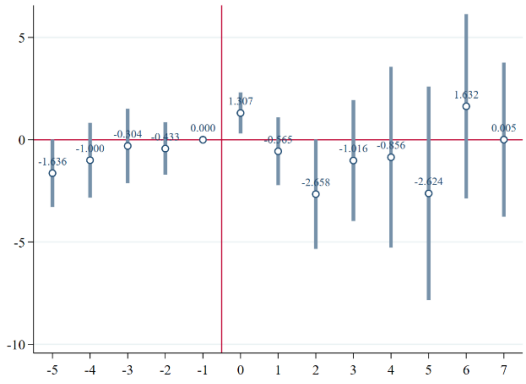


Figure 2.A.12: the Event Study on Subsidized Other Spending (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on subsidized expenditures during 2009-2021. Panel A reports the coefficients of education spending per residents, Panel B health spending per residents, and Panel C environment spending per residents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Figure 2.A.13: the Event Study on the Housing Market (log of Rents)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4) during January 2013-December 2016. This reports the coefficients of log rents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

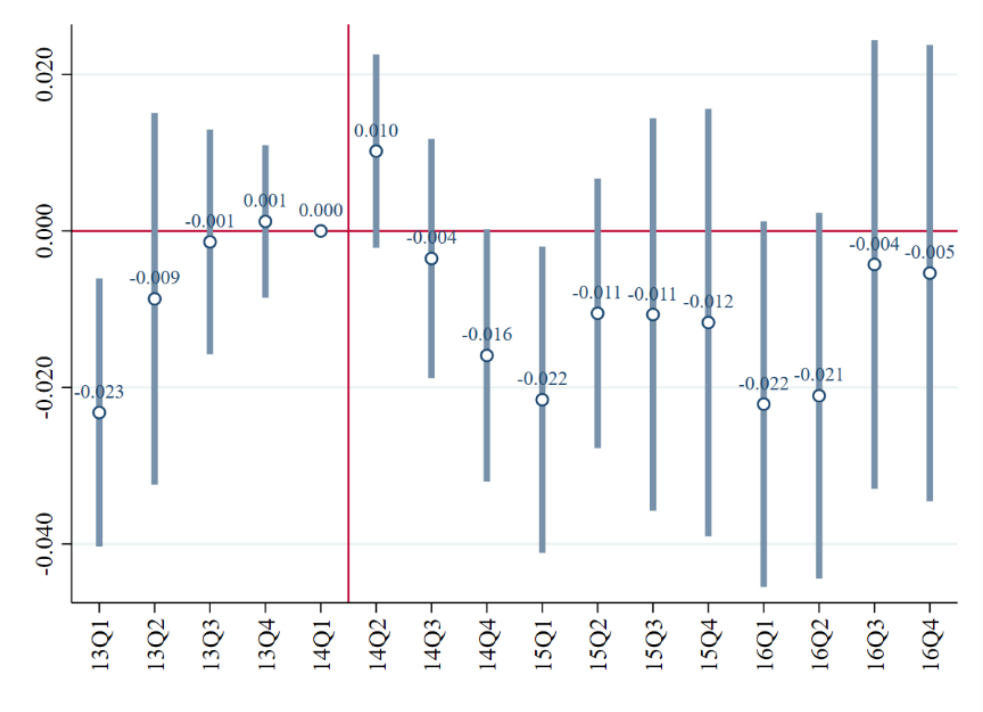


Figure 2.A.14: the Event Study on the Business Rents (log, for Offices and Stores)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4) during January 2013-December 2016. This reports the coefficients of log business rents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

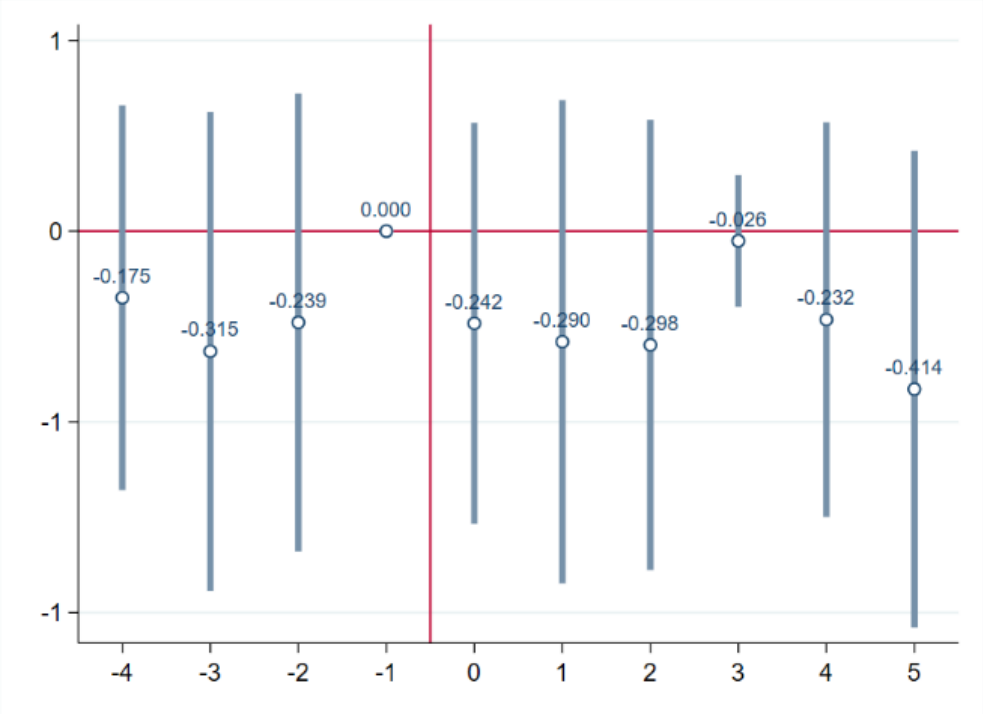


Figure 2.A.15: the Event Study on Political Outcome (Probability of Mayor's Reelection)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4) during January 2013-December 2016. This repots the coefficients of full sample of mayoral reelection dummy. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Appendix 2.B Tables

Table 2.B.1: Population Projections in countries (compared to January 2020)

(a) G7 member countries

	Japan	Italy	Germany	France	United Kingdom	United Kingdom	Canada
2050	-17.0%	-12.1%	-5.0%	2.2%	7.0%	11.8%	21.3%
2080	-33.8%	-30.4%	-13.5%	-2.2%	6.8%	16.6%	35.4%
2100	-41.2%	-38.0%	-17.2%	-5.5%	5.3%	17.5%	42.6%

(b) G20 member countries and region

	South Korea	China	Russia	EU	Brazil	Mexico	Turkey
2050	-11.3%	-7.5%	-8.5%	-4.8%	8.7%	14.4%	14.2%
2080	-39.0%	-31.3%	-18.9%	-16.1%	-1.9%	6.1%	8.5%
2100	-53.3%	-45.8%	-23.0%	-21.6%	-12.9%	-7.6%	-1.2%

	Argentina	Indonesia	India	South Africa	Saudi Arabia	Australia
2050	14.8%	17.0%	20.0%	25.5%	33.1%	25.7%
2080	13.8%	15.8%	19.2%	30.8%	39.9%	41.7%
2100	6.1%	9.7%	10.3%	27.6%	39.4%	48.9%

Notes: the United Nations (2022)

Table 2.B.2: Migration Tests for DID Estimates

Variables	Full Sample	Excluding Iwate and Miyagi prefectures
DID Estimates	0.2603	0.2545
	(0.2235)	(0.2309)
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Control covariates	Yes	Yes
Number of municipalities	1,669	1,602
Observations	20,028	19,224

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on net migration per resident in last year. The estimate is control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.3: the DID Estimates on Unsubsidized Elderly-oriented Spending (1,000 JPY)

Variables	Elderly-oriented
DID Estimates	2.3103
	(1.8436)
Municipality fixed effects	Yes
Year fixed effects	Yes
Control covariates	Yes
Mean in treatment group pre-2014	79.17
Number of municipalities	1,670
Observations	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the elderly-oriented spending per adults over 65. The estimate is control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.4: the DID Estimates on Unsubsidized Other Spending (1,000 JPY)

Variables	Education	Health	Environment
DID Estimates	3.2423***	3.0921***	1.9350***
	(0.9405)	(0.6839)	(0.5442)
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Mean in treatment group pre-2014	65.95	43.46	25.19
Number of municipalities	1,670	1,670	1,670
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the education spending per capita (Column 1), the health spending per capita (Column 2), and the environment spending per capita (Column 3). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.5: the DID Estimates on Municipal Revenues (1,000 JPY)

Variables	Local Tax	Local Debt	Donations	Rents	Intergovernmental Grants
DID Estimates	1.9595	14.7551***	15.5347***	0.4139	-0.6602
	(1.2758)	(2.6356)	(5.4669)	(0.3109)	(5.6546)
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes	Yes	Yes
Mean in treatment group pre-2014	142.85	81.03	2.10	16.67	465.61
Number of municipalities	1,670	1,670	1,670	1,670	1,670
Observations	21,710	21,710	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the local tax revenue per capita (Column 1), the local debt revenue per capita (Column 2), the donations revenue per capita (Column 3), the rents revenue per capita (Column 4), the intergovernmental grants revenue per capita (Column 5). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants (not include for donations, rent, and grants), share of taxes (only include for grants)). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.6: the DID Estimates on Subsidized Service Spending (1,000 JPY)

Variables	Regional revitalization	Child-oriented	Elderly-oriented
DID Estimates	0.8915	1.8638	1.6374
	(0.8389)	(2.4112)	(1.2826)
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Mean in treatment group pre-2014	1.87	159.03	64.10
Number of municipalities	1,670	1,670	1,670
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Column 1), the child-oriented spending per children below 20 (Column 2), and the elderly-oriented spending per adults over 65 (Column 3). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.7: the DID Estimates on Subsidized Other Spending (1,000 JPY)

Variables	Education	Health	Environment
DID Estimates	0.5209	0.8029*	0.0318
	(1.1408)	(0.4717)	(1.0756)
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Mean in treatment group pre-2014	16.84	2.55	1.90
Number of municipalities	1,670	1,670	1,670
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the education spending per capita (Column 1), the health spending per capita (Column 2), and the environment spending per capita (Column 3). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.8: the DID Estimates on Housing Market (Log of Rents)

Variables	Log of Rents
DID Estimates	0.0015
	(0.0024)
Municipality fixed effects	Yes
Quarter fixed effects	Yes
Control covariates	Yes
Observations	33,269,825

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the log of rents. The estimate is control by covariates of housing age, its square footage, floor that the housing room is located on, and dummies of its housing-type (e.g., house or apartment), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. For purchasing prices, I also control for new house dummy. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.B.9: the DID Estimates on the Business Rents (log, for Offices and Stores)

Variables	Log of Business Rents
DID Estimates	-0.0055
	(0.0100)
Municipality fixed effects	Yes
Quarter fixed effects	Yes
Control covariates	Yes
Observations	1,682,816

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the rents for offices and stores. The estimate are control by covariates of housing age, its square footage, floor that the housing room is located on, and dummies of its housing-type (office or store), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

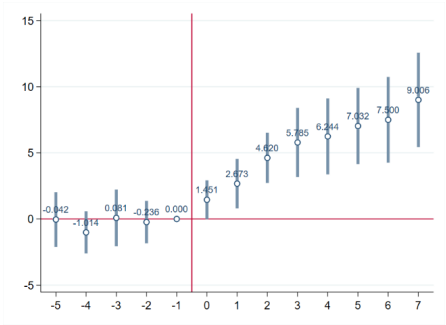
Table 2.B.10: the DID Estimates on Political Outcome (Probability of Mayor's reelection)

Variables	Full Sample	Excluding Iwate and Miyagi prefectures
DID Estimates	-0.0420	-0.0531
	(0.0447)	(0.0454)
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Control covariates	Yes	Yes
Mean in treatment group pre-2014	0.692	0.697
Number of municipalities	1,669	1,602
Observations	4,122	3,954

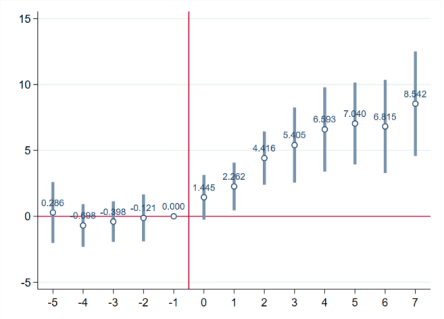
Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the mayoral reelection dummy of the full sample (Column 1), and the subsample excluding Iwate and Miyagi prefectures (Column 2). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and the debt level per capita. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix 2.C Robustness Check Figures

(a) Scores between 0.2 and 0.8



(b) Scores between 0.3 and 0.7



(c) Scores between 0.4 and 0.6

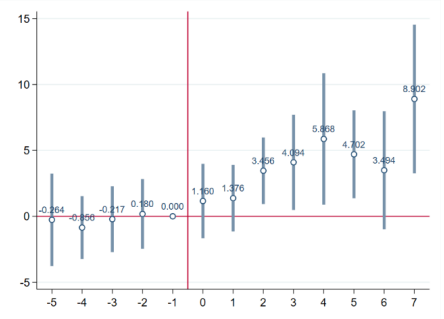
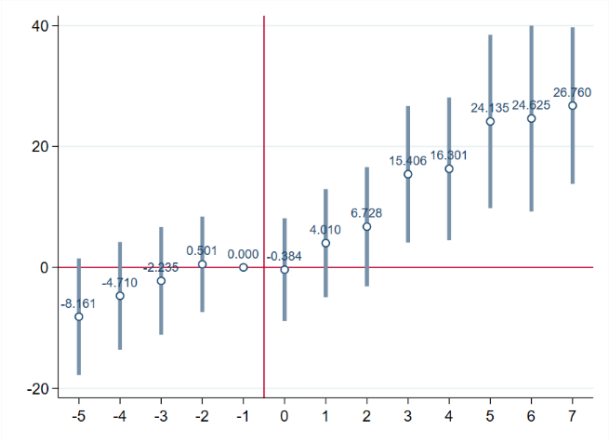


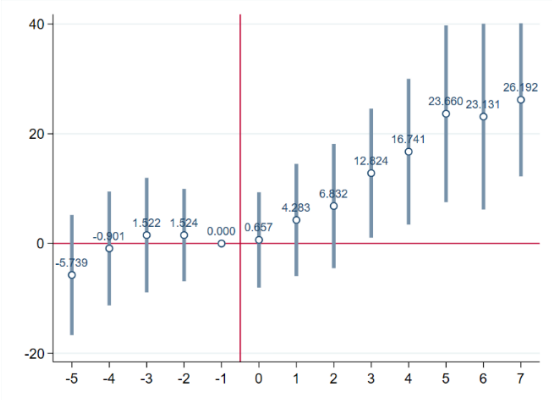
Figure 2.C.1: the Event Study on Unsubsidized Regional Revitalization Spending with Restricted Samples (1,000 JPY)

Notes: These figures plot the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3), on unsubsidized expenditures during 2009-2021. These report the coefficients of regional revitalization spending per residents. Panel A reports the coefficients with scores between 0.2 and 0.8, panel B reports those with scores between 0.3 and 0.7, and panel C reports those with scores between 0.4 and 0.6. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Scores between 0.2 and 0.8



(b) Scores between 0.3 and 0.7



(c) Scores between 0.4 and 0.6

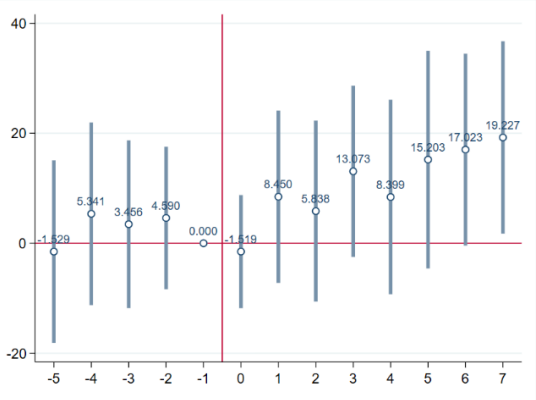
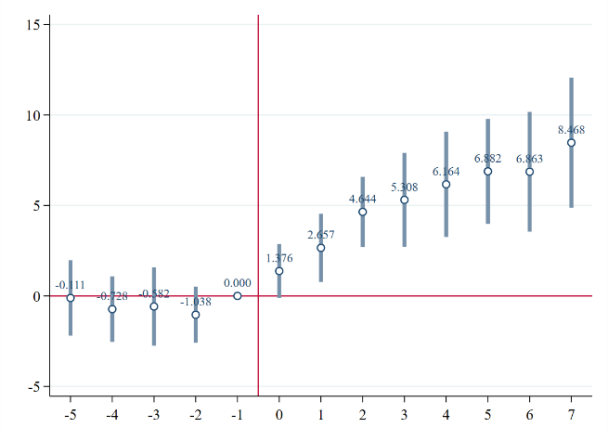


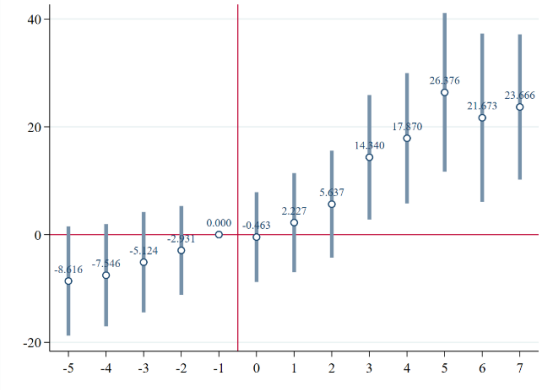
Figure 2.C.2: the Event Study on Unsubsidized Child-oriented Spending per Children below 20 with Restricted Samples (1,000 JPY)

Notes: These figures plot the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3), on unsubsidized expenditures during 2009-2021. These report the coefficients of child-oriented spending per children below 20. Panel A reports the coefficients with scores between 0.2 and 0.8, panel B reports those with scores between 0.3 and 0.7, and panel C reports those with scores between 0.4 and 0.6. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Regional Revitalization Spending



(b) Child-oriented Spending



(c) Elderly-Oriented Spending

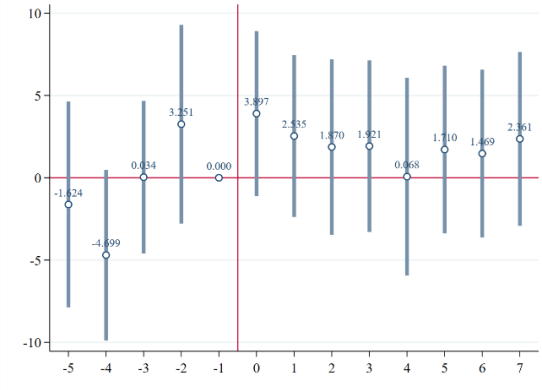
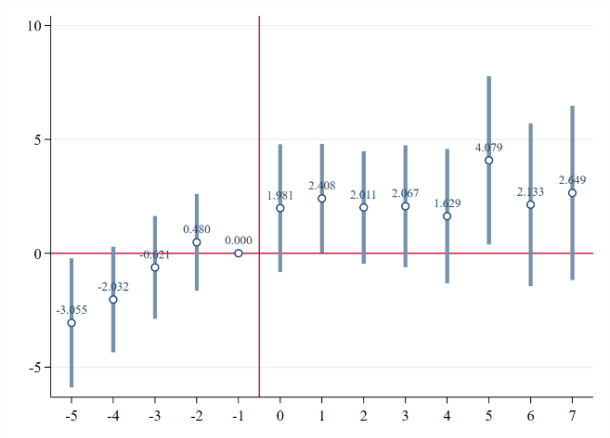


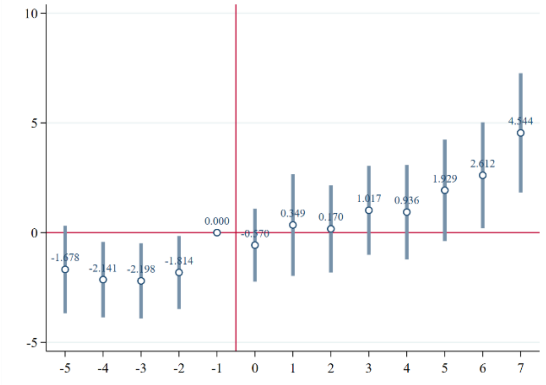
Figure 2.C.3: the Event Study on Unsubsidized Spending (1,000 JPY, Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on expenditures during 2009-2021, excluding Iwate and Miyagi prefectures, and Tokyo 23 wards. Panel A reports the coefficients of regional revitalization spending per residents, Panel B children-oriented spending per children below 20, and Panel C elderly-oriented spending per adults over 65. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Education Spending



(b) Health Spending



(c) Environment Spending

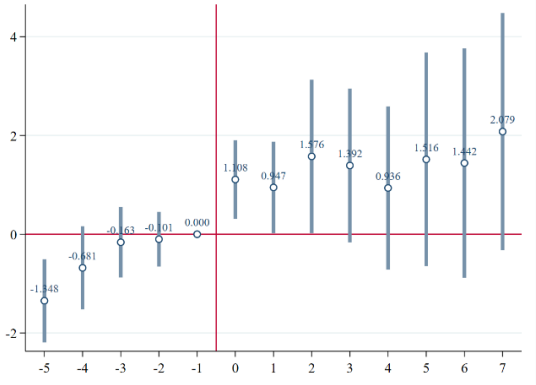
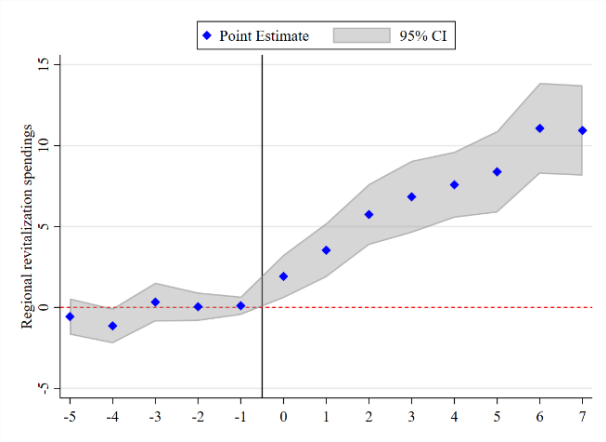


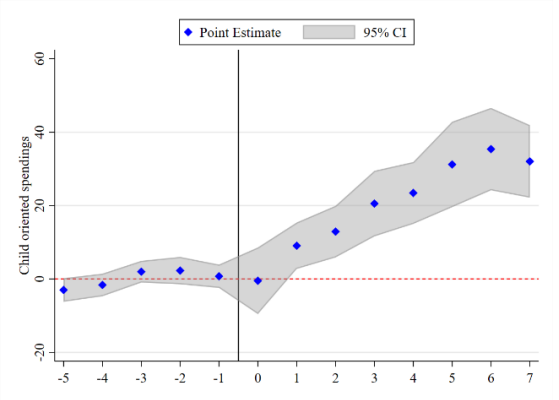
Figure 2.C.4: the Event Study on Unsubsidized Other Spending (1,000 JPY, Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.3) on expenditures during 2009-2021, excluding Iwate and Miyagi prefectures, and Tokyo 23 wards. Panel A reports the coefficients of education spending per residents, Panel B health spending per residents, and Panel C environment spending per residents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Regional Revitalization Spending



(b) Child-oriented Spending



(c) Elderly-Oriented Spending

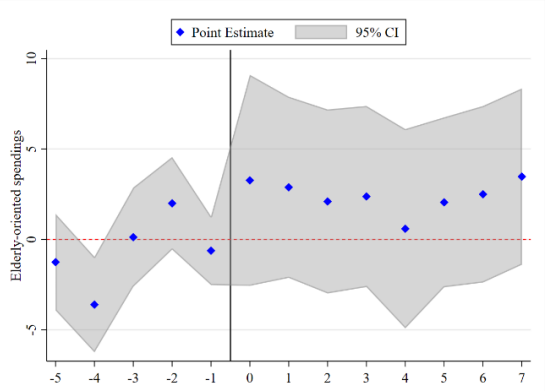
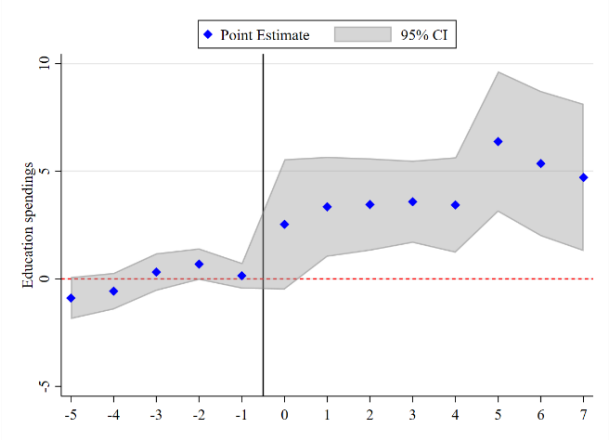


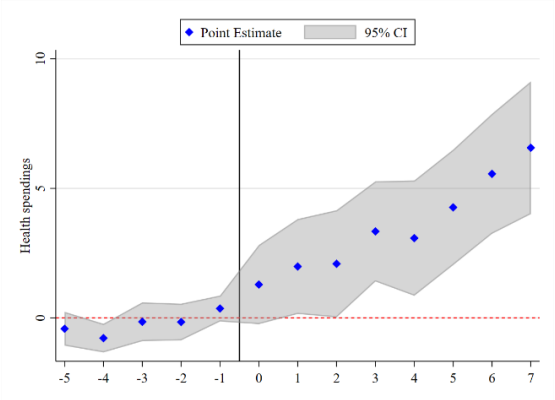
Figure 2.C.5: the Event Study on Unsubsidized Spending, based on the Synthetic DID (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design on expenditures during 2009-2021, based on the Synthetic DID, proposed by Arkhangelsky et al. (2021). Panel A reports the coefficients of regional revitalization spending per residents, Panel B children-oriented spending per children below 20, and Panel C elderly-oriented spending per adults over 65. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Education Spending



(b) Health Spending



(c) Environment Spending

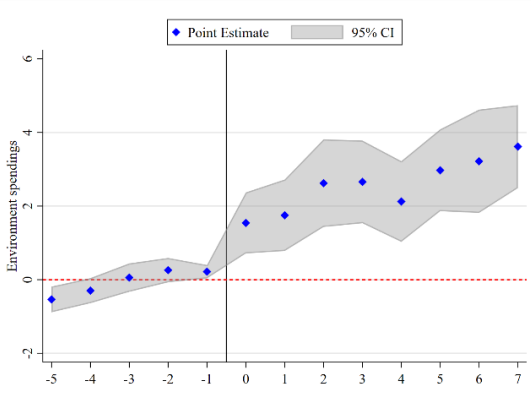
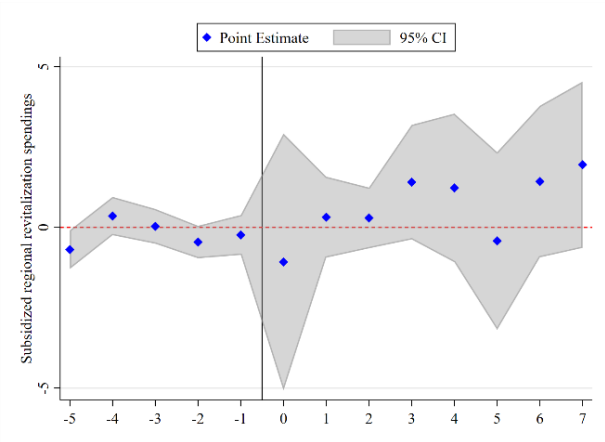


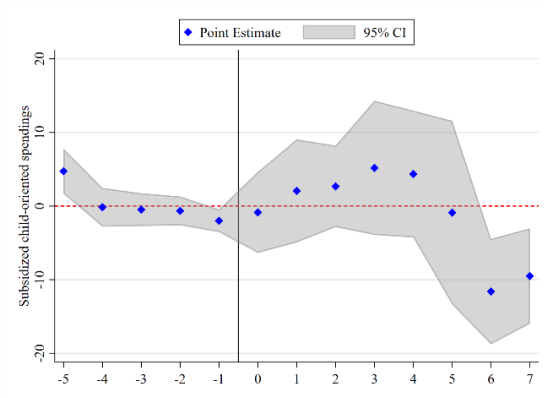
Figure 2.C.6: the Event Study on Unsubsidized Other Spending, based on the Synthetic DID (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design on expenditures during 2009-2021, based on the Synthetic DID, proposed by Arkhangelsky et al. (2021). Panel A reports the coefficients of education spending per residents, Panel B health spending per residents, and Panel C environment spending per residents. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Regional Revitalization Spending



(b) Child-oriented Spending



(c) Elderly-Oriented Spending

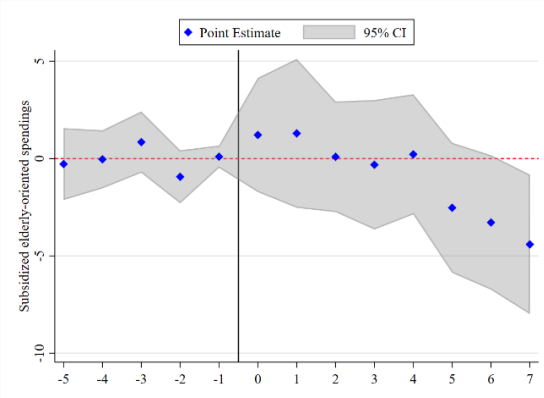
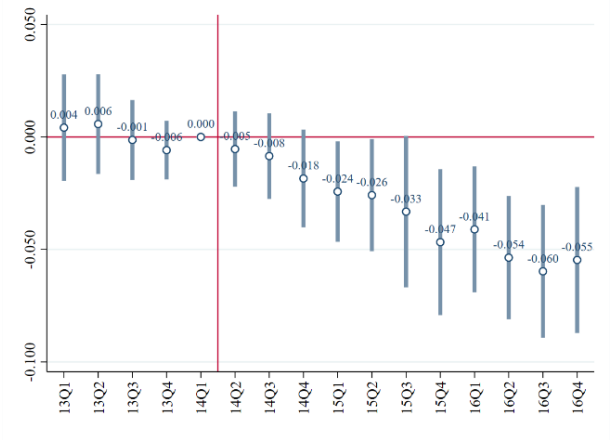


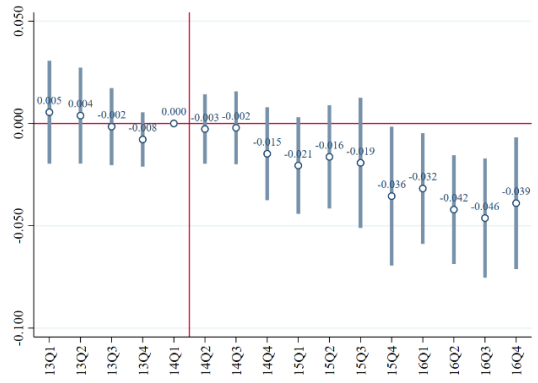
Figure 2.C.7: the Event Study on Subsidized Spending, based on the Synthetic DID (1,000 JPY)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in on expenditures during 2009-2021, based on the Synthetic DID, proposed by Arkhangelsky et al. (2021). Panel A reports the coefficients of regional revitalization spending per residents, Panel B children-oriented spending per children below 20, and Panel C elderly-oriented spending per adults over 65. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

(a) Scores between 0.2 and 0.8



(b) Scores between 0.3 and 0.7



(c) Scores between 0.4 and 0.6

Figure 2.C.8: the Event Study on the Housing Market with restricted samples (1,000 JPY, log of Purchasing Prices)

Notes: These figures plot the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4), on log purchasing prices during January 2013-December 2016. These report the coefficients of child-oriented spending per children below 20. Panel A reports the coefficients with scores between 0.2 and 0.8, panel B reports those with scores between 0.3 and 0.7, and panel C reports those with scores between 0.4 and 0.6. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Figure 2.C.9: the Event Study on the Housing Market (log of Purchasing Prices, Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Notes: This figure plots the impact (point estimates and 95% confidence intervals) of the event study design in equation (2.4) during January 2013-December 2016, excluding Iwate and Miyagi prefectures, and Tokyo 23 wards. This reports the coefficients of log purchasing prices. To the left of 0 (in 2014) is the placebo estimate, which should not be significantly different from 0 if the common trend assumption holds.

Appendix 2.D Robustness Check Tables

Table 2.D.1: the DID Estimates on Unsubsidized Spending with restricted samples (1,000 JPY)

Variables	Scores 0.8-0.2	Scores 0.7-0.3	Scores 0.6-0.4
Panel A: Regional Revitalization Spending (1,000 JPY per Residents)			
DID Estimates	5.3535***	5.2400***	4.3095***
	(0.8610)	(0.9021)	(1.1839)
Panel B: Child-oriented Spending (1,000 JPY per Children below 20)			
DID Estimates	15.7974***	13.9156***	8.1363**
	(3.2462)	(3.3993)	(3.6870)
Panel C: Elderly-oriented Spending (1,000 JPY per Adults over 65)			
DID Estimates	2.5077	1.0377	-1.7708
	(1.8884)	(2.0272)	(2.8637)
Observations	20,072	16,419	9,230

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Panel A), and the child-oriented spending per children below 20 (Panel B), and the elderly-oriented spending per adults over 65 (Panel C), with restricted samples. Column 1 reports the coefficients with scores between 0.2 and 0.8, column 2 reports those with scores between 0.3 and 0.7, and column 3 reports those with scores between 0.4 and 0.6. These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.2: the DID Estimates on Unsubsidized Other Spending with restricted samples (1,000 JPY)

Variables	Scores 0.8-0.2	Scores 0.7-0.3	Scores 0.6-0.4
Panel A: Education Spending (1,000 JPY per capita)			
DID Estimates	2.7881***	2.3353**	0.7766
	(0.9578)	(1.0133)	(1.3341)
Panel B: Health Spending (1,000 JPY per capita)			
DID Estimates	3.1288***	2.7153***	2.4131**
	(0.6920)	(0.7336)	(0.9713)
Panel C: Environment Spending (1,000 JPY per capita)			
DID Estimates	1.8827***	1.7195***	1.2315*
	(0.5606)	(0.6022)	(0.6732)
Observations	20,072	16,419	9,230

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the education spending per capita (Panel A), and the health spending per capita (Panel B), and the environment spending per capita (Panel C), with restricted samples. Column 1 reports the coefficients with scores between 0.2 and 0.8, column 2 reports those with scores between 0.3 and 0.7, and column 3 reports those with scores between 0.4 and 0.6. These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.3: the DID Estimates on Subsidized Spending with restricted samples (1,000 JPY)

Variables	Scores 0.8-0.2	Scores 0.7-0.3	Scores 0.6-0.4
Panel A: Regional Revitalization Spending (1,000 JPY per Residents)			
DID Estimates	0.8322	0.8401	0.4573
	(0.8995)	(0.9886)	(0.6308)
Panel B: Child-oriented Spending (1,000 JPY per Children below 20)			
DID Estimates	2.2665	2.1068	1.4807
	(2.4368)	(2.5883)	(3.2256)
Panel C: Elderly-oriented Spending (1,000 JPY per Adults over 65)			
DID Estimates	1.1103	0.8266	-0.2343
	(1.3253)	(1.4192)	(1.7345)
Panel D: Education Spending (1,000 JPY per capita)			
DID Estimates	0.2863	-0.7280	-1.1380
	(1.1614)	(1.1958)	(1.2491)
Panel E: Health Spending (1,000 JPY per capita)			
DID Estimates	0.5087	0.1570	-0.1953
	(0.4580)	(0.4988)	(0.7894)
Panel F Environment Spending (1,000 JPY per capita)			
DID Estimates	0.1991	0.2037	0.9797
	(1.1221)	(1.1874)	(1.0905)
Observations	20,072	16,419	9,230

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Panel A), and the child-oriented spending per children below 20 (Panel B), and the elderly-oriented spending per adults over 65 (Panel C), the education spending per capita (Panel D), and the health spending per capita (Panel E), and the environment spending per capita (Panel F), with restricted samples. Column 1 reports the coefficients with scores between 0.2 and 0.8, column 2 reports those with scores between 0.3 and 0.7, and column 3 reports those with scores between 0.4 and 0.6. These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.4: the DID Estimates on Unsubsidized Service Spending (1,000 JPY, Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Variables	Regional revitalization	Child-oriented	Elderly-oriented
DID Estimates	5.3377***	16.6562***	2.5769
	(0.8705)	(3.2150)	(1.8660)
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Mean in treatment group pre-2014	23.56	149.22	79.93
Number of municipalities	1,580	1,580	1,580
Observations	20,540	20,540	20,540

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Column 1), and the child-oriented spending per children below 20 (Column 2), and the elderly-oriented spending per adults over 65 (Column 3). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.5: the DID Estimates on Unsubsidized Other Spending (1,000 JPY, Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Variables	Education	Health	Environment
DID Estimates	3.3017***	2.6158***	1.7639***
	(0.9651)	(0.6403)	(0.5718)
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Mean in treatment group pre-2014	66.65	44.08	25.73
Number of municipalities	1,580	1,580	1,580
Observations	20,540	20,540	20,540

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the education spending per capita (Column 1), the health spending per capita (Column 2), and the environment spending per capita (Column 3). These estimates are control by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.6: the DID Estimates on Unsubsidized Service Spending, based on the Synthetic DID (1,000 JPY)

		Including Covariates	
Variables	No Covariates	Optimized	Projected
Panel A: Regional Revitalization Spending (1,000 JPY per Residents)			
Synthetic DID Estimates	7.029***	5.856***	5.042***
	(0.826)	(0.923)	(1.009)
Panel B: Child-oriented Spending (1,000 JPY per Children below 20)			
Synthetic DID Estimates	20.511***	17.920***	19.993***
	(2.929)	(3.423)	(3.679)
Panel C: Elderly-oriented Spending (1,000 JPY per Adults over 65)			
Synthetic DID Estimates	2.309	1.078	3.153
	(2.221)	(2.683)	(2.283)
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Panel A), and the child-oriented spending per children below 20 (Panel B), and the elderly-oriented spending per adults over 65 (Panel C). These estimates are based on the Synthetic DID, proposed by Arkhangelsky et al. (2021) with bootstrapped standard errors using 50 replications. The estimates in Column 1 are not controlled by any covariate, and the estimates in Columns 2 and 3 are controlled by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.7: the DID Estimates on Unsubsidized Other Spending, based on the Synthetic DID (1,000 JPY)

		Including Covariates	
Variables	No Covariates	Optimized	Projected
Panel A: Education Spending (1,000 JPY per capita)			
Synthetic DID Estimates	4.074***	3.149***	3.451***
	(0.997)	(0.883)	(1.120)
Panel B: Health Spending (1,000 JPY per capita)			
Synthetic DID Estimates	3.489***	3.249***	3.686***
	(0.619)	(0.755)	(0.865)
Panel C: Environment Spending (1,000 JPY per capita)			
Synthetic DID Estimates	2.542***	1.446***	1.323
	(0.316)	(0.453)	(0.960)
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the education spending per capita (Panel A), and the health spending per capita (Panel B), and the environment spending per capita (Panel C). These estimates are based on the Synthetic DID, proposed by Arkhangelsky et al. (2021) with bootstrapped standard errors using 50 replications. The estimates in Column 1 are not controlled by any covariate, and the estimates in Columns 2 and 3 are controlled by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.8: the DID Estimates on Subsidized Spending, based on the Synthetic DID (1,000 JPY)

		Including Covariates	
Variables	No Covariates	Optimized	Projected
Panel A: Regional Revitalization Spending (1,000 JPY per Residents)			
Synthetic DID Estimates	0.650	-0.492	-0.381
	(0.750)	(1.099)	(1.135)
Panel B: Child-oriented Spending (1,000 JPY per Children below 20)			
Synthetic DID Estimates	-0.693	1.052	3.126
	(2.277)	(2.543)	(3.747)
Panel C: Elderly-oriented Spending (1,000 JPY per Adults over 65)			
Synthetic DID Estimates	-1.019	-0.039	1.251
	(1.097)	(1.509)	(1.823)
Panel D: Education Spending (1,000 JPY per capita)			
Synthetic DID Estimates	-2.025	-2.831	1.527
	(1.256)	(1.741)	(2.362)
Panel E: Health Spending (1,000 JPY per capita)			
Synthetic DID Estimates	0.198	-0.336	0.625
	(0.729)	(0.736)	(0.587)
Panel F: Environment Spending (1,000 JPY per capita)			
Synthetic DID Estimates	0.490	0.076	-1.159
	(0.608)	(1.030)	(2.215)
Observations	21,710	21,710	21,710

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the regional revitalization spending per capita (Panel A), and the child-oriented spending per children below 20 (Panel B), and the elderly-oriented spending per adults over 65 (Panel C), the education spending per capita (Panel D), and the health spending per capita (Panel E), and the environment spending per capita (Panel F). These estimates are based on the Synthetic DID, proposed by Arkhangelsky et al. (2021) with bootstrapped standard errors using 50 replications. The estimates in Column 1 are not controlled by any covariate, and the estimates in Columns 2 and 3 are controlled by covariates of demographic variables (share under 14, share over 65, female share, and population density), industry shares (primary and third industry shares), and municipal fiscal structure (debt level, share of categorical grants). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.9: the DID Estimates on Housing Market with restricted samples

Variables	Scores 0.8-0.2	Scores 0.7-0.3	Scores 0.6-0.4
Panel A: Log of Purchasing Prices			
DID Estimates	-0.0356***	-0.0256**	-0.0208
	(0.0124)	(0.0121)	(0.0154)
Observations	2,481,562	1,725,720	827,192
Panel B: Log of Rents			
DID Estimates	0.0016	0.0029	0.0005
	(0.0025)	(0.0027)	(0.0033)
Observations	29,424,139	19,310,538	8,657,159
Panel C: Log of Business Rents			
DID Estimates	-0.0049	-0.0030	-0.0173
	(0.0102)	(0.0112)	(0.0125)
Observations	1,572,861	1,036,506	418,409

Notes: The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the log of purchasing house price (Panel A), rents (Panel B), and business rents (Panel C), with restricted samples. Column 1 reports the coefficients with scores between 0.2 and 0.8, column 2 reports those with scores between 0.3 and 0.7, and column 3 reports those with scores between 0.4 and 0.6. These estimates are control by covariates of housing age, its square footage, floor that the housing room is located on, and dummies of its housing-type (e.g., house or apartment), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. For purchasing prices, I also control for new house dummy. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.D.10: the DID Estimates on Housing Market (Excluding Iwate and Miyagi prefectures, and Tokyo 23 wards)

Variables	Log of Purchasing Prices	Log of Rents	Log of Business Rents
DID Estimates	-0.0309**	0.0024	-0.0104
	(0.0122)	(0.0030)	(0.0129)
Municipality fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Control covariates	Yes	Yes	Yes
Observations	2,698,761	24,756,613	1,013,812

*Notes:*The table reports the impacts of the designation of "the municipalities at the risk of extinction by 2040" on the log of purchasing house price (Column 1), rents (Column 2), and business rents (Column 3). The estimate is control by covariates of housing age, its square footage, floor that the housing room is located on, and dummies of its housing-type (e.g., house or apartment), material used in housing (e.g., steel, wooden, or reinforced concrete), and municipal population density. For purchasing prices, I also control for new house dummy. Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix 2.E Details of the designation of future "extinction"

In May 2014, JPC released a list of municipalities predicted to be "extinct" by 2040, including all municipalities except Fukushima prefecture suffered a nuclear disaster in March 2011. The list designated 896 municipalities, about half of the total number in Japan, as "endangered municipalities". JPC focuses on the "reproductive capacity" of the population and uses the population of females aged 20-39, which plays a central role in the population reproduction, as an indicator of this capacity. Specifically, this "extinction" is defined as the case that the number of females aged 20-39 in 2040 predicted by JPC is less than half of those in 2010. This population projection by JPC is based on the projection of municipal populations through 2040 published in March 2013 by the IPSS, a government institution of the Japanese Ministry of Health, Labour and Welfare. The IPSS future projection estimates the population by five-year age and gender groups every five years based on the following formula:

$$Population_{i,g,a,t} = Population_{i,g,a-5,t-5} \times Survival\ Rate_{i,g,a,t} \times Net\ Migration\ Rate_{i,g,a,t}, \tag{2.5}$$

where $Population_{i,g,a,t}$ is the population of municipality i, gender group g, age group a, and year t. $Survival\ Rate_{i,g,a,t}$ and $Net\ Migration\ Rate_{i,g,a,t}$ represent the survival rate and net migration rate, from year $a-5$ to a and from year $t-5$ to t in municipality i, gender g, respectively. The net migration rate of IPSS is assumed to converge to about half of the 2005-10 rate through 2020. JPC multiplies an adjustment coefficient so that the aggregate increase and decrease in migration during 2010-15 remains at the same

level afterward, modifying equation (2.5) to the following equation (2.6):

$$\begin{aligned} Population_{i,g,a,t} = & Population_{i,g,a-5,t-5} \times Survival\ Rate_{i,g,a,t} \\ & \times Net\ Migration\ Rate_{i,g,a,t} \\ & \times Adjustment\ Coefficient_{i,g,a,t}, \end{aligned} \tag{2.6}$$

Based on equation (2.6), JPC calculates its own projection of the female population aged 20-39 in the year 2040. Then, JPC computes the indicator that provides the basis for the extinction designation according to the following equation:

$$\frac{Population_{i,female,20-39,2040}}{Population_{i,female,20-39,2010}},$$

This indicator represents the magnitude of the female population aged 20-39 in municipality i in 2040, relative to the year 2010. The 896 municipalities with this indicator below 50% were listed as "extinct municipalities" in a list published in May 2014.

As noted above, this indicator, which is the basis for the JPC designation, relies on the future population projection of the IPSS. According to JPC, judging by an indicator simply calculated using the IPSS projection, 373 municipalities have an indicator below 50%. Therefore, there is a concern that these municipalities already expect the potential risk of extinction and that the list publication was not a true information shock for them. However, the concern is not serious for the following reasons. First, this indicator is a unique one, defined by the JPC and not included in the publication by the IPSS. Meanwhile, it is possible for these municipalities to calculate this indicator using the IPSS projection. Then, as a second check, I run DID regressions with 373 municipalities whose index is below 50% based on the IPSS projections and the other

523 municipalities as a treatment group, respectively.[58][59] Appendix Table 2.E.1 reports these results, indicating that the DID estimates for both Columns 2 and 3 are identical to the main estimate in Column 1. Based on the results above, I interpret the list publication in May 2014 worked as a real information shock for all municipalities, including the 373 municipalities.

[58] In other words, these are municipalities where the index is below 50% only after multiplying by the JPC's adjustment rate.

[59] In both cases, I use the same municipalities as the control group with the main estimates.

Table 2.E.1: the DID Estimates on Subsidized Spendings and Housing Markets

		Limited Treatment Municipalities	
		Based on IPSS	After JPC
	All Treatment Municipalities	projections only	adjustments only
Variables	(896 municipalities)	(373 municipalities)	(523 municipalities)
Panel A: Regional Revitalization Spending (1,000 JPY per Residents)			
Synthetic DID Estimates	5.4681***	4.9600***	5.3927***
	(0.8370)	(1.3299)	(0.9110)
Observations	21,710	14,911	17,017
Panel B: Child-oriented Spending (1,000 JPY per Children below 20)			
Synthetic DID Estimates	17.0338***	17.5731***	16.0860***
	(3.1812)	(3.9487)	(3.6838)
Observations	21,710	14,911	17,017
Panel C: Log of Purchasing Prices			
Synthetic DID Estimates	-0.0367***	-0.0396**	-0.0348**
	(0.0123)	(0.0197)	(0.0150)
Observations	2,733,019	2,555,594	2,586,982

Notes: The table reports the impacts of the designation of "the districts at the risk of extinction by 2040" on the regional revitalization spending per capita (Panel A), the child-oriented spending per children below 20 (Panel B), and the log of purchasing house price (Panel C). The estimate is control by covariates (see notes on tables in main estimate). Clustered-robust standard errors at the municipal level are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Chapter 3

The Impacts of Raising the Eligibility Age for Public Pension on Lifestyles of the Elderly People: Evidence from Japan

Abstract

Many countries face rapid population aging, and the sustainability of social security systems, including pensions, has become a serious common issue. I evaluate the causal effects of public pension reform on the employment and time allocation of the elderly. In Japan, the Pension Law was amended in 1994 to raise the eligibility age in order to reduce fiscal expenditures on social security. I use a regression discontinuity design (RDD) to estimate the impact of the 2001 reform raising the male eligibility age from 60 to 61. I run a sharp RDD with the month of birth as the running variable, and April 1941 as the cutoff for raising the eligibility age. I estimate the comprehensive impact on the lifestyle of the elderly, in addition to the employment rate. The results present that the pension reform increases employment rates and work hours, but has the effect of decreasing men's housework, leisure for relaxation, and social activities at the same

time. This study provides new evidence on the impact of social security reform, which is an important issue in many countries facing aging populations.

3.1 Introduction

In many countries, population aging is accelerating, and the sustainability of social security systems such as public health care and pensions is a serious common problem among policy makers. In OECD countries, a large portion of the shortfall in pension insurance payments is financed by transfers from national budgets, raising concerns about fiscal pressures caused by the aging of society (OECD (2021b)). The size of the working-age population is projected to fall in the future, while rising life expectancy will increase the length of retirement years in many countries. Figure 3.1 shows population projections for G20 member countries in the United Nations Population Projections (the United Nations (2022)). As the figures show, in the G20 countries, life expectancy at the typical eligibility age (age 65) increased from 11.43 years in 1960 to 16.71 years in 2020, the share of elderly people increased from 5.5% in 1960 to 11.8% in 2020. By 2050, these are projected to rise to 20.30 years and 22.5%, respectively. In this situation, the contribution rates will increase, and the pension replacement rate will decrease to ensure fiscal sustainability, bringing concerns about intergenerational fairness, which burdens the younger generation double (European commission (2021)). To deal with these challenges, many countries have implemented reforms of the public pension system. The primary target of the pension reforms is to mitigate the impact of increasing longevity and declining working-age population by improving incentives to work without retiring and increasing working life expectancy (OECD (2011b)).

Chapter 3 *The Impacts of Raising the Eligibility Age for Public Pension on Lifestyles of the Elderly People*: *Evidence from Japan*

Japan has the most aged population in the world. The share of elderly people in Japan has risen from 12.4% in 1990 to 29.6% in 2020 and is projected to reach 37.5% by 2050 (the United Nations (2022)). In Japan, the aging of the population has led to a significant increase in social security spending, from 11.01% of GDP in FY1990 to 22.85% of GDP in FY2020. In addition, the share of transfer to social security in the national budget rose from 16.6% in FY1990 to 34.9% in FY2020. In order to reduce the growing financial expenditure on social security for the elderly, the Japanese government has decided to reform the public pension system by raising the eligibility age. Based on this reform, the eligibility age for men was gradually increased from 60 to 65 years of age between 2001 and 2013 (with an increase of one year every three years). For women, this took place between 2006 and 2018.

It is critical to comprehensively examine and quantify the effects of the reforms in order to optimally design the public pension system. The impact of pensions on an individual's labor supply has been reported in previous studies. Krueger and Pischke (1992) reported that reduction of Social Security wealth during 1977 in the United States did not have a strong relationship with labor force participation of older men. Duggan et al. (2007) found that a reduction of the generosity of Social Security retired worker benefits in the United States, phased in by birth cohort, had an impact on the share of individuals receiving Social Security Disability Insurance (SSDI) benefits. Mastrobuoni (2009) exploited the reform in the United States that raised the normal retirement age (NRA) by two months each year for cohorts born after 1938 and showed that benefit reductions had the effect of promoting retirement behavior. Hanel and Riphahn (2012) indicated that the permanent reduction of retirement benefits in Switzerland in 1991 by raising NRA for women from 62 to 64 lowered the female retirement probability. Brown

(2013) estimated that labor supply elasticities are relatively insensitive to economic returns on labor, by using a kink in the budget line created by an unexpected increase in California's teacher's pension in 1998. Staubli et al. (2020) found that the raising the early retirement age (ERA) due to the Austrian pension reform increased employment for both affected men and women, while the one-year extension of the ERA resulted in a net government spending reduction of €107 million for men and €122 million for women. Manoli and Weber (2016) provide evidence that individuals respond to the financial incentive of employer-provided retirement benefits in Austria by delaying the timing of their retirement, and collect larger severance payments. Geyer and Welteke (2021) showed that a large increase in ERA for females born after 1951 in Germany had the effect of extending employment for employed women over age 60, while unemployed women remained unemployed. Kolsrud et al. (2024) used consumption indices constructed from Swedish administrative data and found that the public pension reform providing incentives for later retirement has a substantial and potentially pivotal consumption smoothing cost. In relation to Japanese literature, Yashiro and Oshio (1999) describe Japan's public pension system and discuss its relationship to the high labor participation of the older people in Japan. Nakazawa (2022b) estimated the effect on labor supply of the increase in the eligibility age for Japanese public pension, and showed that the effects from 60 to 61 for male, implemented in 2001, was the largest. This paper complements these literatures.

In this paper, I study how raising the eligibility age for public pension in Japan affected the lifestyles of the elderly. The income shock from raising eligibility age is expected to have a significant impact on the lifestyles of the elderly, such as inducing individual retirement, volunteer activities, sports, self-education, nursing or child care

and medical examination. There exists a greater expectation that the elderly will play an active role as "bearers of social activities" by realizing a "lifelong working society" that meets the needs of diverse lifestyles (Japanese Cabinet Secretariat (2019)). Hence, evaluating the impact of pension reforms on socio-economic activities among the elderly, including delayed retirement, is one of the most critical concerns for policymakers.[1] Additionally, all residents aged 20 or older must be covered by the Japanese public pension system. They become eligible for the pension by reaching the age required by law. The eligibility for public pension benefits in Japan is determined mechanically based on age only, without influence from actual employment status. This implies that the reform in Japan is an ideal natural experiment to evaluate the income shock of raising the eligibility age.

Specifically, I estimate causal effects by implementing a sharp regression discontinuity design (RDD) with governmental individual data on the time use of the individuals, where the running variable is the month of birth since this policy only affected specific birth cohorts. The main outcomes are employment status and the allocations of living time spending, such as work, social activities, and leisure. My dataset is the time-use survey conducted by the Japanese government every five years and includes the year 2001, the first year of the reform for men. In this empirical analysis, I primarily focus on the effect for males of the increase in the eligibility age from 60 to 61, setting births month in April 1941 as the cutoff. As a result, I obtained robust results with a discontinuous increase in employment rate and work-related time (work and commuting) and a decrease in housing work-related (e.g., housing work, and shopping), resting leisure

[1]Lifestyle changes are also important for the health of the elderly. Fitzpatrick and Moore (2018) found that Social Security eligibility at age 62 in the United States causes retirement and lifestyle changes, causing a significant increase in male mortality.

(e.g., watching TV and others), and active leisure (e.g., hobbies, sports).

The main contributions of my research are as follows. First, in addition to the impact on employment, I estimate causal effects on other activities related to the lifestyles of the elderly. Most previous studies of pension reforms have focused on the impact on retirement, with respect to the elderly's behavior. Although raising the pension eligibility age increases employment, which should substitutionally reduce other activities, the previous literature had paid little attention to these effects. If activities related to nursing care and health decline, other social security programs such as nursing and health insurance may be affected. Also, if volunteer and social activities become stagnant, this might require the government to take action to deal with the shortage of their bearers. This study provides an important perspective on the comprehensive impact of the policy on the elderly lifestyle.

Second, the present study estimates the causal effects of changes in pension eligibility. I provide rigorous estimates by using sharp RDD, regarding this reform as a quasi-experiment. Japan's pension system is compulsory, and eligibility to receive benefits is strictly based purely on age and is unaffected by actual employment status. Japan's reform targets the eligibility for the fixed-amount benefit. The amount of this benefit is determined by the length of the enrollment month and is independent of the worker's past earnings. This implies that this pension reform is a homogeneous income shock, which is the preferred natural experiment for interpreting policy effects.

Third, this study adds new evidence to the literature on individuals' time use. The various literatures have analyzed the impact of policy changes and events on time allocations. Aguiar and Hurst (2005) discuss the relationship between retirements and food consumption. They indicate that individuals smooth their food consumption by

substituting expenditures for times, illustrating the importance of paying attention to time use. Stancanelli and Soest (2012) run RDD regressions with the French Time Use Survey, and indicates that retirement not only increases one's own home production, but also affects their partner's time allocation. Aguiar et al. (2013) estimated the impact of the decrease in market work hours due to the great recession on other time uses, showing that about 50% of this decrease was spent on leisure and about 30% on home production. Gibson and Shrader (2018) used differences in sunset times in the United States and showed that an increase in sleep hours raises wages, a proxy for labor productivity. Giuntella and Mazzonna (2019) conducted a spatial RDD using natural light timing discontinuities at time zone boundaries to estimate the impact of "social jetlag" misalignment of social and biological rhythms on sleep duration and health outcomes.[2] In this paper, I estimate the causal effect of pension reform on time allocation by using a large micro data set of time-use surveys provided with me from the Japanese government. As a result, I report that raising the pension eligibility age from 60 to 61 for men increases the work-related time by 174.0 minutes, while decreasing housework-related by 30.3 minutes, leisure for relaxation by 33.2 minutes, and social activities by 78.2 minutes, in weekdays. To my knowledge, the present study is the first attempt to estimate the causal effects of public pension reform on time allocation.

Fourth, this study contributes to research on social security and health status. Dealing with the growing cost of health care for the elderly is a major challenge, and identifying the relationship between health and retirement is a significant concern for policymakers. I report a slightly significant decrease in medical examination or treatment time with

[2]For a study using the same data set as this paper, Lee et al. (2012) examined the impact of an exogenous policy change, a significant reduction in legal working hours in Japan, on the allocation of living time. They reported that the decrease in market work hours increased additional personal maintenance and leisure, not additional household production.

an increase in the eligibility age for men in 2001. My data set includes responses on subjective health status at 10 and 15 years after the reform (in 2011 and 2016, respectively). I obtained RD estimates with the share of those who responded "poor health" as an additional outcome. As a result, I find no evidence that pension reform has a negative impact on subjective health.

The remainder of the paper is organized as follows. The next section presents the institutional background. Section 3 explains the identification strategy, section 4 presents the data and descriptive statistics, and section 5 shows the empirical results. Section 6 summarizes the main points and offers conclusions.

3.2 Institutional Background

3.2.1 Public Pension System in Japan

Japan's public pension system consists of the Employees' Pension Insurance (EPI) and the National Pension (NP), as summarized in Appendix Table 3.B.1. EPI covers employees of both firms and the government, with a contribution of 18.3% of income (9.15% paid by each employee and employer). NP covers self-employed and dependent spouses of persons insured by EPI and others.[3] The contribution of NP is at 16,590 JPY per month, but dependent spouses are not required to pay any contributions. All citizens above 20 years old are covered by either EPI or NP.[4] While NP provides only a fixed amount benefit, EPI provides both a fixed amount benefit and an income-related

[3]More than 98% of dependent spouses are female in March 2021 (the Japanese Ministry of Health, Labour and Welfare, MHLW).

[4]Conceptually, there can be those who refuse to pay pension contributions., but more than 98% persons who covered by EPI actually pay contributions in FY 2021 (Japan Pension Service).

benefit. The fixed amount benefit is determined by the formula "1,630 JPY × number of months insured" and does not depend on the amount of income worked. Since the amount received is common for many people, it is called the "basic pension". The income-related benefit is "average monthly earnings × 0.7125% × number of months insured".[5] Pension eligibility is fulfilled once a person reaches the eligibility age, if he or she has paid contributions for at least 25 years (reduced to 10 years after August 2017). Therefore, when reaching the eligibility age, elderly persons who have paid contributions can receive a certain amount of money as a fixed amount benefit, regardless of their past income. Japanese insured persons can receive pension benefits even if they do not retire, but are subject to an earnings test. If current income exceeds a certain threshold (280,000 JPY per month)[6], a pension benefit of 1 JPY is deducted for every 2 JPY of earnings above the threshold.[7]

Table 3.1 presents an international comparison related to labor in older age and public pensions in 11 developed countries (Gruber and Wise (1999)). In Japan, unused labor capacity between ages 55-65 is the smallest among these (Column 1). Gruber and Wise (1999) indicates that social security systems - such as low replacement rates for public pensions (Column 2) and low implicit tax rates for continuing to work until age 69 (Column 3) - have a strong relationship with these retirement behaviors.[8]

[5]This is about the portion paid before March 2003. The benefit for the portion paid after April 2003 is "(average monthly earnings + bonus) × 0.5481% × number of months insured"

[6]This is for 60-64 years old. For those aged 65 and over, it is mitigated to 470,000 JPY per month.

[7]For 60-64 years old, the earnings test covers both fixed amount benefits and income-related benefits, while for those aged 65 and over, only income-related benefits are covered and fixed amount benefits are not.

[8]Japan s net pension replacement rate is 39% in 2020, which is lower than the OECD average (62%) and the United States (51%).

3.2.2 Raising the Pension Eligibility Age

Japan faces the most serious problem of population aging in the world. Figure 3.1 shows that the share of elderly people increased from 12.4% in 1990 to 29.6% in 2020 and life expectancy at 65 increased from 18.32 years in 1990 to 22.56 years in 2020. In addition, since the social security spending has raised from 11.01% of GDP in FY1990 to 22.85% of GDP in FY2020, the share of transfer to social security in the national budget expanded from 16.6% in FY1990 to 34.9% in FY2020, raising concerns about the sustainability of the pension system and national finances.

Therefore, the Japanese government decided to raise the eligibility age for receiving the fixed amount benefit of EPI from 60 to 65, and amended the Employees' Pension Insurance Law in 1994.[9] Since the eligibility age for the NP has been 65 from the beginning, only EPI was affected by this reform. As shown in Figure 3.2, the reforms were implemented at a pace of raising one age every three years, from 2001 to 2013 for men and from 2006 to 2018 for women.[10] Specifically, the pension eligibility age was raised from 60 to 61 for males born after April 1941, from 61 to 62 for males born after April 1943, from 62 to 63 for males born after April 1945, from 63 to 64 for males born after April 1947, and from 64 to 65 for males born after April 1949. The reform schedule for females proceeded five years behind that of males. Appendix Table 3.B.2 provides a summary of public pension reforms in several developed countries. As the table shows, other countries generally increase by a few months, whereas Japan has the largest range of increases, by one year. For example, the reform in Japan raised the

[9]The eligibility age for fixed amount benefits in the NP has been 65 from the beginning.

[10]In addition, in 2000, The government has amended the Employees' Pension Insurance Law again to raise the eligibility age for income-related benefits from 60 to 65. This reform is still ongoing, scheduled to implement between 2013 and 2025 for men and between 2018 and 2030 for women.

eligibility age by 1 year at a time, which is a larger raise than the reform in the United States (by 2 months at a time). Appendix Figure 3.A.1 represents the share of EPI and NP insured in 2004, respectively. These figures show that EPI's share of the insured population is only 36.5% for females, but 68.8% for males. Then, I focus mainly on reform for men, and additionally estimate the effect of reform for women.

Japan's social insurance system consists of three components: pension, healthcare, and nursing care. Healthcare insurance is a compulsory system that covers all individuals, but the amount of co-payment varies depending on the age of the persons. Basically, individuals have to pay 30% of their own medical expenses, but this is reduced to 20% for those under 6 and 70-74 years old, and 10% for those over 75 years old. Nursing care insurance is mandatory for individuals over age 40. Individuals certified as needing nursing care by municipalities are eligible for services, and persons over age 65 can be certified with broader requirements. Thus, the EPI eligibility age (60 to 64) before or during the reform is a unique one that differs from the eligibility ages of other social insurance systems.

My data set includes surveys from 2001 and 2006, the first years of the reform for men and women, respectively. Hence, in this paper, I estimate the causal effects of raising the eligibility age for the fixed amount benefit of EPI from age 60 to 61. As mentioned earlier, whether an individual joins NP or EPI depends on their employment status. However, my data set does not include information on which employment status the elderly worked in before retirement. Then I use the fact that education is recorded in the data set. According to Japan's Census in 2000, the share of employees in the workforce was more than 90% for those with a college degree or higher.[11] Hence, I focus

[11]For males, the share of employees in the workforce is 67.5% with a junior high school degree or less, 83.9% with a high school degree, 87.3% with a junior college or technical college degree, and

mainly on the individuals with a college degree or higher for males. For the analyses for women, I include those who have a junior college or technical college degree because these females also have a high employee share, and most women chose junior colleges rather than universities.[12]

3.3 Identification Strategy

3.3.1 Regression Discontinuity Design

I compare individuals' outcomes just above (treatment group) and below (control group) the cutoff in order to identify the effects of raising the eligibility age for the fixed-amount benefits of EPI. In my data set, the only years in which the year of reform coincides with the year of the survey are 2001, the first raises for men. I estimate the causal effects of raising the pension eligibility age from 60 or 61.[13] I use the month of birth as the running variable, and set the cutoff date as April 1941 for men. Specifically, I implement the sharp RDD estimation as follows: [14]

$$y_{it} = \alpha + \beta \cdot \mathbb{1}[Month\ of\ birth_i \geq cutoff\ date] + f(Month\ of\ birth_i) + \epsilon_i \tag{3.1}$$

91.4% with a college degree or higher. For females, the share of employees in the workforce is 65.2% with a junior high school degree or less, 82.4% with a high school degree, 90.5% with a junior college or technical college degree, and 90.3% with a college degree or higher.

[12] According to the Japan's Census in 2000, the number of employed women with a college degree or higher is 2,287,303, while that with a junior college or technical college degree is 4,869,705.

[13] Nakazawa (2022b) reports that raising in 2001 (ages 60 to 61) has the largest effect on the male employment rate. As this reason, he points out that the period between the policy announcement date and the implementation date was short, making it difficult for smoothing behavior to occur.

[14] In all RD regressions, I use the "rdrobust" software package developed and provided by Calonico et al. (2014).

where the outcome variable y_{it} is the individual i's the employment rate and the allocations of time use, such as work, social activities, and leisure. $\mathbb{1}[Month\ of\ birth_i \geq cutoff\ date]$ is a dummy variable that takes one if the individual i's month of birth is after the cutoff date and the zero otherwise. $f(Month\ of\ birth_i)$ is a smooth function of the individual i's month of birth on either side of the cutoff. ϵ_i represents the standard error, and I use the heteroskedasticity-robust standard error.[15] β is the coefficient of my main interest, which I interpret as the causal effect of raising the eligibility age for the fixed-amount benefit of EPI from 60 to 61.

Additionally, I run a sharp RDD about reform for women in 2006 by setting the cutoff date as April 1946. I also estimate not only for the elderly themselves, but also for their spouses and to identify spillover effects within the household. In the baseline estimation, the shape of $f(Month\ of\ birth_i)$ will be used in local linear functional form, a triangular kernel, and an optimal bandwidth that minimizes the mean squared error. As a robustness test, I also estimate the second order polynomial and uniform kernel using several bandwidth sizes.

3.3.2 Validity Tests

In order to estimate the causal effects in RDD, the continuity assumption must hold. First, for the RDD to be unbiasedly estimated, the running variable should not be manipulated. Since the running variable in this paper is the individual's birth month, no concerns about manipulation exist. In addition, I conducted the density test proposed by McCrary (2008) to examine whether the running variable is manipulated at the cutoff.

[15] Kolesár and Rothe (2018) recommends using heteroskedasticity-robust standard errors instead of clustered standard errors on the running variables in RDD with a discrete running variable.

Appendix Figure 3.A.2 shows the results of the density test. Since the p-value is 0.550 for males in 2001, so the null hypothesis that "density is continuous at the cutoff" cannot be rejected. indicating evidence of manipulation is not observed.

In addition, in order to test whether continuity assumption may hold or not, I implement covariate balance tests for observable predetermined variables. Appendix Figure 3.A.3 plots covariates along the running variable and solid lines with second-order polynomial fitted curves. These figures show that there seems to be no discontinuity, and the p-values are not statistically significant, which suggests that the research design satisfies internally validity. Finally, I run RD regressions using placebo cutoffs. Appendix Table 3.B.3 reports the placebo RD estimates of employment rate and working hours during weekdays and weekends. The results are statistically insignificant, and the signs are unstable. Hence, there is no evidence that shows placebo effects exist.

3.4 Data

I use the Survey on Time Use and Leisure Activities (Shakai seikatsu kihon chosa)[16] to obtain data that represents the individuals' lifestyles. This is a large-scale repeated cross-section survey implemented every five years by the Statistics Bureau, the Japanese Ministry of Internal Affairs and Communications (MIC), started from 1976. The survey covers approximately 190,000 randomly-sampled individuals aged above ten years old. Japan's Statistics Law requires these individuals to respond accurately on this survey, and the response rates are about 95.0%. Aggregate data is publicly available, but access to individual data is limited to the ministry officials or academic researchers

[16]This survey corresponds to the American Time Use Survey (ATUS) in the United States.

commissioned by the government. I obtain this survey individual data of this survey in 2001, 2006, 2011, and 2016 from MIC, including the period when public pension reforms were implemented.

The survey asked respondents how much time they spent on each activity during two days (48 hours) in October. This allows for a comprehensive understanding of which activities they have allocated their time to, including sleep, shopping, nurse caring, self-education, and volunteer activities, rather than simply whether they are employed or not. Appendix Table 3.B.4 presents examples of detailed categories. In addition, this survey questionnaire includes each individual's personal attributes such as date of birth, marital status, level of education. Since the questionnaires are distributed on a household level, we can check not only the individuals themselves, but also on their spouse.

Table 3.2 reports the summary statistics for the outcomes and covariates used in the empirical analysis. This table shows that my data set contains 30,576 observations for males with a college degree or higher in 2001. This has 9,584 observations when the sample is restricted to ages 50-70. The average daily work-related time use is about 300 minutes, housework-related time is about 50 minutes, leisure time for relaxation is about 250 minutes, and social activities are about 150 minutes. Appendix Table 3.B.5 shows that, for females with a junior college degree or higher, the data set contains 42,711 observations in 2006. The sample is restricted to ages 50-70 has 10,244 observations. In contrast to men, women use less than about 200 minutes for daily work-related time and more than about 250 minutes for housework-related time.

3.5 Empirical Results

3.5.1 Impacts on the Employment Rate and Work-related Time Use

3.5.1.1 Raising the Eligibility from 60 to 61 for Male in 2001

3.5.1.1.1 Graphical Evidence for Males

Figure 3.3 presents graphical evidence of the effect of the pension reform on the employment rate by equation (3.1). Specifically, this study focuses on the impact of the 2001 increase in the pension eligibility age from 60 to 61 on the male employment rate. This figure plots the percentage of employed persons excluding self-employed and family workers, the horizontal axis is the running variable ($f(Month\ of\ birth_i)$), and the straight lines represent linear fitted values. The cutoff is set at zero for those born in April 1941, at which point they become the target of the 2001 pension reform. The sample on the right is individuals whose eligibility age is 61, and the sample on the left is individuals whose eligibility age is 60. This figure shows that there exists a discontinuity at the cutoff point. Appendix Figure 3.A.4 plots employment rate using locally weighted scatterplot smoothing (LOWESS) values or no bins. As in Figure 3.3, there is a clear discontinuity at the cutoff.

3.5.1.1.2 RD Estimation Results for Males

Table 3.3 shows the results of the RD estimates of raising male pension eligibility age from 60 to 61, implemented in 2001. As described in section 4, the baseline uses a local linear functional form with a triangular kernel. The bandwidth of the estimates is set by two different mean squared-error (MSE)-optimal bandwidth selectors. Column 1 reports the causal effect on the employment rate, Column 2 the effect on the time-use for

work during weekdays (Monday through Friday), and Column 3 the effect on the work time during weekends (Saturday and Sunday). As the graphical evidence indicates, the RD estimates are observed to have positive effects at the cutoff for raising the pension eligibility age. All estimates are statistically significant at the 1% level. The results imply that the pension reform has the effect of increasing the employment rate by 22.1% and the use of work time on weekdays by 174.0 minutes (2.90 hours) per day. Although the magnitude is smaller than the weekday effect, an increase of 47.6 minutes (0.79 hours) per day is reported for work time on weekends. Thus, these results indicate that raising the pension eligibility age has the effect of encouraging the elderly to work, consistent with previous literature.

As robustness tests, Appendix Table 3.C.1 shows the results of the sensitivity analysis. First, I run the RDD with different lengths of bandwidth. Specifically, I use 30 bandwidths longer and 30 bandwidths shorter than two different MSE-optimal bandwidth selectors and two different coverage error rate-optimal bandwidth selectors. Panel A shows that the statistical significance and magnitude of the estimates do not change for all bandwidths, indicating that these RD estimates are robust. Second, I run the RD with several functional form s and kernels. Panel B reports that all RD estimates remain statistically significant and positive. Third, I extend the sample to include all educational backgrounds, including elementary school graduates, not just those with a college degree or higher. Panel C indicates that the employment rate and weekday work time remain statistically significant for all educated individuals, although the estimates become smaller. The reasons for the smaller estimates may include the following: First, this reflects the fact that the less educated are more likely to be self-employed or family workers, who are not affected by the reform. Second, higher-wage workers are more

affected by the raise in pension eligibility (Staubli and Zweimüller (2013)).[17]

In addition, I test the possibility that these RD estimates are not due to the reforms of raising the eligibility age, but only to pension receipt, such as the easing of liquidity constraints. Specifically, I pool data sets from 2006 to 2016 and run RD regressions. I set the cutoffs to the birth month when they just reach the eligibility age in October (the survey month) of each year, respectively.[18] I add year dummies to equation (3.1) as covariates. In this case, since the individuals simply receive their scheduled pensions after each cutoff, there are no income shocks before or after the cutoff. In addition, I can mitigate a bias at each age by using the reform to pool individuals with different eligibility ages, such as 62 in 2006, 64 in 2011, and 65 in 2016. Appendix Table 3.C.2 reports the RD estimates on employment rate and work time use on weekdays and weekends. All RD estimates are not statistically significant and signs are not consistent. This indicates that the RD estimates represent an income shock due to the raise in the eligibility age from 60 to 61.[19]

3.5.1.2 Raising the Eligibility from 60 to 61 for Feale in 2006

3.5.1.2.1 Graphical Evidence for Females

The raising of the pension eligibility age for women began in 2006, five years later than for men. Panel A of Appendix Figure 3.A.6 plots the average share of employed persons

[17] However, Nakazawa (2022b) found that no heterogeneity in education levels were observed in Japan's pension reforms. In addition, Fitzpatrick and Moore (2018) reports that the effect of Social Security Eligibility in the U.S. was greater for the less educated, and Lindeboom and Montizaan (2020) indicates that the reform in Netherlands increased labor supply among the average treated worker, excluding those with high incomes.

[18] The cutoffs are set to be born in October 1944 in 2006, October 1947 in 2011, and October 1951 in 2016, respectively.

[19] This result contrasts with the conclusion of Seibold (2021) and Lalive et al. (2023), which indicated that a reference dependence affects retirement behavior more than the financial incentives themselves.

excluding self-employed and family workers. The horizontal axis represents the running variable ($f(Month\ of\ birth_i)$), the straight lines are linear fitted values, and the cutoff is zero for those born in April 1946. Females born after this point are covered by the 2006 pension reform. In other words, individuals to the right of the cutoff have an eligibility age of 61, while those to the left have an eligibility age of 60. In contrast to men, this panel shows that no discontinuity seems to exist at the cutoff point. Additionally, Panel B of Appendix Figure 3.A.6 presents the average work-related time during weekdays (Monday through Friday), showing that a discontinuity appears to exist at the cutoff.

3.5.1.2.2 RD Estimation Results for Females

I estimate the effects of raising the eligibility age for the fixed-amount benefits of EPI for women in 2006 by using a sharp RDD. The reform for women was five years later than for men, so the cutoff is set to be born in April 1946. Appendix Table 3.B.6 shows that the RD estimates on the employment rate and work time uses, for females with a junior college degree or higher. Column 1 shows that the effect on employment rate is less significant and smaller than the effect for males, indicating that the magnitude of the impact of the reform on women could be small. However, the effects on work time per day are observed more clearly than the employment rate: 76.7 minutes (1.28 hours) on weekdays and 30.0 minutes (0.50 hours) on weekends. The magnitude of the work time increases is smaller than for men, but its impact is close to males, at about 30%. These results can be interpreted that the raise in the eligibility age for females has the effect of increasing the working hours rather than the employment rate. The smaller effect for females than for males may be because men have higher employment rates, to begin with, and the gender bias that men are "household earners," so their response to

the income shock of the reforms tends to be more significant. In addition, the share of those affected by the reform may be small because, due to historical context, the raising the eligibility age for female government officials has been those born in April 1941, the same as men.[20]

As robustness tests, Appendix Table 3.C.3 shows the results of the sensitivity analysis for women. Panels A and B report RD estimates with several bandwidths and functional forms. Although the effect on employment rate is not statistically significant, the results for work time are robust. In addition, Panel C reports that the RD estimate on employment rate becomes statistically significant at 1% level for all educated individuals. This is consistent with the results of Hanel and Riphahn (2012), which reported that less-educated females respond most strongly to changes in retirement incentives.

3.5.1.3 RD Estimation Results of Long-run Impacts for Males

Individuals might adjust their retirement behavior and work practices over time in response to an income shock from an increase in the eligibility age. As an additional analysis, I estimate the impact of raising the eligibility age from 60 to 61 on outcomes 5 and 10 years after the reform, using my set of data from 2006, 2011, and 2016.[21] Appendix Table 3.B.7 represents the RD estimates of the long-run impacts. Panel A shows the effects for males, and Panel B for females. Almost all estimates are not statistically significant, have unstable signs, and are small in magnitude. These results

[20] Other possible explanations include that the decision on pension scheduling was made for men and women at the same time, so females had a longer anticipation period, which may have mitigated the impact on labor supply (Nakazawa (2022b)). Huixin and Zubairy (2023) analyze public pension reforms in 10 OECD countries, including Japan, and find that as well as the income effect channel, there is a foresight channel, which means that when pension cuts are announced in advance, retirees react to the news and retire earlier.

[21] It should be noted that my data set is not panel data, but repeated cross sections.

imply that the reduction in lifetime incomes due to raise in the eligibility age may be compensated primarily by continuing to work during the period when pensions are not available.

3.5.1.4 RD Estimation Results for Males' Spouses in 2001

The impact of pension benefits on spouse behavior is also an important research topic for pension reform. Gelber (2014) analyzed a large-scale tax reform in Sweden and found that when the tax rate for an individual falls, the income of the spouse also rises, meaning that the labor supply of the couple is complementary. Since my data set can identify spouses within household, I run RD regressions on the wife's employment rate and work time use by setting the husband's month of birth as the running variable. Appendix Table 3.B.8 illustrates the RD estimates of the 2001 pension reform on the outcomes, showing that employment or work time uses are not affected by spouse facing the pension reform. This result is consistent with Stancanelli and Soest (2017), which reported that in the French public pension reform, the wife's retirement probability did not respond when the husband was affected by the reform.

3.5.2 Impacts on Other Time Uses

3.5.2.1 Raising the Eligibility from 60 to 61 for Male in 2001

3.5.2.1.1 Graphical Evidence for Males

Figure 3.5 plots the other time uses for males, the horizontal axis is the running variable ($f(Month of birth_i)$), and the straight lines represent linear fitted values. The cutoff is set at zero for those born in April 1941, where the eligibility age of males was raised from

60 to 61 in 2001. In this figure, I also restrict my sample to weekdays because work-related time can vary substantially between weekdays (Monday through Friday) and weekends (Saturday and Sunday). I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV, etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. Panels of this figure show that although not as convincing as work time use, there are visual discontinuities in housing-related, leisure for relaxation, and social activities. Appendix Figure 3.A.7 plots the employment rate using LOWESS values or no bins. Overall, there is more variation than in employment rates and work time, indicating that the lifestyles of the elderly are diverse.

3.5.2.1.2 RD Estimation Results for Males

Table 3.4 reports the RD estimates of raising male pension eligibility age from 60 to 61, implemented in 2001. The baseline uses a local linear functional form with a triangular kernel and two different MSE-optimal bandwidth selectors. Panel A represents the causal effect on the time use during weekdays, Panel B the effect during weekends. As the graphical evidence shows, I obtained statistically significant and negative effects of weekday's time use for housing-related (-30.3 minutes), leisure for relaxation (-33.2 minutes),[22] and social activities (-78.2 minutes). In particular, the impact derived from dividing the RD estimates by the mean for ages 50 to 70 is very large for housing-related and social activities. Time use for social activities has a statistically significant

[22]This means that the magnitude of time uses for housing-related and leisure-for-relaxation is almost identical. This result is consistent with prior literature findings that when one or more household members shift from full-time work to not working, leisure and household production increase proportionally after retirement (Rogerson and Wallenius (2018).

negative effect at the 5% level, also during weekends. Additionally, time use for medical examination is statistically significant, at the 5% level, which might raise concerns about health issues.

In order to identify the impact of the increase in the eligibility age on lifestyle in detail, I also conduct RD estimations for the detailed categories. Appendix Table 3.B.9 presents the RD result of detailed categories. On weekdays, housework, shopping, hobbies, and sports decreased at the 1% level of significance, and watching TV etc. at 5% level. These estimates have impacts with large magnitudes.[23] Since the effects on nursing care and social life are statistically insignificant, negative effects on elderly care or social life are not observed. In addition, no significant effects on volunteers are found, indicating that the increase in market labor does not raise concerns about crowding out non-market work outside of the home. I would also note the effect on sleep. Sleep length is not only related to health status but also to the labor productivity of individuals (Gibson and Shrader (2018)). RD estimate indicates that the increase in work time due to the pension reform has no significant effect on sleep. The time allocation on weekends has no significant response in any categories, suggesting that the behavioral change occurs primarily on weekdays.

3.5.2.2 Raising the Eligibility from 60 to 61 for Feale in 2006

3.5.2.2.1 Graphical Evidence for Females

Appendix Figure 3.A.8 shows the average other time use during weekdays (Monday through Friday) for women. The horizontal axis is the running variable ($f(Montho f birth_i)$),

[23] Additionally, housework and shopping are negative and statistically significant, and as shown in Appendix Table 3.B.4, the former includes cooking and the latter includes purchasing food. These results are consistent with the argument by Aguiar and Hurst (2005) that retirement has a positive relationship with the frequency of shop for food and the use of time for food production.

normalized to zero for births in April 1946, the target of the 2006 reform. The straight line are linear fitted values. These panels indicate that there seems to be no convincing discontinuity, including housing-related, leisure for relaxation, and social activities, where a discontinuity is likely to be present for men. This implies that there is more variation than in female lifestyles than males.

3.5.2.2.2 RD Estimation Results for Females

Next, I also estimate the effects of raising the eligibility age for the fixed-amount benefits of EPI for women in 2006. Appendix Table 3.B.10 shows the RD estimates by using a local linear functional form with a triangular kernel and two different MSE-optimal bandwidth selectors. Panel A reports the estimates of time use on weekdays, Panel B the effect on weekends. Similar to males, the effect on social activities during weekdays is statistically significant and negative, although the magnitude of the impact is about half (-32.2 minutes). It is notable that the effect on housework-related time is significantly negative for men, whereas it is negative but not statistically significant for women. This implies that the increase in work time is replaced by social activities and that housework continues to be done by females, suggesting the existence of a difference across genders.

I conduct RD estimates for detailed categories as well, identifying the impact of the pension reform on lifestyles. Appendix Table 3.B.11 presents the result of RD regressions. While no significant reduction effect is found in either category on weekday housework-related time, a positive effect is estimated for weekend nursing care time. Since no negative effects can be observed in sleep, sport and medical examination, there may be small concerns about worsening health status. In addition, in contrast to men, no significant effect on watching TV is found for women, despite the fact that the

average length is about 2 hours for both genders. This may also reflect the normative consciousness that females prioritize rest inside their homes rather than social activities.

3.5.3 Impacts on Health outcomes

The impact of pension reform on health outcomes is one of the major issues in the prior literature. In Grossman (1972)'s health capital model, health has two features: as a consumption good that increases utility and as an investment good that increases productivity. Retirement eliminates the incentive to invest in productivity, but may also increase consumption due to increased free time. In addition, retirement can have both positive effects that remove the emotional or physical burden from the workplace and negative effects through loss of occupational responsibility and the unhealthy lifestyles. Therefore, in the increase in work time due to the pension reform, it is ambiguous about which impact is more significant. Frimmel and Pruckner (2020) estimated that an increase in the retirement age, by raising the pension eligibility age in Austria, reduced subsequent medical visit and health care spendings, arguing that this may be due to lower levels of mental and physical stress. Kuhn et al. (2020) exploited a policy change in Austria and found that early retirement in men had strong negative effects on health and significantly increased the risk of early mortality because of the decline in contemporaneous income and change to an unhealthy lifestyle.

I estimate the impact on health status of the increase in the pension eligibility age for men from 60 to 61. Since my data set in 2011 includes respondents' self-rated health status, I use this as the outcome. Specifically, I define a dummy variable that takes one if the self-rated health status is answered "not good" or "poor" as the outcome. Appendix Table 3.B.12 presents the result for both males and females. Column 1 reports the effect

on self-rated health status for males in 2011 and Column 2 for females in 2016 as an effect 10 years after the reform. Since none of these are significant, it indicates that the reforms did not affect the health status, at least subjectively.

3.6 Conclusion

Many countries face rapid population aging, and the sustainability of social security systems, including pensions, has become a serious common issue among policy makers. Since Japan has the largest population of elderly people in the world, the Japanese government has decided to reform the public pension system by raising the eligibility age in order to reduce fiscal expenditures on social security and ensure its sustainability. The income shock from the raising of the eligibility age is expected to have impacts not only on individual retirement, but also on the lifestyles of the elderly, including social activities such as volunteering and sports. Therefore, it is critical to comprehensively examine the effects of the reform.

The first contribution of this paper is presenting new evidence on various activities related to the lifestyles of the elderly in addition to employment. Raising the eligibility age should increase employment and alternatively decrease other activities, but previous literature has yet to study this point in depth. The paper shows that pension reform increases employment rates and work hours, but has the effect of decreasing men's housework, leisure for relaxation, and social activities at the same time. In addition, the impact of pension reform on females similarly increases work time, but differences are observed in some respects, such as housework. These results provide clear evidence needed for a comprehensive understanding of the effects of pension reforms.

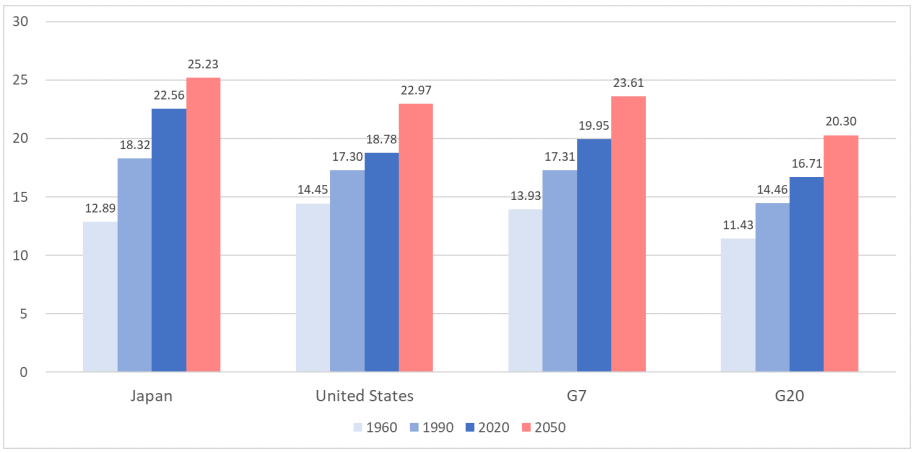
Second, I estimate the rigorous causal effects of the pension reform by using a sharp RDD. Since Japan's fixed amount pension benefits only rely on age and are not affected by employment status or income levels during working, I can interpret the increase in the eligibility age as a clear income shock. This study of this natural experiment adds new evidence to the literature on social security reforms. Third, this paper contributes to the research on individual time use and health. As far as I know, this paper is the first study that estimates the causal effects of pension reform on time use. In addition, the effects on sleep and medical examinations are not statistically significant, consistent with the result that self-rated health status does not have a significant impact. Since social security spending has increased partly due to the expansion of healthcare costs, this paper that analyzes pensions and health may be helpful to policymakers.

As with any research, the present study has certain limitations. First, these RD estimates are limited to the around the cutoff, and we must be careful in generalizing this conclusion. Second, the pension system and pension reforms are different in each country, so care should be taken when applying the results here to other countries.[24] These are issues for further research.

[24]Time use surveys have been implemented in many countries, including Europe as well as the United States and Japan (Gimenez-Nadal and Molina (2015)).

3.7 Figures and Tables of Chapter 3

(a) "Life Expectancy at the Typical Eligibility Age (age 65)"



(b) the Share of Elderly People (above Age 65)

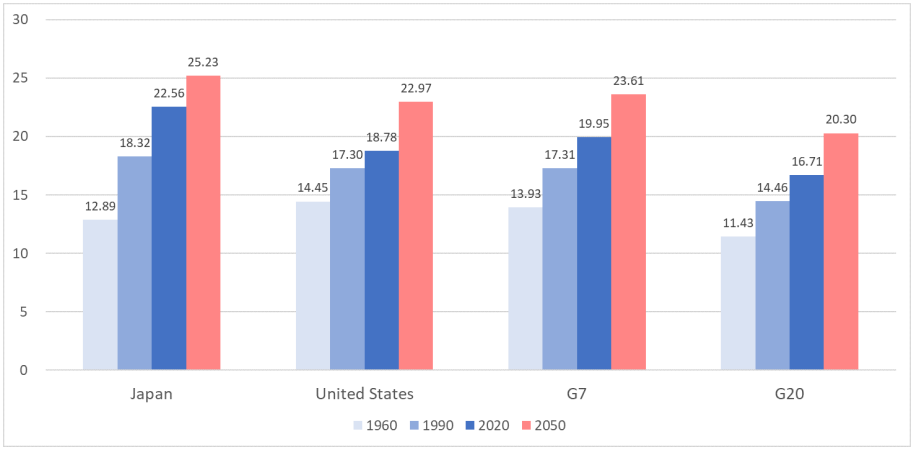


Figure 3.1: Future Population Projections for Countries

Notes: the United Nations (2022).

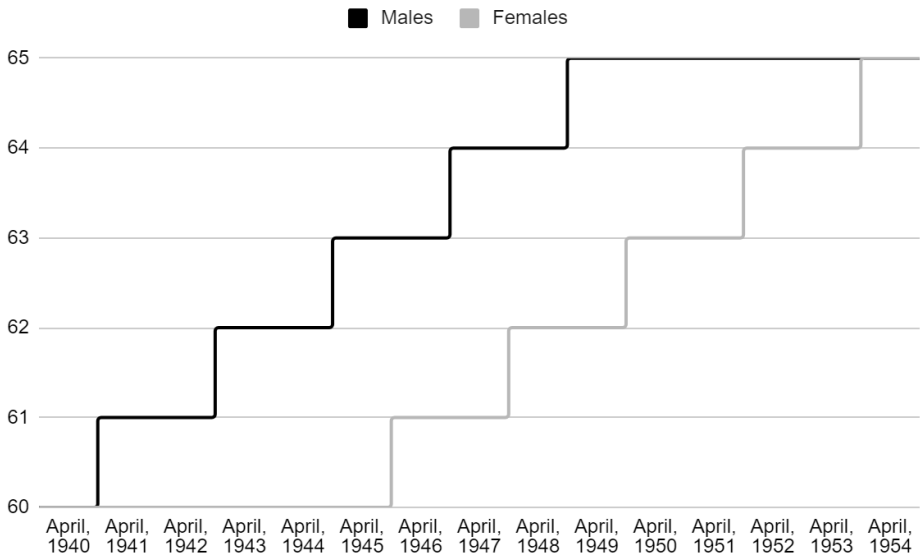


Figure 3.2: the Schedule of the Raising Eligibility Ages for EPI's Fixed Amount Benefit

Notes: This figure plots the male and female eligibility ages for EPI's Fixed Amount Benefit by month of birth.

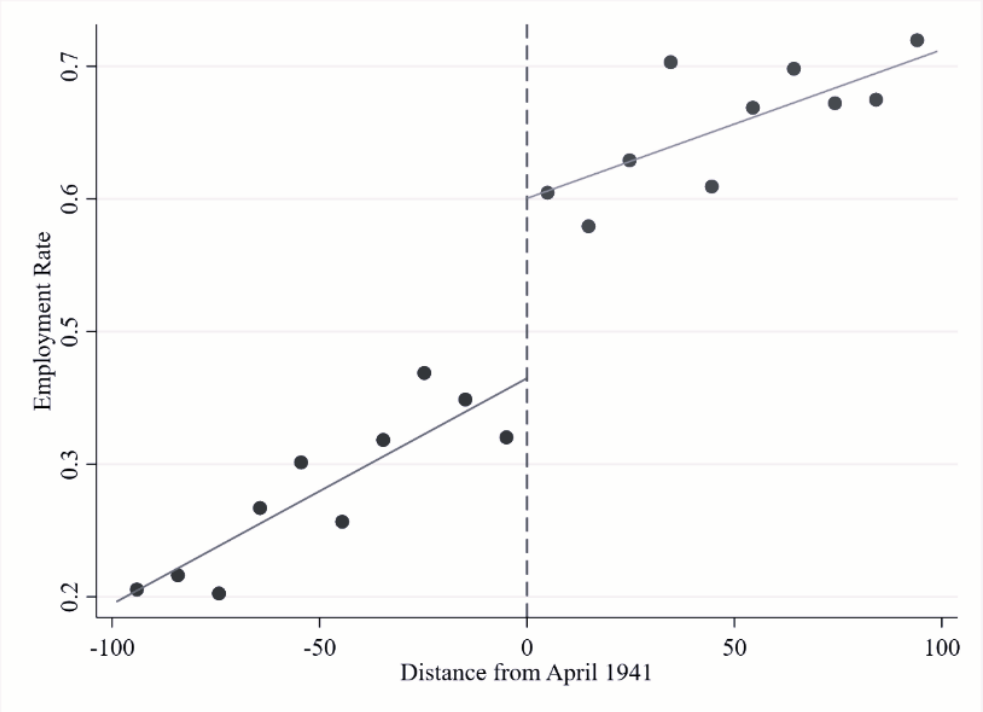


Figure 3.3: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment (Male, 2001 reform)

Notes: This figure plots the average employment rate for males with a college degree or higher. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

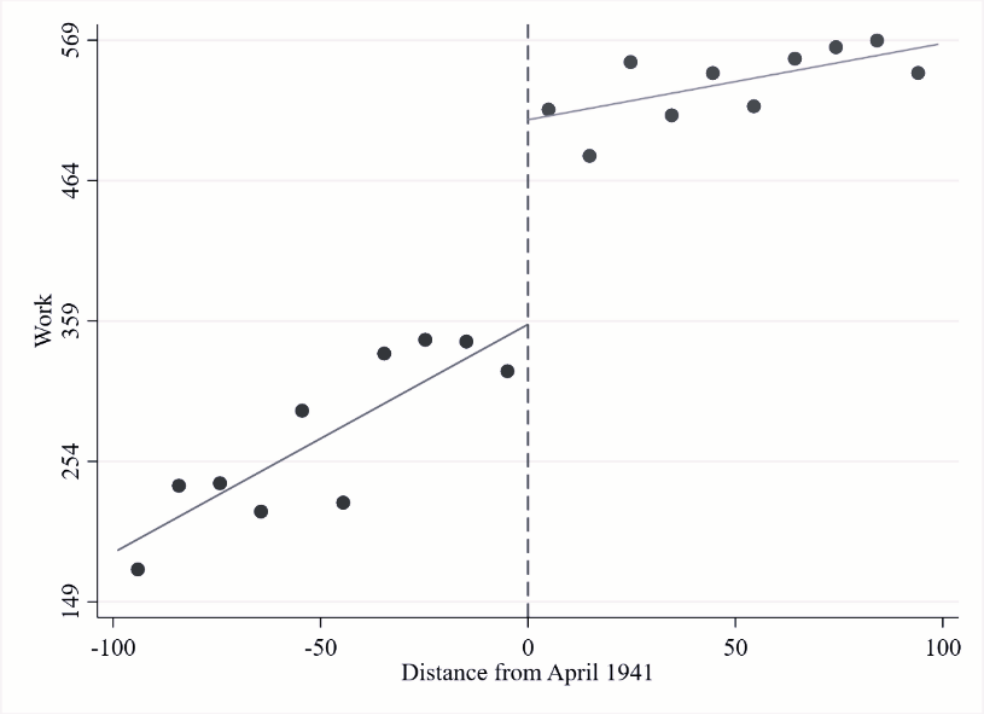


Figure 3.4: RD Estimates of Raising Eligibility Age from 60 to 61 on Work Time Use (Male, 2001 reform)

Notes: This figure plots the average work time use for males with a college degree or higher during weekdays. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

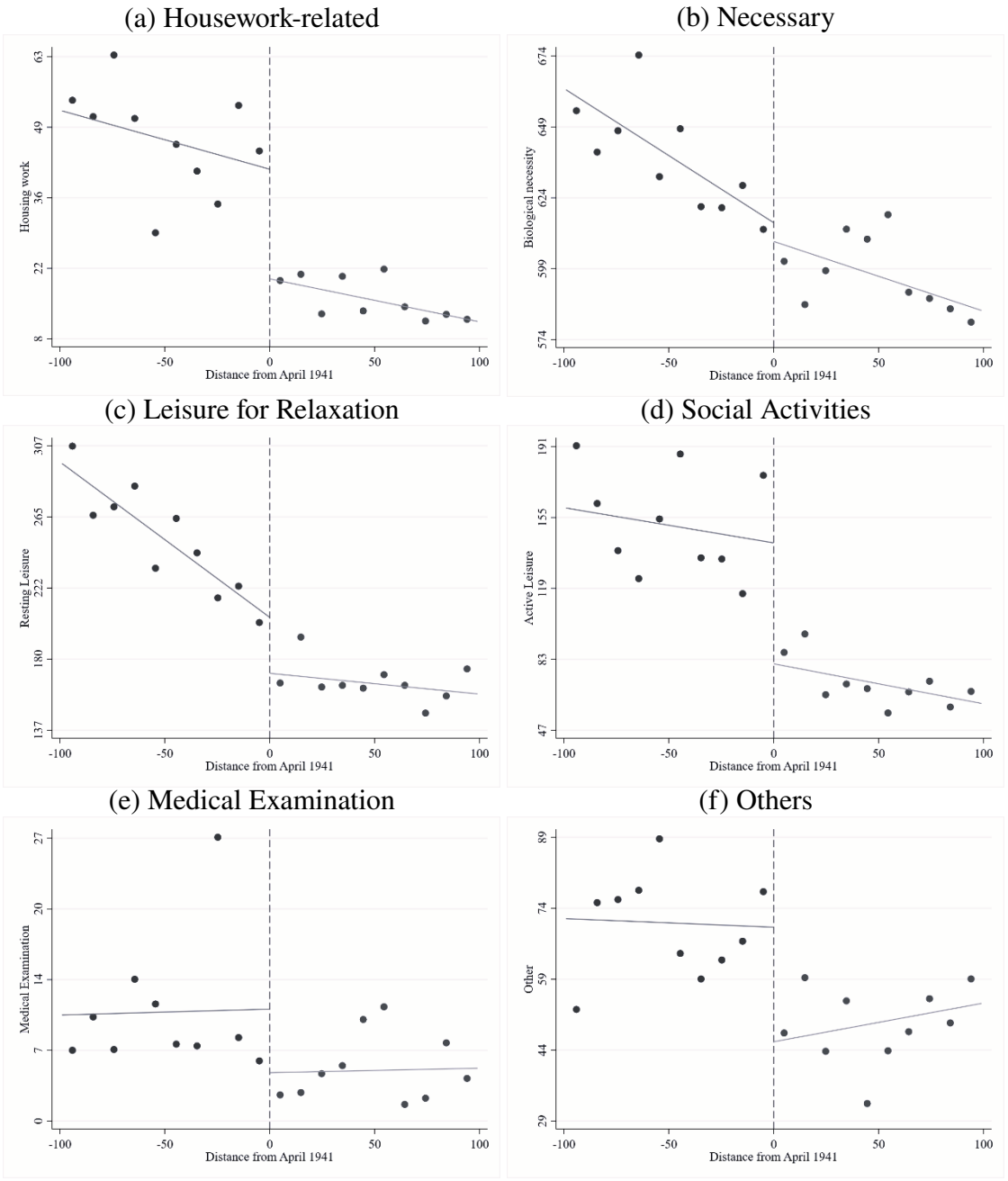


Figure 3.5: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Male, 2001 reform))

Notes: These figures plot the average time uses for males with a college degree or higher during weekdays. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

Table 3.1: Comparison of Labor Force and Public Pension by Developed Countries

Countries	Unused Labor Capacity, Age 55-65	Men Out of Labor Force, Age 59	Replacement Rate at Early Retirement Age (%)	Tax Force Early Retirement Age to 69
Belgium	67	58	77	8.87
France	60	53	91	7.25
Italy	59	53	75	9.2
the Netherland	58	47	91	8.32
the United Kingdom	55	38	48	3.77
Germany	48	34	62	3.45
Spain	47	36	63	2.49
Canada	45	37	20	2.37
the United States	37	26	41	1.57
Sweden	35	26	54	2.18
Japan	22	13	54	1.65

Notes: Gruber and Wise (1999).

Table 3.2: Summary Statistics for Males in 2001

	Full Sample		Age 50-70	
Variables	Mean	Standard deviation	Mean	Standard deviation
Employment rate	0.71	0.45	0.55	0.50
Work related	314.94	323.34	266.41	300.31
Work	282.16	291.55	237.37	268.71
Commuting	32.77	52.95	29.05	52.51
Housework related	46.46	89.75	45.69	85.77
Housework	15.72	50.40	22.12	61.74
Nursing care	1.45	17.81	2.37	23.42
Child care	7.52	40.40	1.33	17.83
Shopping	21.76	49.85	19.87	44.26
Necessary	630.16	128.89	634.56	115.13
Sleep	466.59	104.43	461.28	88.28
Personal care	66.01	58.48	67.86	57.59
Meal	97.57	44.78	105.42	45.36
Leisure for relax	233.58	179.83	259.55	180.22
Watching TV etc.	152.82	152.25	178.03	155.18
Relaxation	80.75	106.36	81.53	105.05
Social activities	140.75	179.19	152.60	178.20
Studies	17.85	66.11	21.03	69.73
Hobbies	60.76	121.16	63.32	120.54
Sports	20.61	69.34	27.35	78.28
Volunteer	8.98	54.34	9.44	53.13
Social life	32.55	93.76	31.46	87.30
Medical examination	4.63	38.53	5.92	46.57
Others	69.49	115.69	75.26	121.76
Share of Marriage	0.76	0.42	0.93	0.25
	30,576		9,584	

Notes: This table reports the means and standard deviations of the employment rate, time use per day, and marital status for males with a college degree or higher in 2001. Columns 1 and 2 represent the full sample, and columns 3 and 4 show the sample is restricted to ages 50 to 70. Employment rate and marriage are equal to one if individuals are employed (excluding self-employed or family workers) or married and zero otherwise. Time uses are at the minute level.

Table 3.3: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use (Male, 2001 reform)

		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
RD Estimate	0.2211***	174.01***	47.62***
	(0.0342)	(27.47)	(16.45)
Mean of the dependent variable	0.546	456.6	158.1
Impact of the reform (%)	40.5%	38.1%	30.1%
Observations	30,576	11,457	19,119

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1) and time use per day (Column 2 and 3) for males with a college degree or higher in 2001. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.4: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Use (Male, 2001 reform)

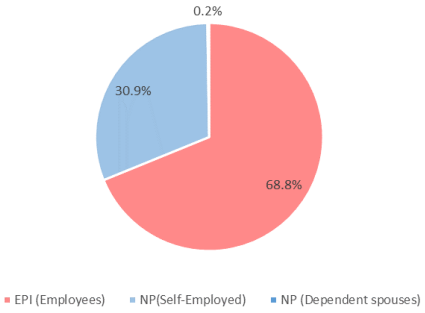
Variables	Housework-related	Necessary	Leisure for Relaxation	Social Activities	Medical Examination	Others
Panel A: Effects on Time Uses during Weekdays						
RD Estimate	-30.27***	-0.14	-33.22**	-78.15***	-7.25**	-23.46**
	(8.88)	(10.72)	(14.07)	(18.42)	(3.60)	(10.62)
Mean	26.65	607.5	193.1	95.27	6.22	54.67
Impact (%)	-113.6%	0.0%	-17.2%	-82.0%	-116.6%	-42.9%
Observations	11,457	11,457	11,457	11,457	11,457	11,457
Panel B: Effects on Time Uses during Weekends						
RD Estimate	-0.30	0.66	-14.85	-29.59*	6.37**	-13.81
	(7.11)	(8.36)	(14.34)	(15.68)	(2.75)	(9.08)
Mean	56.53	650.0	297.4	185.3	5.748	86.99
Impact (%)	-0.5%	0.1%	-5.0%	-16.0%	110.7%	-15.9%
Observations	19,119	19,119	19,119	19,119	19,119	19,119

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the time uses per day for males with a college degree or higher in 2001. Panel A represents the time use during weekdays, Panel B during weekends. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix

Appendix 3.A Figures

(a) Males



(b) Females

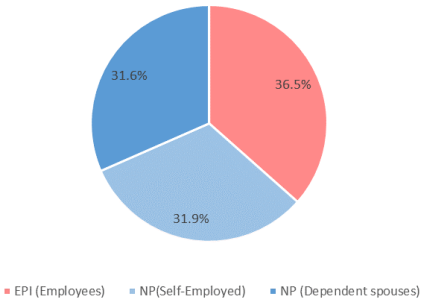


Figure 3.A.1: the Share of EPI and NP Insured in 2004

Notes: "Statistics on Employees' Pension Insurance and National Pension Programs," Japanese MHLW.

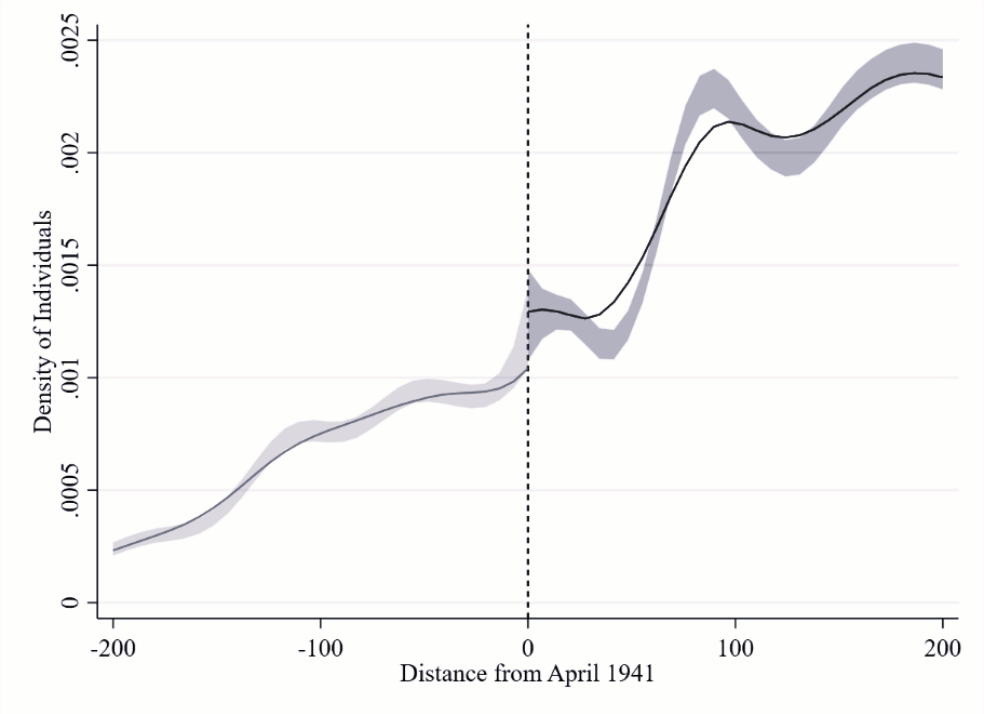
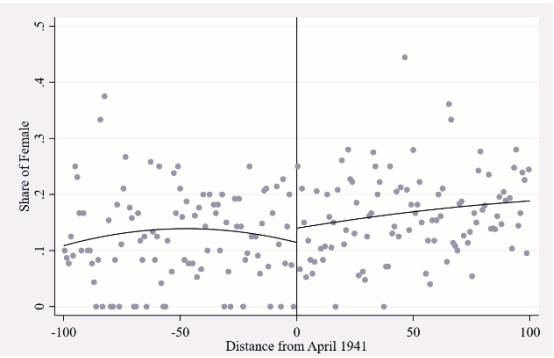


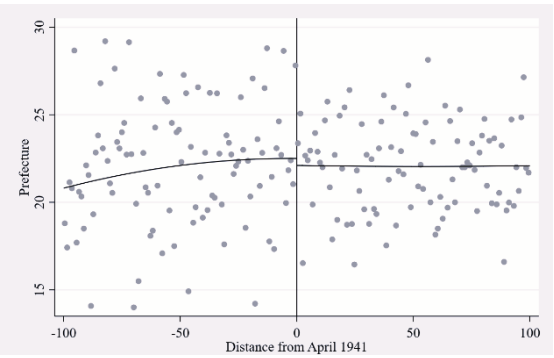
Figure 3.A.2: Density Estimate of Running Variable (Month of Birth)

Notes: The figure reports the density of running variable ($Month\ of\ birth_i$) for males in 2001, and the p-value is 0.550. The p-values for the density test for females in 2006 is 0.124.

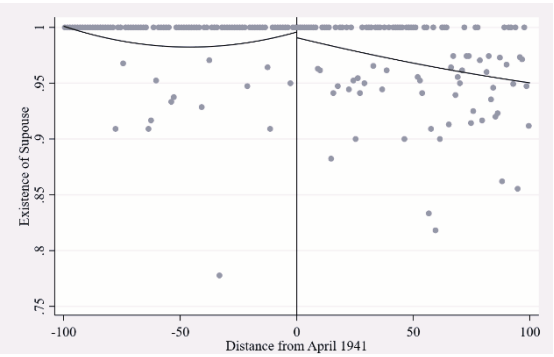
(a) Share of Females



(b) Prefectures



(c) Marriage Experience



(d) Share of Weekends

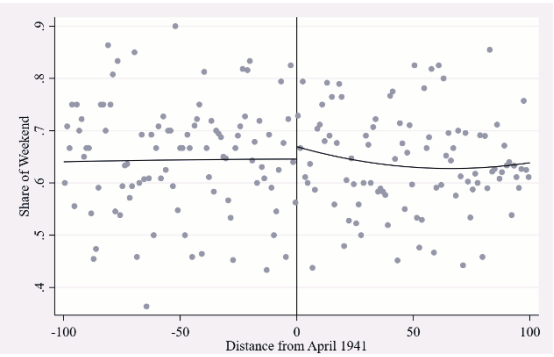
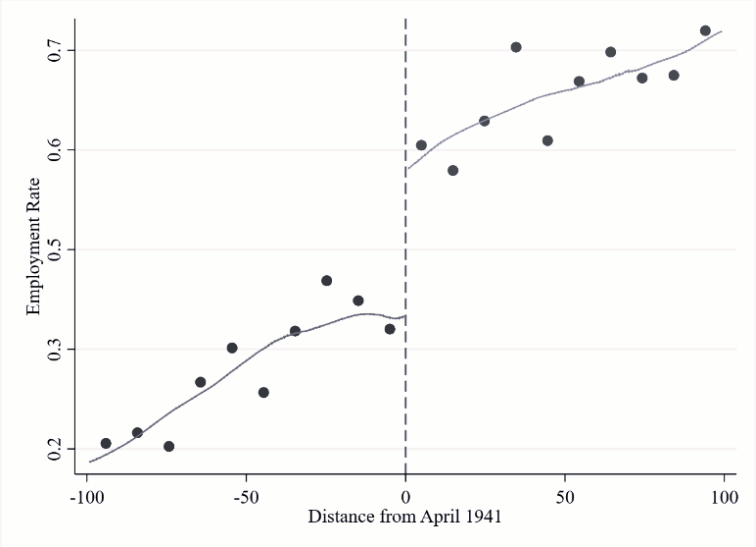


Figure 3.A.3: Covariate Balance Tests

Notes: These figures plot the covariates by $Month\ of\ birth_i$ for males in 2001. Panel A reports the share of females, Panel B reports the prefecture numbers assigned by the government in order from north to south, Panel C reports the share of individuals with spouses, and Panel D reports the share of weekends. The solid lines on the panels are second order polynomial fitted curves. The p-values for continuity at the cutoff are respectively 0.159, 0.463, 0.747, and 0.699 for the first polynomials, and 0.152, 0.461, 0.863, and 0.658 for the second polynomials.

(a) LOWESS



(b) No bins

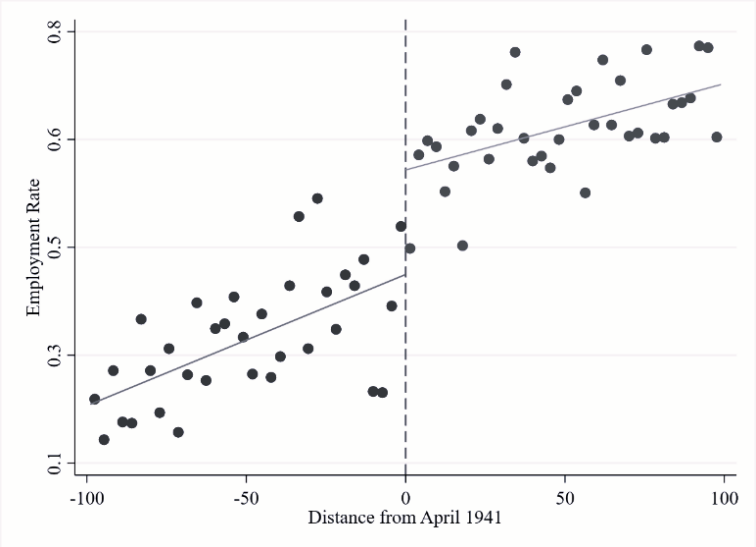
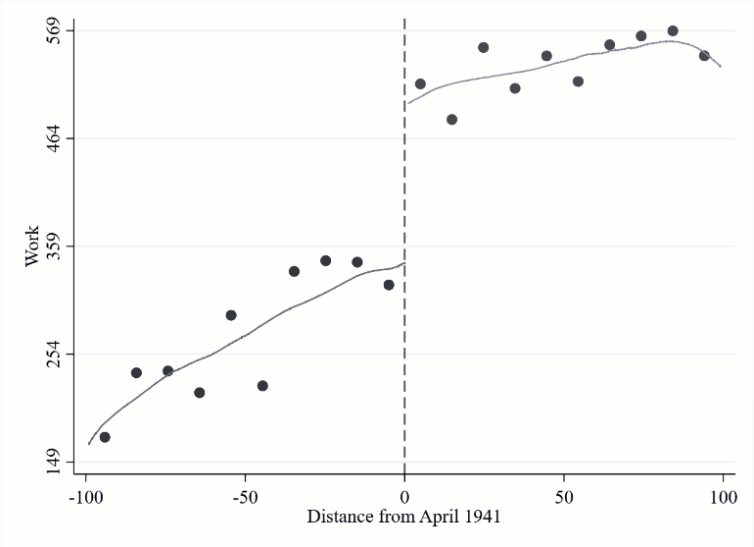


Figure 3.A.4: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment (Male, 2001 reform)

Notes: This figure plots the average employment rate for males with a college degree or higher. Panel (a) plots them with 5 bins, and Panel (b) with no bins. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

(a) LOWESS



(b) No bins

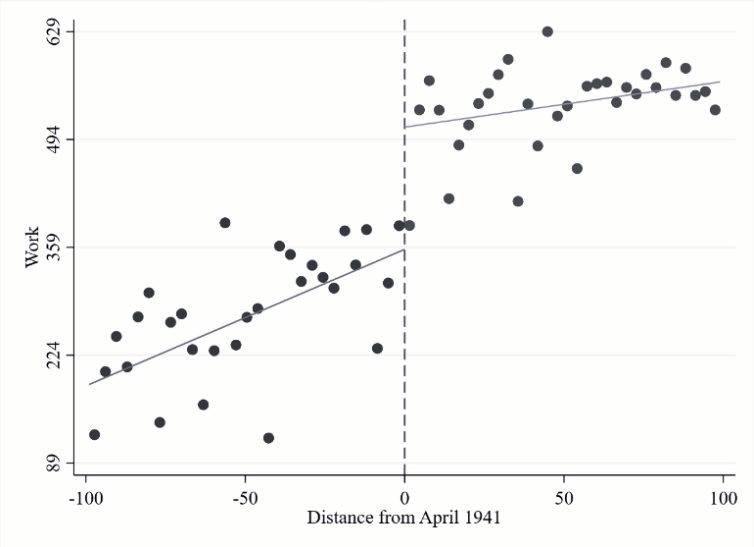
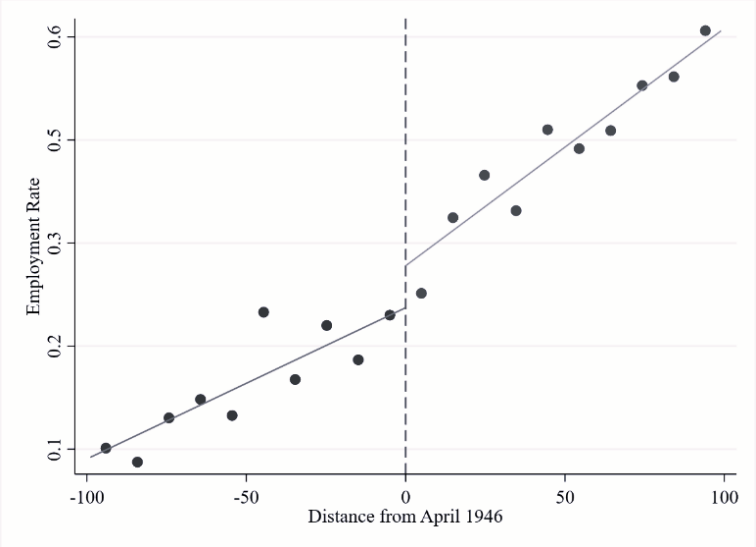


Figure 3.A.5: RD Estimates of Raising Eligibility Age from 60 to 61 on Work Time Use (Male, 2001 reform)

Notes: This figure plots the average work time use for males with a college degree or higher during weekdays. Panel (a) plots them with 5 bins, and Panel (b) with no bins. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

(a) LOWESS



(b) No bins

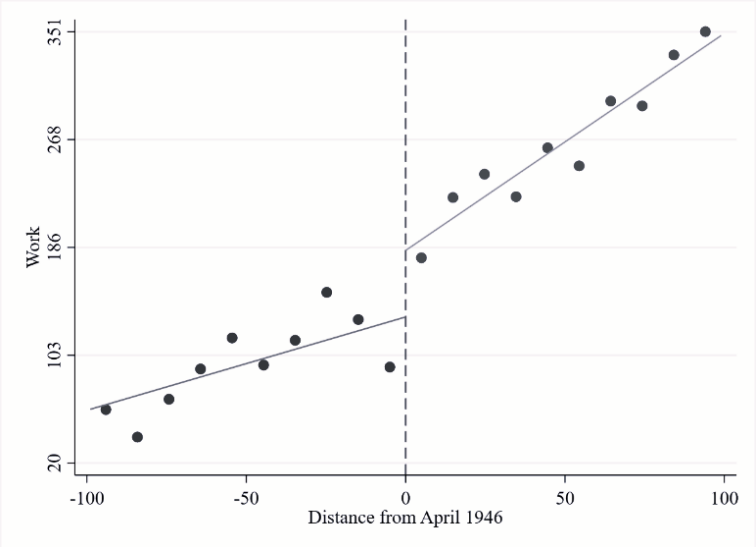
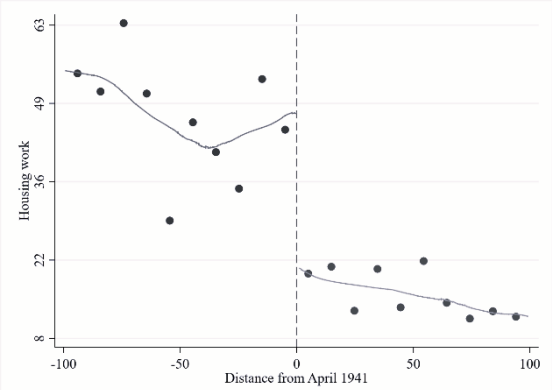


Figure 3.A.6: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment (Female, 2006 reform)

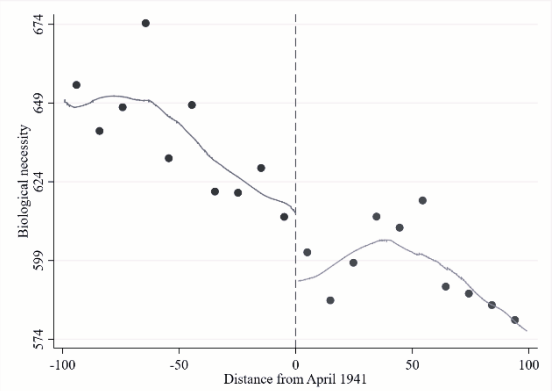
Notes: This figure plots the average employment rate (Panel A) and work time use (Panel B) for females with a junior college degree or higher. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

(1) LOWESS

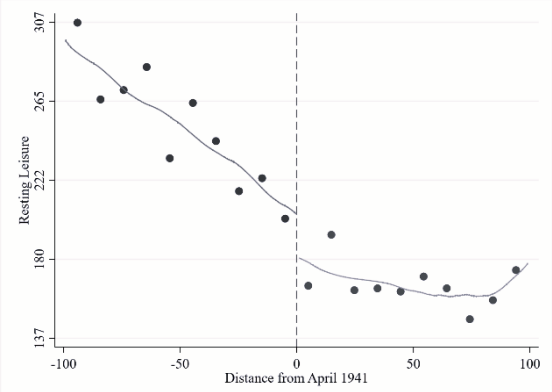
(a) Housework-related



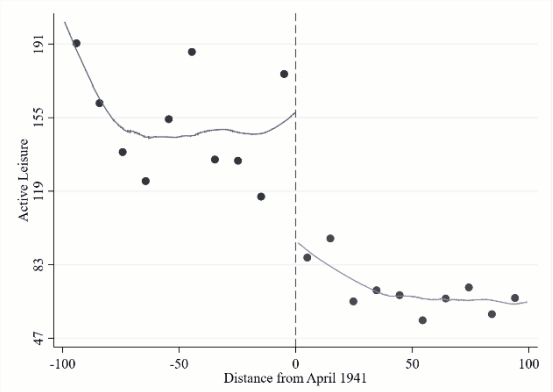
(b) Necessary



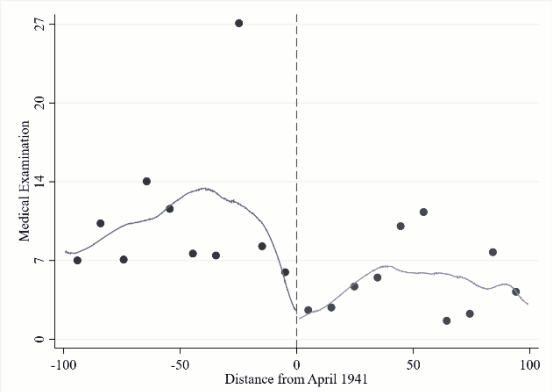
(c) Leisure for Relaxation



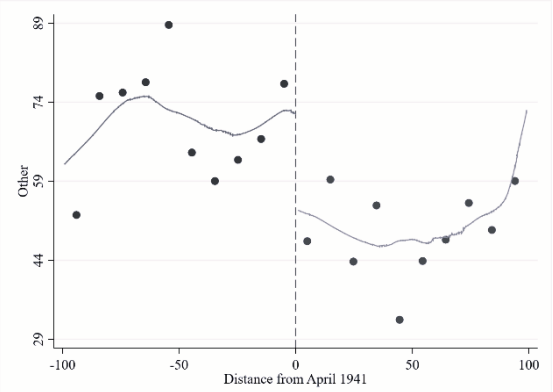
(d) Social Activities



(e) Medical Examination



(f) Others



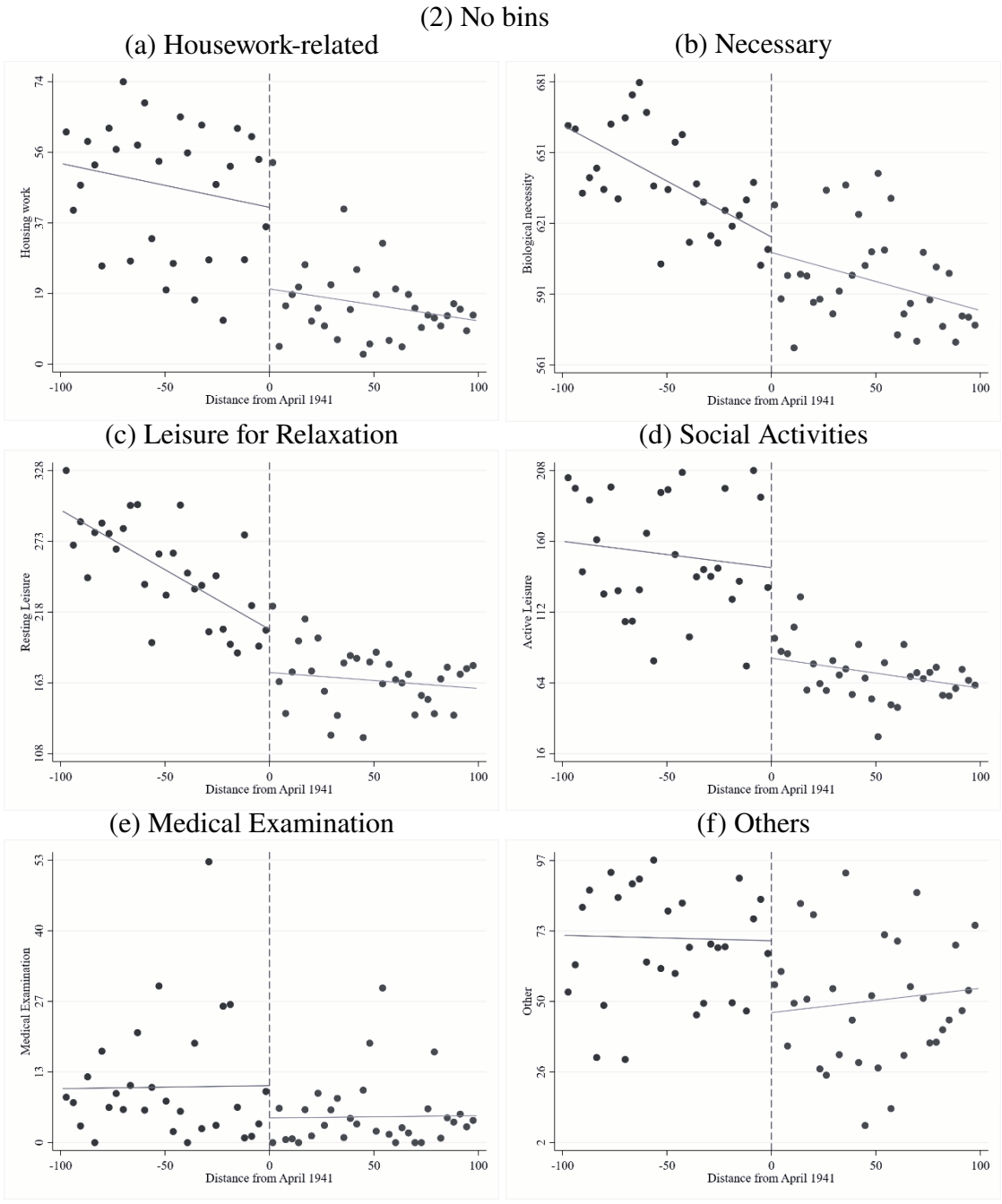


Figure 3.A.7: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Male, 2001 reform)

Notes: These figures plot the average time uses for males with a college degree or higher during weekdays. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. Panel (1) plots them with 5 bins, and Panel (2) with no bins. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

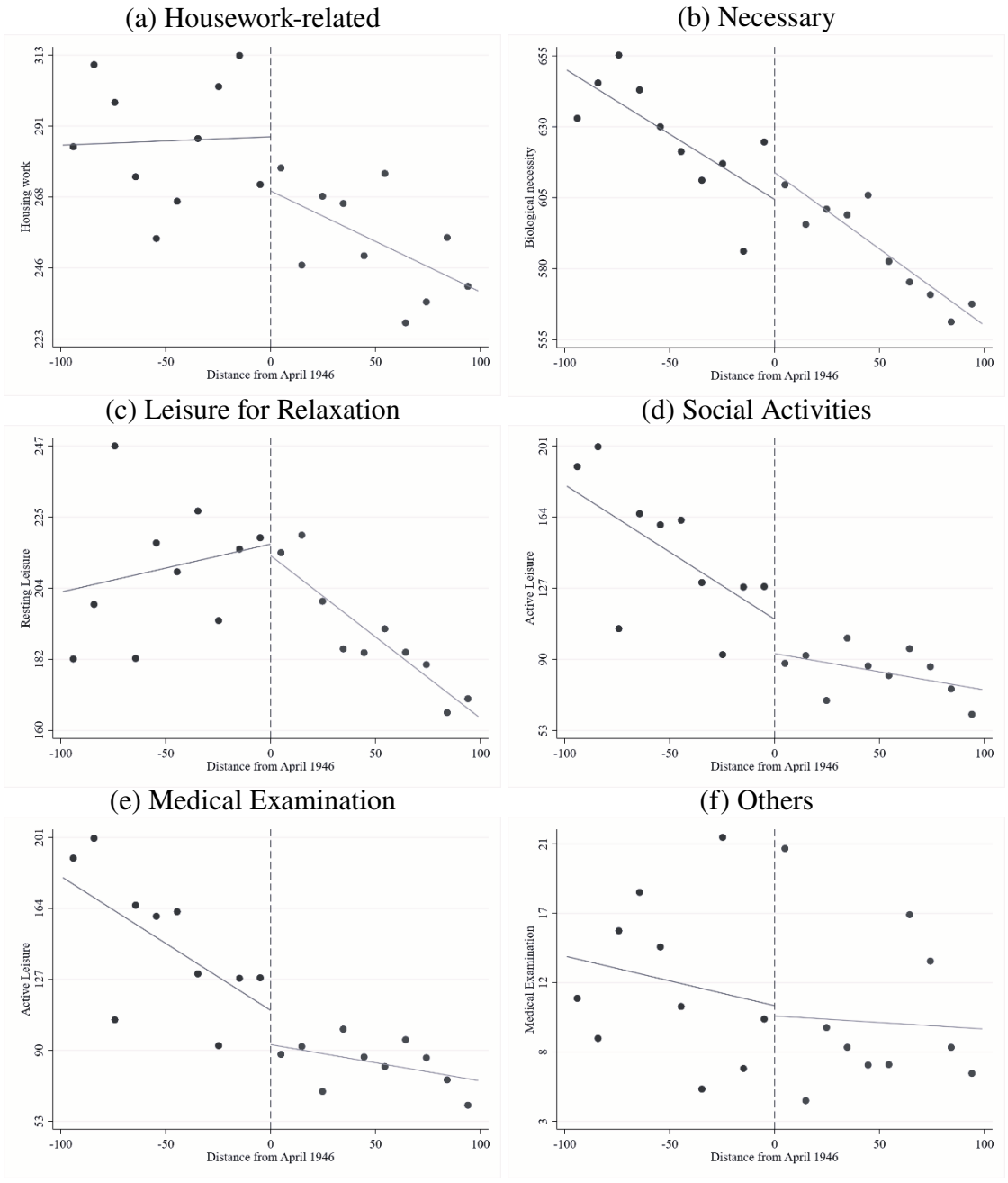


Figure 3.A.8: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Female, 2006 reform)

Notes: These figures plot the average time uses for females with a junior college degree or higher during weekdays. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The solid lines on the panels are linear fitted values. The sample on the left side is not affected by the pension reform that raises the eligibility age from 60 to 61, whereas the sample on the right side is affected by the reform.

Appendix 3.B Tables

Table 3.B.1: Comparison of Public Pension Reform for Male in Developed Countries

Country	Eligibility Age	Start Year	End Year	Discontinuity in Eligibility Age around the Cutoff
Japan	60 → 65	2001	2013	1 year (every three years from 2001 to 2013)
the United States	65 → 67	2003	2027	2 months (every year from 2003 to 2009) 2 months (every year from 2021 to 2027)
Germany	65 → 67	2012	2029	1 month (every year from 2012 to 2023) 2 months (every year from 2023 to 2029)
the United Kingdom	65 → 67	2018	2027	1-4 months (from Dec 2018 to Oct 2020) 1 month (every month from Apr 2026 to Mar 2027) 3 months (in 2012)
Italy	65 → 67	2012	2019	4 months (in 2016) 5 months (in 2019)
France	65 → 67	2016	2022	The age of the full-rate pension is gradually increasing from 65 to 67 between 2016 and 2022.
Canada	65 (→ 67)	2012	2029	The federal government reversed the reform in 2015

Notes: Nakazawa (2022b). The figure shows the comparison of ongoing public pension reforms and full retirement ages for males in the developed countries.

Table 3.B.2: Public Pension System in Japan

	the National Pension	the Employees' Pension Insurance
Coverage	Self-employed persons, Dependent spouses of EPI, and others	Employees of companies and government
Contributions	16,590 JPY per month	18.3% of income (9.15% each from employers and employees)
Benefits	the fixed amount benefits	the fixed amount benefits and the income-related benefits

Table 3.B.3: Placebo Tests for RD Estimates

	RD Estimates		
		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
Panel A: Males in 2001			
Month of Birth = April 1938	-0.0139	-15.01	-25.34
	(0.0351)	(37.01)	(20.33)
Month of Birth = April 1935	-0.0405	-51.38	-16.62
	(0.0343)	(39.32)	(16.83)
Observations	30,576	11,457	19,119
Panel B: Females in 2006			
Month of Birth = April 1943	-0.0419	-27.98	3.72
	(0.0295)	(23.44)	(14.41)
Month of Birth = April 1940	0.0780**	48.24*	6.32
	(0.0350)	(25.36)	(15.42)
Observations	42,711	16,168	26,543

Notes: The table reports the impact on employment rate and work time use at the placebo cutoffs. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.4: RK Estimates on Municipal Spending by Department (1,000 JPY per capita)

Time Uses	Examples
House Work	Cooking, tidying up after meals, cleaning house, taking out the garbage, laundry, ironing, mending clothes, drying the bedding, arranging and folding/storing clothes, caring for family members, keeping the household accounts, checking stock prices / exchanging stocks, removal of weeds in the yard, business at the bank, city office, etc., car care, repair of furniture
Nursing Care	Helping a family member or a relative living in another household to take a bath, go to the toilet, move, have a meal, etc., or nursing him/her
Child Care	Care for infants, attending on a child, helping a child to study, playing with a child, picking up infants, attending a parents meeting
Shopping	Purchasing food, daily commodities, electronic equipment, leisure goods, etc., renting a DVD
Sleep	Sleep at night, daytime nap, catnap, waiting time from going to bed until dropping off to sleep
Personal Care	Washing face, bathing, toileting, dressing, change of clothes, makeup, hair-dressing, shaving, having a hair perm or cut at a hair salon, esthetic treatments, bathing using home-visit bathing service
Meal	Eating and drinking at home and restaurants, etc., school lunch, eating and drinking at the workplace
Medical	Consulting with a doctor/receiving medical treatment at a hospital, recuperation at home
Watching TV etc.	Watching TV, listening to the radio, reading a newspaper or magazine, watching a recorded TV show, reading news on the Internet
Relaxation	Time to enjoy a family get-together, break time at work or school, snack/tea time, mealtime, quick nap, get-well visits to a family member
Self-education	Learning in classes, courses and seminars, or through social correspondence education or TV/radio programs, learning to use a PC as part of club activities, learning to drive
Hobbies	Seeing a movie, art or sports game, sightseeing, driving, caring for pets, playing a video game, reading books as hobbies, reading comics, playing a musical instrument as part of a group or club activities.
Sports	Participation in various athletic competitions, play involving full-body movement, shape-up workout at home, sports as club activities, including baseball (excluding sports that students learn during class), fishing.
Volunteer	Cleaning up roads and parks, visits to welfare homes, Braille translation, sign language, procurement of relief supplies for disaster areas, blood donations, providing daily life assistance to the elderly, serving as a welfare commissioner, caring for a children's group, serving as a guide at an art museum, recycling campaigns, road safety campaigns Labor movements, political activities, doing missionary work, voting in an election Labor movements, political activities, doing missionary work, voting in an election
Social Life	Eating and drinking with friends, ceremonial occasions, attendance/preparation for a reunion party, courtesy visits, get-well visits to a friend, talks with a friend face-to-face or on the phone, interacting with friends via text or on social media, writing a letter

Notes: MIC

Table 3.B.5: Summary Statistics for Females in 2006

	Full Sample		Age 50-70	
Variables	Mean	Standard deviation	Mean	Standard deviation
Employment rate	0.59	0.49	0.43	0.50
Work related	187.53	263.77	154.31	237.73
Work	169.48	238.95	141.61	218.59
Commuting	18.05	36.84	12.70	30.77
Housework related	252.32	208.27	271.73	175.83
Housework	168.37	152.73	213.98	150.02
Nursing care	4.95	36.14	10.35	50.53
Child care	37.29	103.73	5.22	35.13
Shopping	41.70	61.89	42.18	55.33
Necessary	630.31	127.73	616.45	116.94
Sleep	446.72	98.34	428.72	80.65
Personal care	84.58	68.77	83.08	71.35
Meal	99.01	44.18	104.65	43.58
Leisure for relax	192.78	142.71	210.48	133.90
Watching TV etc.	111.94	116.48	135.93	113.72
Relaxation	80.83	98.08	74.55	88.56
Social activities	103.92	145.72	111.36	143.59
Studies	10.75	47.19	13.02	50.79
Hobbies	45.71	97.19	48.12	95.70
Sports	9.00	40.06	12.36	43.73
Volunteer	7.80	47.40	11.64	57.56
Social life	30.66	87.86	26.23	75.46
Medical examination	6.07	41.80	7.20	48.84
Others	67.07	104.22	68.47	108.92
Share of Marriage	0.67	0.47	0.84	0.37
	42,711		10,244	

Notes: This table reports the means and standard deviations of the employment rate, time use per day, and marital status for females with a junior college degree or higher in 2006. Columns 1 and 2 represent the full sample, and columns 3 and 4 show the sample is restricted to ages 50 to 70. Employment rate and marriage are equal to one if individuals are employed (excluding self-employed or family workers) or married and zero otherwise. Time uses are at the minute level.

Table 3.B.6: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use (Female, 2006 reform)

		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
RD Estimate	0.0326	76.86***	30.04**
	(0.0292)	(23.73)	(14.54)
Mean of the dependent variable	0.433	238.8	102.9
Impact of the reform (%)	7.5%	32.2%	29.2%
Observations	42,711	16,168	26,543

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1) and time use per day (Column 2 and 3) for females with a junior college degree or higher in 2006. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.7: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use after 5 and 10 years

	5 years later			10 years later		
	Employment	Work (minutes)		Employment	Work (minutes)	
Variables	rate	Weekdays	Weekends	rate	Weekdays	Weekends
Panel A: Males in 2001						
RD Estimate	-0.0124	11.07	23.02	-0.0137	13.31	-22.72
	(0.0322)	(27.91)	(15.03)	(0.0262)	(22.45)	(16.13)
Mean	0.572	465.0	161.6	0.581	411.9	142.5
Impact (%)	-2.2%	2.4%	14.2%	-2.4%	3.2%	-15.9%
Observations	32,234	12,117	20,117	36,098	13,510	22,588
Panel B: Females in 2006						
RD Estimate	-0.0101	-12.72	-3.23	-0.0207	30.26	11.80
	(0.0257)	(17.82)	(10.24)	(0.0502)	(26.29)	(14.74)
Mean	0.433	219.8	95.28	0.474	228.4	78.56
Impact (%)	-2.1%	-5.8%	-3.4%	-4.4%	13.3%	15.0%
Observations	49,556	18,485	31,071	19,159	7,271	11,888

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1 and 4) and time use per day (Column 2, 3, 5, and 6). Panel A represents the effects on males with a college degree or higher, Panel B females with a junior college degree or higher. Column 1-3 shows the effect after 5 years (2006 for males and 2011 for females), Column 4-6 after 10 years (2011 for males and 2016 for females). The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.8: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use (Female Spouses, 2001 reform)

		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
RD Estimate	0.0178	-17.84	-2.45
	(0.0272)	(24.28)	(15.06)
Mean of the dependent variable	0.313	198.2	114.7
Impact of the reform (%)	5.2%	-9.0%	-2.1%
Observations	23,387	8,817	14,570

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1) and time use per day (Column 2 and 3) for wives of a husband with a college degree or higher in 2001. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.9: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Detailed Categories, Male, 2001)

	Housework-related				Necessary			
Variables	House Work	Nursing Care	Child Care	Shopping	Sleep	Personal Care	Meal	Medical
Panel A: Effects on Time Uses during Weekdays								
RD Estimate	-20.00***	-4.64	0.39	-7.17***	6.02	-7.06	1.05	-7.25**
	(7.26)	(2.84)	(0.54)	(2.67)	(7.53)	(5.10)	(4.50)	(3.60)
Mean	14.32	2.467	1.164	8.699	440.8	66.71	99.99	6.215
Impact (%)	-139.7%	-187.9%	33.6%	-82.4%	1.4%	-10.6%	1.1%	-116.6%
Observations	11,457	11,457	11,457	11,457	11,457	11,457	11,457	11,457
Panel B: Effects on Time Uses during Weekends								
RD Estimate	-0.20	1.41	0.47	-1.91	-3.93	5.49	-1.56	6.37**
	(4.99)	(1.86)	(0.87)	(3.48)	(6.40)	(4.20)	(3.60)	(2.75)
Mean	26.57	2.319	1.417	26.23	472.9	68.52	108.5	5.75
Impact (%)	-0.8%	60.8%	33.0%	-7.3%	-0.8%	8.0%	-1.4%	110.7%
Observations	19,119	19,119	19,119	19,119	19,119	19,119	19,119	19,119

	Leisure for Relaxation		Social Activities				
Variables	Watching TV etc.	Relaxation	Self-education	Hobbies	Sports	Volunteer	Social Life
Panel A: Effects on Time Uses during Weekdays							
RD Estimate	-23.03**	-7.61	-15.97*	-41.58***	-17.43***	-1.92	-6.88
	(11.36)	(7.93)	(8.67)	(10.13)	(5.71)	(4.13)	(6.84)
Mean	131.9	61.19	18.84	34.76	13.68	5.947	22.04
Impact (%)	-17.5%	-12.4%	-84.8%	-119.6%	-127.4%	-32.3%	-31.2%
Observations	11,457	11,457	11,457	11,457	11,457	11,457	11,457
Panel B: Effects on Time Uses during Weekends							
RD Estimate	-6.47	-4.92	-10.36	1.45	-12.05	-2.30	-5.18
	(12.49)	(8.59)	(7.23)	(10.69)	(7.49)	(4.14)	(7.87)
Mean	204.3	93.11	22.28	79.59	35.13	11.43	36.83
Impact (%)	-3.2%	-5.3%	-46.5%	1.8%	-34.3%	-20.1%	-14.1%
Observations	19,119	19,119	19,119	19,119	19,119	19,119	19,119

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the time uses per day for males with a college degree or higher in 2001. Panel A represents the time use during weekdays, Panel B during weekends. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.10: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Female, 2006 reform)

Variables	Housework-related	Necessary	Leisure for Relaxation	Social Activities	Medical Examination	Others
Panel A: Effects on Time Uses during Weekdays						
RD Estimate	-7.74	19.08*	-0.30	-32.19**	2.36	-28.19**
	(16.41)	(10.40)	(13.31)	(12.50)	(4.54)	(12.35)
Mean	261.2	591.1	189.4	96.74	9.37	53.40
Impact (%)	-3.0%	3.2%	-0.2%	-33.3%	25.2%	-52.8%
Observations	16,168	16,168	16,168	16,168	16,168	16,168
Panel B: Effects on Time Uses during Weekends						
RD Estimate	0.01	14.39	-6.88	-25.09*	-4.23	-3.85
	(13.55)	(9.70)	(12.40)	(13.58)	(3.84)	(9.41)
Mean	278.1	631.9	223.3	120.3	5.884	77.64
Impact (%)	0.0%	2.3%	-3.1%	-20.9%	-71.8%	-5.0%
Observations	26,543	26,543	26,543	26,543	26,543	26,543

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the time uses per day for females with a junior college degree or higher in 2006. Panel A represents the time use during weekdays, Panel B during weekends. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.11: RD Estimates of Raising Eligibility Age from 60 to 61 on Time Uses (Detailed Categories, Female, 2006)

	Housework-related				Necessary			
Variables	House Work	Nursing Care	Child Care	Shopping	Sleep	Personal Care	Meal	Medical
Panel A: Effects on Time Uses during Weekdays								
RD Estimate	-1.83	-7.33	2.03	-2.68	16.44**	4.48	-1.47	2.36
	(15.30)	(5.53)	(4.74)	(4.54)	(6.87)	(5.74)	(4.33)	(4.54)
Mean	212.2	9.257	5.043	34.66	412.5	78.69	99.92	9.37
Impact (%)	-0.9%	-79.1%	40.3%	-7.7%	4.0%	5.7%	-1.5%	25.2%
Observations	16,168	16,168	16,168	16,168	16,168	16,168	16,168	16,168
Panel B: Effects on Time Uses during Weekends								
RD Estimate	-4.52	8.69***	2.25	-3.08	-5.39	7.68	9.70**	-4.23
	(12.13)	(3.31)	(4.32)	(4.11)	(6.69)	(6.23)	(4.00)	(3.84)
Mean	215	11.01	5.321	46.76	438.6	85.75	107.5	5.88
Impact (%)	-2.1%	78.9%	42.2%	-6.6%	-1.2%	9.0%	9.0%	-71.8%
Observations	26,543	26,543	26,543	26,543	26,543	26,543	26,543	26,543

	Leisure for Relaxation		Social Activities				
Variables	Watching TV etc.	Relaxation	Self-education	Hobbies	Sports	Volunteer	Social Life
Panel A: Effects on Time Uses during Weekdays							
RD Estimate	-12.56	10.00	-11.65**	-18.87*	-2.24	-12.56	10.00
	(9.65)	(8.04)	(5.93)	(9.66)	(3.84)	(9.65)	(8.04)
Mean	122.3	67.12	14.38	39.84	11.52	9.435	21.56
Impact (%)	-10.3%	14.9%	-81.0%	-47.4%	-19.4%	-10.3%	14.9%
Observations	16,168	16,168	16,168	16,168	16,168	16,168	16,168
Panel B: Effects on Time Uses during Weekends							
RD Estimate	-5.77	-2.03	0.86	-10.91	-4.65	-4.19	-6.39
	(10.65)	(7.61)	(3.79)	(8.50)	(4.21)	(7.01)	(7.15)
Mean	144.2	79.07	12.19	53.16	12.87	12.98	29.07
Impact (%)	-4.0%	-2.6%	7.1%	-20.5%	-36.1%	-32.3%	-22.0%
Observations	26,543	26,543	26,543	26,543	26,543	26,543	26,543

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the time uses per day for females with a junior college degree or higher in 2006. Panel A represents the time use during weekdays, Panel B during weekends. I classified the time use categories into the following six types: (1) housework related (housework, nursing care, child care, and shopping), (2) necessary (sleep, personal care, meal), (3) leisure for relaxation (watching TV etc., relaxation), (4) social activities (self-education, hobbies, sports, volunteer, social life), (5) medical examination, (6) others. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.B.12: RD Estimates of Raising Eligibility Age from 60 to 61 on Health after 10 years

	Self-rated Health Status	
Variables	Males	Females
RD Estimate	0.0499	-0.0246
	(0.0384)	(0.0370)
Mean of the dependent variable	0.0896	0.0827
Impact of the reform (%)	55.7%	-29.7%
Observations	30,221	19,137

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on self-rated health status for males (Column1) with a college degree or higher and females (Column 2) with a junior college degree or higher. Column 1 presents the outcome for males in 2011 and Column 2 for females in 2016. The regression uses the local linear RD estimate with a triangular kernel. Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix 3.C Robustness Checks

Table 3.C.1: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use (Robustness Tests, Male, 2001 reform)

	RD Estimates		
		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
Panel A: Sensitivity Analysis by Length of Bandwidth			
Bandwidth: baseline + 30	0.2233***	176.19***	53.96***
	(0.0367)	(29.32)	(17.77)
Bandwidth: baseline - 30	0.1566**	191.78***	69.77***
	(0.0628)	(40.17)	(23.05)
Bandwidth: two different CER-optimal	0.2307***	174.73***	56.80***
	(0.0408)	(30.79)	(18.54)
Panel B: Functional Forms and Kernels			
Local Quadratic with triangular kernel	0.2300***	181.14***	66.17***
	(0.0396)	(34.68)	(22.00)
Local Linear with uniform kernel	0.1975***	162.41***	47.81***
	(0.0303)	(25.28)	(16.92)
Local Quadratic with uniform kernel	0.2233***	179.46***	50.59**
	(0.0362)	(32.66)	(20.16)
Panel C: Educational Backgrounds			
Include All Educational Backgrounds	0.0819***	33.01**	5.14
	(0.0159)	(13.39)	(8.77)

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1) and time use per day (Column 2 and 3) for males with a college degree or higher in 2001. The regression uses the local linear RD estimate with a triangular kernel. Panel A reports the RD estimates with several length of bandwidths. Panel B reports the estimates with several functional forms and kernel. Panel C shows the estimates for males with all educational backgrounds. Heteroskedasticity-robust standard errors are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.C.2: RD Estimates of Pension Receipt on Employment and Work Time Use (Male)

		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
RD Estimate	0.0128	-20.79-10.66	
	(0.0163)	(16.98)	(8.56)
Mean of the dependent variable	0.586	460.4	155.0
Impact of the reform (%)	2.2%	-4.5%-6.9%	
Observations	108,596	40,915	67,681

Notes: The table reports the impact of receiving the pension on the employment rate (Column 1) and time use per day (Column 2 and 3) for males with a college degree or higher. The regression uses the local linear RD estimate with a triangular kernel. The cutoffs are set to be born in October 1944 in 2006, October 1947 in 2011, and October 1951 in 2016, respectively. The covariates are year dummies (2006, 2011, and 2016). Heteroskedasticity-robust standard errors are in parentheses. The means of the dependent variable are means for ages 50 to 70. Impact of the reform is the RD estimates divided by the means of the dependent variable. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.C.3: RD Estimates of Raising Eligibility Age from 60 to 61 on Employment and Work Time Use (Robustness Tests, Female, 2006 reform)

	RD Estimates		
		Work (minutes)	
Variables	Employment rate	Weekdays	Weekends
Panel A: Sensitivity Analysis by Length of Bandwidth			
Bandwidth: baseline + 30	0.0293	89.25***	34.62**
	(0.0323)	(25.69)	(15.78)
Bandwidth: baseline - 30	-0.0346	63.25*	47.69**
	(0.0469)	(36.61)	(22.13)
Bandwidth: two different CER-optimal	0.0170	81.14***	38.91**
	(0.0348)	(26.89)	(16.92)
Panel B: Functional Forms and Kernels			
Local Quadratic with triangular kernel	0.0375	83.05***	39.64**
	(0.0339)	(26.56)	(17.59)
Local Linear with uniform kernel	0.0364	53.21**	29.47**
	(0.0279)	(23.35)	(14.32)
Local Quadratic with uniform kernel	0.0446	89.15***	38.98**
	(0.0344)	(27.42)	(17.84)
Panel C: Educational Backgrounds			
Include All Educational Backgrounds	0.0385***	47.59***	12.44**
	(0.0128)	(8.77)	(6.03)

Notes: The table reports the impact of raising the pension eligibility age from 60 to 61 on the employment rate (Column 1) and time use per day (Column 2 and 3) for females with a junior college degree or higher in 2006. The regression uses the local linear RD estimate with a triangular kernel. Panel A reports the RD estimates with several length of bandwidths. Panel B reports the estimates with several functional forms and kernel. Panel C shows the estimates for females with all educational backgrounds. Heteroskedasticity-robust standard errors are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

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