Cabinet Office

ESRI Discussion Paper Series No.348

Decomposing Local Fiscal Multipliers: Evidence from Japan

Taisuke Kameda
Ryoichi Namba
Takayuki Tsuruga

April 2019

Economic and Social Research Institute
Cabinet Office
Tokyo, Japan

Decomposing Local Fiscal Multipliers: Evidence from Japan*

Taisuke Kameda† Ryoichi Namba‡ Takayuki Tsuruga§

First draft: July 2017

This draft: February 2019

Abstract

Recent studies on fiscal policy use the cross-sectional data and estimate local fiscal multipliers along with the spillover. This paper estimates local fiscal multipliers, using the Japanese prefectural data comparable to the national accounts. We estimate local fiscal multiplier on output to be 1.7 at the regional level. This regional fiscal multiplier consists of the prefecture-specific components and the component common across prefectures within the same region, and we interpret the latter as the region-wide effect. Converting the latter into the spillover, we find that the spillover is positive and small in size. We decompose the regional fiscal multiplier on output into multipliers on expenditure components. The regional fiscal multiplier on absorption exceeds 2.0, because of the crowding-in effect in consumption and investment. Moreover, we find that the spillover to absorption is considerable in contrast to the spillover to output.

JEL Classification: E62, R12, R50

Keywords: Fiscal stimulus, spillover, geographic cross-sectional fiscal multiplier

---

*We thank Andrew Hallett, Hirokazu Ishise, Yasushi Iwamoto, Yi Lu, Jun Nagayasu, Etsuro Shioji, Justin Wolfers, Lianming Zhu, and seminar and conference participants at Osaka University, Shanghai University of International Business and Economics, the University of Tokyo, the 19th Macroeconomic Conference, the ESRI international conference, and the WEAI international conference for helpful discussions and comments. Tsuruga gratefully acknowledges the financial support of Grant-in-aid for Scientific Research (15H05729 and 15H05728), the Murata Science Foundation, and Zengin Foundation for Studies on Economics and Finance. Views expressed in this paper are the authors' and do not necessarily reflect the official views of the government of Japan.

†Cabinet Office, the Government of Japan

‡Chubu Region Institute for Social and Economic Research

§Osaka University; Cabinet Office, the Government of Japan; Centre for Applied Macroeconomic Analysis

1 Introduction

One of the cornerstone issues of macroeconomics is the interaction of economic activity and government spending. The interaction is often measured by the fiscal multiplier, the percentage increase in output when government spending increases by one percent of the gross domestic product (GDP). While the literature traditionally measures the fiscal multiplier from the time series data, recent studies rely on geographic cross-sectional variations in government spending. The fiscal multiplier estimated from the regional cross-sectional data is often called the local fiscal multiplier (LFM).[1] While one can interpret the LFM as a fiscal multiplier that measures the effect of government spending in one region in a monetary union (Nakamura and Steinsson 2014), the LFM has an important dimension differing from the traditional national fiscal multiplier. In particular, because local economies have strong interdependence without the border effect, government spending in a local economy may easily spill over into other local economies. According to Auerbach et al. (2018), understanding the spillover from government spending is "a fundamental and largely unresolved task in macroeconomics."

In this paper, we estimate and decompose the LFM to understand the spillover in local economies. The objective of this paper is threefold. First, we provide evidence of the LFM in Japan, comparable to those in other countries. Second, more importantly, we measure the spillover within the region, using the prefectural data. We separate a single country into regions consisting of prefectures and estimate the *regional fiscal multiplier* (RFM) as the sum of the *prefectural fiscal multiplier* (PFM) and the *region-wide effect*. The former is a component of the RFM that is estimated from variations in prefectural government spending. The latter is also a component of the RFM but is estimated from variations in regional government spending, and thus it is related to the spillover. We convert the estimated region-wide effect into the spillover within the region and assess the contribution of the spillover to the RFM. Third, exploiting an advantage of Japanese prefectural data, we estimate the RFM on expenditure components of GDP. The prefectural data are the "prefectural accounts" that are highly comparable to the national accounts so that the data of consumption, investment, government spending, and net exports are available at the prefectural level. The data availability contrasts with the U.S. state-level data published by the Bureau of Economic Analysis.[2] Exploiting

[1] Chodorow-Reich (2018) comprehensively reviews numerous recent studies on the LFM. Ramey (2011) surveys fiscal and tax multipliers including the time-series evidence.

[2] For example, the Bureau of Economic Analysis does not publish the data of net exports and business investment

the data compiled by the single government agency, we measure the contribution of the RFM on expenditure components such as private consumption and investment to the RFM on output. With this decomposition, we study which expenditure components of GDP are crowded out or in by local government spending.

As the previous studies on the fiscal multiplier emphasized, identifying the fiscal multipliers requires isolation of changes in government spending uncorrelated with shocks to the local economy. We construct instruments from the national treasury disbursements in the local public finance data.[3] The expenditure by the local governments highly depends on the transfers from the central government, because of the large vertical fiscal gap between the central and the local governments (see Bessho 2016). The national treasury disbursements are the earmarked, program-based transfers from the central government to the local government. By definition, the national treasury disbursements are financed by the national tax revenues which are less likely to be affected by shocks to specific prefectures' economic activity. Furthermore, the dataset allows us to identify purposes and programs supported by the disbursements (e.g., education, social welfare, construction, etc.). Using the detailed information in the local public finance data, we exclude the transfers that are strongly correlated with shocks to local economies (e.g., subsidies for the recovery from disasters) in constructing the instruments.

The main findings are as follows. First, when government spending increases at the regional level by one percent of GDP, the regional output increases by 1.7 percent. In other words, the RFM on output is 1.7. Second, we find that the spillover in output is estimated to be positive but small in size. Our benchmark estimation suggests that the spillover converted from the region-wide effect is, on average, 0.26 out of the estimated RFM of 1.7. Third, regional government spending substantially crowds in private consumption and private fixed investment. In particular, the sum of the contributions of these expenditure components to the RFM on output amounts to 65 percent of the RFM on output. As a result, the multiplier on "domestic absorption" or the expenditure before the leakage to the other local economies is also large. We find that the RFM on absorption is 2.2

at the state level. In the literature on the LFM in the U.S., the data of state-level government spending are often taken from the U.S. Census Bureau.

[3] Our approach is similar to Kraay (2012) and Guo et al. (2016) who use variations in the fund lent or transferred from the organization other than the local government for identification. Kraay (2012) estimates the fiscal multiplier in developing countries with the instrument of the world bank lending. Guo et al. (2016) estimate the LFM in China. Focusing on the local public finance fact that the poor Chinese counties receive preferential earmarked treatment in receiving transfers, they identify the LFM.

in the benchmark regression. We also find that the region-wide effect on absorption is statistically and economically significant in contrast to that on output. Our conversion of the region-wide effect into the spillover implies that the spillover to absorption is 0.68 out of the RFM on absorption of 2.2. By contrast, net exports decrease with regional government spending, suggesting a leakage in the aggregate demand to other local economies.

The literature on the LFM is very active and thus numerous previous studies contribute to the literature.[4] Some studies focus on spillover in the context of the LFM. Dupor and McCrory (2017) discover the evidence for the positive spillover in wage bills and employment within the regional market. Dupor and Guerrero (2017), using on federal defense contracts at the U.S. state level, find a positive interstate spillover in income and employment multipliers. Auerbach et al. (2018) also use the U.S. federal defense data and find positive spillover across industries as well as locations. Suárez-Serrato and Wingender (2016) also explore the income spillover across neighboring counties but find no evidence of sizable spillovers. Acconcia et al. (2014) use Italian provincial data and find a statistically insignificant spillover to the provincial output. Our paper studies the spillover more closely than these previous studies by looking at expenditure components of GDP, as well as output. Guo et al. (2016) investigate the Chinese county data and estimate the LFM on investment at the county level as well as output. They find the crowding-in effect on investment without assuming spillover. Cohen et al. (2011) also estimate the impact of the state-level government spending on investment at the publicly traded U.S. firms. They find negative impacts of local government spending on firms' investment and payouts to the investors of firms.

Regarding the LFM in Japan, Brückner and Tuladhar (2014) provide evidence on the estimated LFM. While their data source of the Japanese prefectural data is the same as ours, they mainly focus on the financial distress in the 1990s and on its impact on the LFM. Other previous studies on the Japanese fiscal multipliers provide time-series evidence. Among these the time-series-based studies, recent works emphasize the state dependence of the national fiscal multipliers.[5]

This paper is organized as follows. Section 2 describes the empirical strategies. In Section 3, we discuss the data and the construction of instruments. Section 4 presents the main results and section 5 shows robustness. Section 6 concludes.

[4] A few examples of earlier works include Clemens and Miran (2012), Nakamura and Steinsson (2014), Fishback and Kachanovskaya (2015), Shoag (2016) and Suárez-Serrato and Wingender (2016). Regarding the impact of the American Recovery and Reinvestment Act on employment at the state and county levels, see Chodorow-Reich et al. (2012), Wilson (2012), and Conley and Dupor (2013) among others.

[5] See Morita (2015), Miyamoto et al. (2016), and Auerbach and Gorodnichenko (2017).

2 Local fiscal multipliers and the region-wide effect

In the literature, a typical equation for estimating the LFM is

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} = \beta_R \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \alpha_r + \delta_t + \varepsilon_{r,t}, \tag{1}$$

where $Y_{r,t}$ is the regional-level per capita output in period t and $G_{r,t}$ is the regional-level per capita government spending. We refer to β_R as the *regional fiscal multiplier* (RFM) because we estimate β_R using the regional-level data. The index r represents regions in a country, $r \in \{r_1, r_2, ..., r_M\}$, where the country has M regions. Notice that α_r and δ_t include the entity and time fixed effects, respectively. For now, we assume no covariates to simplify the discussion, but the actual empirical analysis includes covariates. The error term is $\varepsilon_{r,t}$. The entity fixed effect α_r controls for the region-specific variations in per capita output and government spending. The time fixed effect δ_t captures the unobserved nation-wide effects of aggregate shocks and macroeconomic policy on the regional output (e.g., aggregate productivity, monetary policy, national tax changes, and predictable changes in the national output and government spending, etc.). Due to the fixed effects, the RFM measures how much output in a region increases relative to that in other regions when government spending in the region increases relative to that in other regions. The time unit is one year. Following Nakamura and Steinsson (2014), we take the two-year growth rate of output for the dependent variable. Therefore, β_R is the two-year cumulative fiscal multipliers.

The estimation equation in this paper takes the following prefecture analog of (1), but with an additional regressor:

$$\frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} = \gamma_P \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} + \gamma_S \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \eta_{r,p} + \delta_t + \varepsilon_{r,p,t}, \tag{2}$$

where $y_{r,p,t}$ is per capita output, and $g_{r,p,t}$ is per capita government spending in prefecture p that belongs to region r. Formally, each region r_i has R_i prefectures and the index p_i is defined by $p_i \in r_i = \{1, 2, ..., R_i\}$ for $i = 1, ..., M$. For notational simplicity, we drop the index i from r_i and p_i in (2). As before, $\eta_{r,p}$ captures the entity fixed effect as defined similarly to α_r in (1). Note that (2) includes changes in both prefectural and regional government spending. We interpret γ_P as *the prefectural fiscal multiplier* (PFM), because if $\gamma_S = 0$, (2) has the same structure as (1) in which we discussed the RFM. However, if $\gamma_S \neq 0$, this equation indicates that the prefectural output growth responds to changes in the regional government spending (scaled by the regional output). Even if government spending in the prefecture stays constant, the output of the same prefecture may change with regional government spending. Therefore, we interpret γ_S as the *region-wide effect*.

The sign of the region-wide effect γ_S can be positive and negative through the spillover discussed in the literature.[6] On the one hand, an increase in government spending in a prefecture may increase the relative price of the prefecture's output to the same goods in other prefectures. Thus, expenditure to the prefecture's output switches to output in other prefectures, perhaps in prefectures of the same region. This expenditure switching implies a positive γ_S. Also, the increase in the prefecture's government spending may boost liquidity-constrained households' demand.[7] If the increase in demand leaks into other prefectures in the same region, γ_S is again positive. On the other hand, when the increase in government spending stimulates the production in the prefecture, it may also lead to the relocation of factor inputs (e.g., labor) from other prefectures within the same region. Because this may reduce the output in the other prefectures, the spillover may produce a negative γ_S.

We interpret that the sum of γ_P and γ_S can approximate β_R in (1). Let $\omega_{r,p}$ be the time-series mean of the GDP share of a prefecture to the region. Taking the weighted average of both sides of (2) with the GDP share $\omega_{r,p}$, we can approximate the equation by

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} \simeq (\gamma_P + \gamma_S) \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \alpha_r + \delta_t + \varepsilon_{r,t}, \tag{3}$$

where we redefine α_r as the weighted average of $\eta_{r,p}$: $\alpha_r = \sum_{p \in r} \omega_{r,p} \eta_{r,p}$ and the error term $\varepsilon_{r,t} = \sum_{p \in r} \omega_{r,p} \varepsilon_{r,p,t}$. Here, the derivation of the above equation requires that the distributions of output and population be stable over the sample periods.

More specifically, let the level of prefectural and regional GDP be $y^*_{r,p,t}$ and $Y^*_{r,t}$, respectively. Here, a superscript $*$ on a variable denotes the level of variable rather than per capita variable. The levels of output are given by $y^*_{r,p,t} = y_{r,p,t} n^*_{r,p,t}$, and $Y^*_{r,t} = Y_{r,t} N^*_{r,t}$ where $n^*_{r,p,t}$ and $N^*_{r,t}$ are the population in prefecture p and in region r, respectively. Also note that the regional output and the regional population satisfy $Y^*_{r,t} = \sum_{p \in r} y^*_{r,p,t}$ and $N^*_{r,t} = \sum_{p \in r} n^*_{r,p,t}$, respectively. By the assumption of the stable distributions of output and population, we mean that $y^*_{r,p,t}/Y^*_{r,t}$ and

[6] For example, see Acconcia et al. (2014), Suárez-Serrato and Wingender (2016) and Chodorow-Reich (2018).

[7] See Galí et al. (2007) for the model with liquidity-constrained households. They consider households who have no access to capital markets. An increase in government spending that leads to higher household income can directly increase their consumption.

$n^*_{r,p,t}/N^*_{r,t}$ do not substantially fluctuate over the sample periods (e.g., around the time-series mean). This approximation assumption leads to

$$\sum_{p\in r}\omega_{r,p}\frac{y_{r,p,t}-y_{r,p,t-2}}{y_{r,p,t-2}} \simeq \frac{(Y_{r,t}-Y_{r,t-2})}{Y_{r,t-2}}. \tag{4}$$

Likewise, let $G_{r,t}$

$$\sum_{p\in r}\omega_{r,p}\frac{g_{r,p,t}-g_{r,p,t-2}}{y_{r,p,t-2}} \simeq \frac{G_{r,t}-G_{r,t-2}}{Y_{r,t-2}}. \tag{5}$$

Comparing (3) with (1) yields $\beta_R \simeq \gamma_P + \gamma_S$. Therefore, we interpret that the RFM can be decomposed into the PFM and the region-wide effect.

We emphasize that the region-wide effect γ_S is not necessarily the same as the measure of spillover discussed in the literature. The previous studies on the spillover in the fiscal multiplier have measured the spillover to a location (i.e., a prefecture in our case) by the coefficient on the sum of government spending in *other* prefectures, rather than the coefficient on regional government spending as a whole. For example, Auerbach et al. (2018) employ the weighted sum of government spending in other locations. Acconcia et al. (2014) and Suárez-Serrato and Wingender (2016) employ government spending aggregated across adjacent areas (provinces or counties). To allow for the spillover in our regression analysis, use (5) to rewrite (2) as

$$\frac{y_{r,p,t}-y_{r,p,t-2}}{y_{r,p,t-2}} = (\gamma_P+\omega_{r,p}\gamma_S)\frac{g_{r,p,t}-g_{r,p,t-2}}{y_{r,p,t-2}} + \gamma_S\sum_{p'\neq p}\omega_{r,p'}\frac{g_{r,p',t}-g_{r,p',t-2}}{y_{r,p',t-2}} + \eta_{r,p}+\delta_t+\varepsilon_{r,p,t}, \tag{6}$$

Notice that the second term of the right-hand side is

$$\gamma_S\sum_{p'\neq p}\omega_{r,p'}\frac{g_{r,p',t}-g_{r,p',t-2}}{y_{r,p',t-2}} = \gamma_S\left(1-\omega_{r,p}\right)\sum_{p'\neq p}\tilde{\omega}_{r,p',p}\frac{g_{r,p',t}-g_{r,p',t-2}}{y_{r,p',t-2}}, \tag{7}$$

where $\tilde{\omega}_{r,p',p} = \omega_{r,p'}/\left(1-\omega_{r,p}\right)$ and $\sum_{p'\neq p}\tilde{\omega}_{r,p',p} = 1$. Define $Y_{r,-p,t}$ and $G_{r,-p,t}$ by $Y_{r,-p,t} \equiv Y^*_{r,-p,t}/N^*_{r,-p,t}$ and $G_{r,-p,t} \equiv G^*_{r,-p,t}/N^*_{r,-p,t}$, respectively. Here, $Y^*_{r,-p,t} = \sum_{p'\neq p} y^*_{r,p',t}$, $G^*_{r,-p,t} = \sum_{p'\neq p} g^*_{r,p',t}$ and $N^*_{r,-p,t} = \sum_{p'\neq p} n^*_{r,p',t}$. In these definitions, we all exclude prefecture p from the weight $\tilde{\omega}_{r,p',p}$ and the aggregate variables $Y^*_{r,-p,t}$, $G^*_{r,-p,t}$, and $N^*_{r,-p,t}$. Under the stable distributions of output and population, we combine (6), (7) and the above definitions to obtain[8]

$$\begin{aligned}\frac{y_{r,p,t}-y_{r,p,t-2}}{y_{r,p,t-2}} &= \left(\gamma_P+\omega_{r,p}\gamma_S\right)\frac{g_{r,p,t}-g_{r,p,t-2}}{y_{r,p,t-2}}+\gamma_S\left(1-\omega_{r,p}\right)\frac{G_{r,-p,t}-G_{r,-p,t-2}}{Y_{r,-p,t-2}} \\ &\quad +\eta_{r,p}+\delta_t+\varepsilon_{r,p,t}.\end{aligned} \tag{8}$$

Here $\gamma_S(1-\omega_{r,p})$ is the coefficient on the sum of government spending in other prefectures, so we interpret $\gamma_S(1-\omega_{r,p})$ as the measure of spillover for prefecture p in region r. In our analysis, we use the data of $\omega_{r,p}$ and assess the size of spillover.

Our measure of the spillover $\gamma_S(1-\omega_{r,p})$ takes the relative size of the local economy into account, while the previous studies assume that the degree of spillover is the same across all local economies. That is, the spillover in our specification is not identical across prefectures. More specifically, if a prefecture is large relative to the region (e.g., Tokyo in the Kanto region), we evaluate that the spillover to the large local economy is low. On the other hand, if a prefecture is small or almost negligible, the spillover to the small local economy is close to γ_S. Put differently, the region-wide effect γ_S is the upper bound of the spillover within the region, since $\omega_{r,p} \geq 0$.

In our empirical analysis, we estimate γ_P and γ_S from (2) and report $\gamma_P+\gamma_S$ as an estimate of β_R. However, some other factors may weaken the link between $\gamma_P+\gamma_S$ and β_R, in addition to the assumption on the distribution of output and population. First, we must define the region as a group. In other words, we must have $Y^*_{r,t}=\sum_{p\in r} y^*_{r,p,t}$ and $N^*_{r,t}=\sum_{p\in r} n^*_{r,p,t}$. In the subsequent sections, we use the definition of regions that satisfy these conditions to estimate parameters in (2). Second, if we include the vector of prefectural control variables $x_{r,p,t}$ into (2), it requires that (1) also have the vector of the control variables $X_{r,t}=\sum_{p\in r}\omega_{r,p}x_{r,p,t}$ as additional regressors. Therefore, to maintain the approximation results of $\beta_R \simeq \gamma_P+\gamma_S$, the control variables in (1) are also the weighted average of the control variables across prefectures. Likewise, if (1) includes additional regressors that are not the weighted average of prefectural control variables, the inclusion may weaken the link between β_R and $\gamma_P+\gamma_S$.

Regarding the control variables introduced in (2), the benchmark regression includes the dummy variable for the Great East Japan Earthquake on March 11, 2011, the last month of the fiscal year 2010.[9] This natural disaster shock is considered to have a prefecture- and time-specific negative

[8]See Appendix A for the derivation of (8).
[9]The fiscal year in Japan begins in April and ends in March.

impact on the output growth in some prefectures off the northeast coast of Japan. See also the location of these prefectures in Figure 1. To control for the negative impact of the earthquake, we introduce a dummy variable $D^E_{r,p,t}$ that takes one if prefecture p experienced strong influences of the earthquake and year $t = 2011, 2012$:[10]

$$D^E_{r,p,t} = \begin{cases} 1 & \text{if the prefecture is Fukushima, Ibaraki, Iwate, Miyagi and } t = 2011, 2012 \\ 0 & \text{otherwise.} \end{cases} \tag{9}$$

Another factor that we should take into account in (2) is information on the revenue of the prefectural government. The information on the local tax rates may be useful because they may directly affect the prefectural output. However, the local tax rates in a given year are very similar across prefectures, and their changes in time-series dimension take place in the same fiscal year across all prefectures. Therefore, the effect of local tax rates could be captured by the time-fixed effects.

3 Data and the instruments

3.1 Data

We use the data of prefectural output and government spending from *Annual Report on Prefectural Accounts* published by the Economic and Social Research Institute (ESRI) in the Cabinet Office of the Government of Japan. The report provides the "prefectural accounts" highly comparable to the national accounts, including consumption, investment, and net exports as well as output and government spending. The sample period is over 1990–2012. Government spending used for regressions includes the government final consumption expenditure and the gross fixed capital formation for public sectors in the report.

Japan comprises 47 prefectures. Traditionally, the country separates into eight regions (Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyusyu).[11] Each region has multiple prefec-

[10] We choose these prefectures for the earthquake dummy based on whether the central government immediately provided a massive amount of special earmarked transfers (the grants for recovery from the Great East Japan Earthquake). In the fiscal year 2011, only these four prefectures received the transfers from the central government. In the next year, the central government provided the transfers to other prefectures. However, they are not necessarily a prefecture that is severely damaged by the earthquake (e.g., Osaka and Kagawa prefectures located in the western area of Japan).

[11] These regions are not officially specified because regions do not have their own elected officials and local policy

tures, except for Hokkaido which is located in the northern-end islands of Japan. Following the *Annual Report on Prefectural Accounts,* we combine Hokkaido and Tohoku into one region (see Figure 1).

As we will elaborate in the next subsections, we utilize the cross-sectional variations of transfers from the central government to the prefectural governments in instrumenting government spending. We take the data of the transfers from *Annual Statistical Report on Local Government Finance* published by the Ministry of Internal Affairs and Communications. All data are reported as nominal variables. When we transform the nominal variables into the real variables, we deflate the nominal variables by the prefecture-specific GDP deflator, with the base year of 2005.

3.2 Instrumenting government spending

Government spending $g_{r,p,t}$ and $G_{r,t}$ are endogenous. Indeed, they are a policy variable affected by the states of the local economy. In the estimation, the time fixed effect can control for all aggregate shocks to the prefectural output. However, government spending is still correlated with prefectural-specific shocks to prefectural output. For example, disasters that decrease prefectural output may cause government spending to increase in the prefecture, relative to other prefectures.

To address the endogeneity issues, we use cross-sectional variations in transfers from the central government to the local governments. To instrument government spending with transfers, we rely on the institutional background of local public finance: (i) The local government spending in Japan highly depends on the transfers from the central government in their revenue. (ii) The transfers from the central government are financed by the national tax revenue that is unlikely to be affected by the local business cycles. (iii) Depending on the type of transfers, the transfers are disbursed to achieve specific national objectives and are hard to reconcile with the local government's intention of stimulating the local economy. We will discuss each institutional fact in turn.

3.2.1 Institutional background

The government activity in Japan is highly centralized, and the local government activity relies on transfers or redistribution of national tax revenue from the central government, in financing their expenditure. This large dependence stems from the vertical fiscal gap between the central and local

decisions within the same region are independent.

governments. Whereas the central government assigns various functions to local governments, the local governments do not sufficiently have their sources of revenues to carry out their functions (see Bessho 2016). In particular, whereas the local governments' expenditure accounts for about 60 percent of total government expenditure, the local governments' revenue is only 40 percent of the total government revenue. This large vertical fiscal gap between the central and local governments implies the necessity of the transfers from the central government. In the fiscal year 2012, for example, these transfers from the central government to all prefectural governments account for 34 percent of the total revenue of all prefectural governments. These transfers are comparable in size to local tax revenues which account for 32 percent of the total revenue of the prefectural governments (The Ministry of Internal Affairs and Communications 2014). These facts suggest that there would be significant correlations between the local government spending and the transfers from the central government.

The national tax revenue finances the transfers from the central government. By construction, the national tax revenue is unlikely to be affected by the state of the local economies, because it is pooled in the central government. Business cycle fluctuations and the fiscal policy at the national level strongly affect the national tax revenue. However, the time fixed effect in regressions controls for such macroeconomic variations over time, unless the macroeconomic shocks have heterogeneous impacts on the local economy.

The local governments in Japan broadly receive two types of transfers from the central government: "the local allocation tax" and "the national treasury disbursements." While the former has a substantial fraction of the total revenue of the prefectural governments (e.g., 18.3 percent in the fiscal year 2012), it is not qualified as the instrument. This is because the local allocation tax is allocated to reduce the horizontal fiscal gap across local governments. For example, when the local tax revenue in a prefecture is lower than other prefectures, the central government allocates more funds to the prefecture than to the other prefectures to reduce the imbalance in the tax revenue across local governments. Therefore, the local allocation tax is likely to be strongly correlated with shocks to the local economy. Likewise, if the output growths are similar in two prefectures within the same region, transfers from the local allocation taxes are likely to comove in these prefectures because of the similarity in changes in their tax revenue. Again, the local allocation taxes are strongly correlated with shocks to the local economy.

In the latter type of transfers from the central government to local governments ("treasury disbursements" for short), the problem is much less severe than the former. While they account for 15.6 percent of the total revenue in the fiscal year 2012, the treasury disbursements are the grants by the central government which aims to promote projects that contribute to specific national objectives (e.g., education, social welfare, and social capital constructions, etc.). To acquire the treasury disbursements, local governments prepare applications describing specific projects with an emphasis on the necessity and earmarking of grants. Ministries in the central government review their applications and decide whether or not to approve the grants and/or subsidies. In general, it is difficult for the applications to have the local government's intention of implementing counter-cyclical fiscal policy, because the fiscal stimulus to specific prefectures is not necessarily consistent with the national objectives. Of course, some projects supported by treasury disbursements have the purposes related to the specific local economy. For example, the central government promotes the disaster-hit prefectures to recover from natural disasters (e.g., the grants for restoring from disaster and the special grants for restoring from the Great East Japan earthquake). However, the dataset of the treasury disbursements includes various categories based on the purposes and programs of grants. Using detailed information on purposes and programs supported by the treasury disbursements, we can remove the grants related to the specific local economy in constructing the instruments for regression analysis.

3.2.2 Constructing the instruments

The *Annual Statistical Report on Local Government Finance* provides the detailed information on purposes and programs of the treasury disbursements transferred to prefectures. Table 1 shows the purposes and programs that we can identify from the report in 2012. As indicated in Table 1, main components of the treasury disbursements are education (30.3% of the treasury disbursements), construction (21.3%), grants and subsidies that may be related to local business cycles and counter-cyclical policies (12.3%) and grants for recovery from disasters (9.2%).

We look for purposes and programs of the treasury disbursements that we can keep track of during the sample period to construct instruments. We choose three categories that are considered to be uncorrelated to shocks to the local economy, based on purposes and programs shown in Table 1.

The first category we choose is the treasury disbursements for education. This category mainly includes compulsory education. The total amount of this subsidy largely depends on the number of teachers and staffs in public schools prescribed by law and on the salary for teachers and staffs in public schools that is insensitive to local business cycles.[12] We argue that other subsidy and grants used for education would mainly vary based on the prefecture's distribution of children.

The second category we select for constructing instruments is constructions which include "ordinary construction" and "grants for comprehensive infrastructure development." They include grants for building public facilities and infrastructures (e.g., construction and maintenance of public facilities, road and bridges, river improvement, and coastal defenses). For the latter, for example, the Ministry of Land, Infrastructure, Transport and Tourism exclusively approves the infrastructure-related grants. To apply for these types of grants, the local governments need to prepare the application describing that their spending contributes to the national objectives.

We do not choose purposes and programs in the treasury disbursements that are strongly related to shocks to the local economy. In particular, we do not select subsidies for livelihood protection (i.e., supplemental social security income for low-income people) and child protection because these subsidies depend on the number of recipients which comoves with business cycle fluctuations at the prefectural level. Also, we do not include the grants for regional autonomous strategies to construct instruments, because this category of grants is designed to allow the local government to use them for discretionary purposes. We exclude the grants for disaster restoration because these grants are designed for stimulating the local economies.

The third category selected for constructing instruments is earmarked transfers, though these transfers account for only 3.6 percent of the treasury disbursement. More specifically, the subsidy for self-support of the disabled is the statutory subsidy. The subcategory of "money in trust" corresponds to the cost of conducting the national projects (e.g., national elections, the collection of statistical data and census data, etc.) and is fully funded by the central government. Grants for area locating electric power plants and grants for locating petroleum reserving facilities are given to prefectures, depending on the presence of power plants or petroleum reserving facilities in the prefecture. These sub-categories may be assumed to be unrelated to shock to the local economy.

The *Annual Report* does not provide detailed information on other small grants, while the total sum accounts for 23.3 percent of the treasury disbursements. The report treats these grants

[12] The transfers from the central government for construction of school buildings and related facilities are included as the category of construction in the treasury disbursements.

as "others" in which we cannot identify the programs and purposes. Therefore, we exclude this category in constructing instruments.

We construct instruments used for our analysis by taking the sum of the grants in the selected categories of the treasury disbursements. In what follows, we refer to the sum as the "selected treasury disbursements." Figure 2 shows how the selection of categories in the treasury disbursements influences the data fluctuations. The figure plots the total treasury disbursements and the selected treasury disbursements, both of which are at the national level. The treasury disbursements (shown in a black line) reflects two large-scale changes in government spending. We see the impacts of the large-scale fiscal stimulus package in the aftermath of the 2008 global financial crisis and the large-scale expenditure for recovery from the Great East Japan Earthquake in 2011. The selected treasury disbursements (shown in red) does not have a large increase in 2009, because most grants for implementing the fiscal stimulus packages are temporary and discretionary grants categorized as "others" which we excluded from the instruments. Likewise, we observe no significant increase in 2011 in the selected treasury disbursements because we remove the grants for recovering from the earthquake from the instruments.

3.2.3 First-stage regressions

With the above discussions in mind, we instrument two endogenous regressors in the estimation equation (2) with changes in the lagged selected treasury disbursements. We employ the instruments at both prefectural- and regional-levels because (2) includes the prefectural government spending ($g_{r,p,t}$) and the regional government spending ($G_{r,t}$). More specifically, our instruments are $\Delta s_{r,p,t-1}/y_{r,p,t-2}$, $\Delta s_{r,p,t-2}/y_{r,p,t-3}$, $\Delta S_{r,t-1}/Y_{r,t-2}$, and $\Delta S_{r,t-2}/Y_{r,t-3}$, where $s_{r,p,t}$ and $S_{r,t}$ are the selected treasury disbursements at prefectural and regional levels, respectively.[13] Therefore, the resulting number of excluded instruments (denoted by L) is four, while there are two endogenous regressors in the regression.

Table 2 reports the results of the first-stage regressions. The first-stage regressions suggest that our instruments are not weak to identify the fiscal multipliers. In the table, the first column reports the first-stage regression results for $\left(g_{r,p,t} - g_{r,p,t-2}\right)/y_{r,p,t-2}$ and the second column reports the first-stage regression results for $\left(G_{r,t} - G_{r,t-2}\right)/Y_{r,t-2}$. The Angrist–Pischke F statistics exceed

[13] We checked the robustness of our results when using instruments that are not scaled by output. The results are essentially unaltered.

10 in both regressions (39.3 and 540.5, respectively). The adjusted R^2s are also high: 0.64 for the regression of $\left(g_{r,p,t} - g_{r,p,t-2}\right) / y_{r,p,t-2}$ and 0.82 for the regression of $\left(G_{r,t} - G_{r,t-2}\right) / Y_{r,t-2}$. The signs of coefficients are consistent with our prediction that higher treasury disbursements lead to higher government spending. In particular, the coefficients on $\Delta s_{r,p,t-1}/y_{r,p,t-2}$ and $\Delta s_{r,p,t-2}/y_{r,p,t-3}$ in the first-stage regression of $\left(g_{r,p,t} - g_{r,p,t-2}\right) / y_{r,p,t-2}$ are both positive (2.03 and 0.82, respectively). Similarly, the coefficients on $\Delta S_{r,t-1}/Y_{r,t-2}$ and $\Delta S_{r,t-2}/Y_{r,t-3}$ in the first-stage regression of $\left(G_{r,t} - G_{r,t-2}\right) / Y_{r,t-2}$ are both positive. Therefore, the signs of coefficients are again consistent with the expected relationship between regional government spending and transfers from the central government.[14]

4 Main Results

4.1 Estimates of fiscal multipliers and the geographic decomposition

Table 3 reports our results of the output multipliers estimated from (2). In all specifications, we include the time fixed effect and the entity fixed effect at the prefectural level into the regressions. The numbers in the parentheses below the estimate are the standard errors clustered by regions to allow for possible correlations of error terms within regions. Note that the number of clusters is only seven (i.e., $M = 7$), as suggested in Figure 1. As noted in Cameron and Miller (2015), it is not appropriate to use the critical values obtained from the normal distribution with a small number of clusters. Following Cameron and Miller (2015), we make a finite sample correction by rescaling the regression residuals by $\sqrt{M/\left(M-1\right)}$.[15] Given this finite-sample correction, it is common to use the critical value obtained from the t distribution with $M - 1$ degrees of freedom.

Panel (A) of Table 3 describes the ordinary least squares (OLS) estimates to compare them to the two-stage least squares (2SLS) estimates. The estimated RFM is 1.07 in the second column when we assume the region-wide effect.[16] The RFM of 1.07 is decomposed into the PFM of 0.45 and the region-wide effect of 0.62. In the second column of the same panel, we assume no region-wide

[14] Here, we compute the standard errors of the estimated coefficients from the cluster-robust estimate of the variance matrix by regions. We also make corrections to mitigate the finite-sample bias arising from the small number of clusters (i.e., regions). We will elaborate this issue in Section 4.

[15] We also make the finite-sample correction for the number of parameters in estimation results. In other words, we rescale the regression residuals by $\sqrt{M/\left(M-1\right)} \times \sqrt{N/\left(N-K\right)}$, where N is the number of observations used in the regression and K is the number of parameters.

[16] When we estimate β_R directly from (1) by OLS, we obtain similar estimates.

effect (i.e., $\gamma_S = 0$ and thus $\beta_R = \gamma_P$). In this case, the output fiscal multiplier equals 0.60, smaller than one.

Panel (B) reports the 2SLS estimates. The RFM is 1.74, statistically different from zero at the conventional significance level. The estimate is larger than the OLS estimate. This result may be due to the endogenous counter-cyclical policy taken by the prefectural governments. The RFM when we assume no region-wide effect (i.e., $\beta_R = \gamma_P$) is 1.59, as shown in the second column of Panel (B). Again, the estimate suggests a much stronger impact on output than the OLS estimate of 0.60. In Panel (C), we also estimate the multipliers using the limited information maximum likelihood (LIML), in which the bias arising from possible weak instruments is less severe than that in 2SLS. The LIML estimates are very similar to the 2SLS estimates. In both of 2SLS and LIML, the p-values of overidentifying restrictions suggest that the null hypothesis of the validity of instruments cannot be rejected.

In terms of the geographic decomposition into the PFM and the region-wide effect, we find that the estimated PFM and the region-wide effect is 1.43 and 0.30, respectively. The contribution of the region-wide effect to the RFM is 17 percent of the estimated RFM, and the region-wide effect is estimated somewhat imprecisely. The result of the LIML estimates is again very similar to the 2SLS estimates.

Using the estimated region-wide effect and the data of the GDP share in prefecture p in region r, we calculate the size of spillover in our regression. We use the GDP share averaged over the sample period for $\omega_{r,p}$ and calculate $\gamma_S (1 - \omega_{r,p})$. The spillover averaged across prefectures is 0.26, which is relatively small compared to the RFM of 1.74. The spillover ranges between 0.16 and 0.29, depending on the value of $\omega_{r,p}$. The spillover is the lowest in Tokyo because the GDP share is the largest in the sample. Conversely, the spillover is high in a prefecture with the low GDP share relative to the region to which the prefecture belongs.

Our estimates are broadly consistent with multipliers estimated by previous studies. Nakamura and Steinsson (2014) report that the LFM is 1.43 using the U.S. state-level data and 1.85 using the U.S. regional-level data. Shoag (2010) also uses the U.S data and finds that the LFM on the U.S. state personal income is 2.12. Acconcia et al. (2014) use the Italian provincial data and estimate the LFM on output to be 1.5 or 1.9. These estimates of the LFM including ours may be large if we directly compared these LFM with the national fiscal multipliers. However, the estimated LFM are in line with the literature. Chodorow-Reich (2018) concludes that the cross-study mean of the

LFM is about two. Ramey (2011) reports that the LFM on income takes a value between 1.5 and 1.8.[17]

The 2SLS and LIML estimates suggest weak evidence for spillovers in the data. This result is also consistent with previous studies. For example, Acconcia et al. (2014) find positive spillovers, but the spillover is small in size and statistically insignificant at a five percent significance level. Suárez-Serrato and Wingender (2016) use the U.S. county-level data to estimate the LFM. They find negative spillovers in their regression, but, again, the effect is not statistically different from zero. Brückner and Tuladhar (2014) introduce government expenditures aggregated across neighboring prefectures and estimate its coefficient. They find that the effect is positive but not significantly different from zero. In the next subsection, however, we argue that the spillover may not be weak when focusing on the expenditure within the prefecture.

Before closing this subsection, two remarks are in order. First, we modified the standard errors of regression coefficients by rescaling residuals and referred to the t-distribution. However, the standard errors may still be underestimated with a small number of clusters (Cameron et al. 2008, Cameron and Miller 2015). Therefore, following the suggestions by Cameron and Miller (2015), we also use the wild cluster bootstraps to test the statistical significance of regression coefficients.[18] Based on the bootstrap, we can reject the null hypothesis that $\gamma_P + \gamma_S = 0$ with the p-value of 0.010 and the null hypothesis that $\gamma_P = 0$ with the p-value of 0.040. That is, both of the RFM β_R and the PFM γ_P are significantly different from zero, similarly to the tests based on the standard errors with the finite sample corrections. The p-value for the null hypothesis that $\gamma_S = 0$ is 0.521 so that γ_S is not significantly different from zero. This result is also the same as the test based on the standard errors with the finite sample corrections. Therefore, even if we use better tests for the statistical significance of coefficients, our results are unaffected.

Second, our estimates are larger than the estimates in Brückner and Tuladhar (2014) who used the same data for estimating the LFM as ours. Using the sample period over 1990 – 2000, they estimate the impact multiplier defined as one-year changes in output in response to one-year changes in government spending. Their estimates range between 0.55 and 0.78. To see whether we can

[17] Clemens and Miran (2012) argue that the LFM tends to be large when the source of variations in government spending is "windfall-financed" like the transfers from the central government. This may be another reason that we obtain relatively large estimates of the RFM.

[18] More specifically, we use a six-point distribution of Webb (2014) for the weights in constructing pseudo residuals, to ensure the sufficient number of bootstrap samples of 3,999. In computation, we used the Stata package `boottest` developed by Roodman et al. (2018).

reproduce estimates similar to Brückner and Tuladhar (2014), we replace $(y_{r,p,t} - y_{r,p,t-2})/y_{r,p,t-2}$ and $(g_{r,p,t} - g_{r,p,t-2})/y_{r,p,t-2}$ in (2) by one-year growth of output and one-year change in government spending divided by the lagged output, respectively. We then estimate the impact multiplier without the region-wide effect, using the sample period over 1990 – 2000. Our estimation yields the estimated PFM of 0.78 with the standard error of 0.18, which is very close to that in Brückner and Tuladhar (2014).[19]

4.2 Expenditure decomposition

We next focus on the decomposition based on expenditure components in the "prefectural accounts," using the data of private consumption, private fixed investment, and net exports. Recall that the point estimates of the RFM exceed unity. The large RFM imply the crowding-in effect in some expenditure components. The question is, which expenditure components are crowded in by local government spending?

To answer this question, we estimate the following regression equation:

$$\frac{d_{r,p,t} - d_{r,p,t-2}}{y_{r,p,t-2}} = \gamma_P \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} + \gamma_S \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \eta_{r,p} + \delta_t + \varepsilon_{r,p,t}, \tag{10}$$

where $d_{r,p,t}$ is the expenditure component per capita in prefecture p in region r. Here, we slightly abuse notations for γ_P and γ_S, because regressors in (10) are the same as those in (2). The dependent variable in (10) is scaled by the prefectural output. Therefore, an increase in government spending by one percent of the prefectural output leads to an increase in the corresponding expenditure component by γ_P percent of the prefectural output. Likewise, an increase in regional government spending by one percent of the regional output leads to an increase in the corresponding expenditure component by γ_S percent of the prefectural output. As before, we interpret $\gamma_P + \gamma_S$ as the RFM (β_R) on the corresponding expenditure component and $\gamma_S(1 - \omega_{r,p})$ as the spillover to the corresponding expenditure component.

In what follows, we will present our estimates of the RFM on consumption, investment, and "domestic absorption" (i.e., the sum of private consumption, the government consumption, and the gross capital formation in a single prefecture). Because absorption consists of only within-prefecture

[19] We obtain this results using $\Delta s_{r,p,t}/y_{r,p,t-1}$ and $\Delta S_{r,t}/Y_{r,t-1}$ as additional instruments, because the instruments used in the benchmark regressions are weak.

aggregate expenditure, we measure the RFM on expenditure before the aggregate demand leaks to economies outside the region. We also estimate fiscal multipliers on net exports. Here, we construct net exports by subtracting the domestic absorption from the prefectural GDP compiled from the production side.

Panels (A) and (B) in Table 4 presents the estimated multipliers on private consumption and private fixed investment. Importantly, these two expenditure components are crowded in by local government spending. In particular, the RFM on private consumption and private fixed investment are estimated to be positive and statistically significant. They are economically significant as well if we compare them to the RFM on output. The RFM on private consumption is 0.48, 27 percent of the RFM on output. The RFM on private fixed investment is also large, 0.66, approximately 38 percent of the RFM on output. The sum of the contribution to the RFM on output is substantial: 65 percent of the RFM on output.

As shown in panel (C) of Table 4, the RFM on absorption is 2.18, which is by 25 percent larger than the RFM on output. By definition, the sum of the RFM on consumption, investment and government spending (which is unity by definition) roughly equals the RFM on absorption.[20] Furthermore, the sum of the RFM on absorption and the RFM on net exports equals the RFM on output. We thus expect that the local government spending reduces net exports because the estimated RFM on absorption is larger than that on output. Panel (D) of the same table indicates that the estimated RFM on net exports is -0.44, though it is not statistically different from zero. The negative RFM on net exports implies that taking regional exports as given, an increase in regional government spending may generate a leakage of regional aggregate demand to other regions of Japan or foreign countries.

Figure 3 summarizes the results of our decomposition of the RFM. The most left bar of the figure represents the RFM on output which amounts to 1.74. The middle bar represents the results when we decompose the RFM on output (1.74) into those on absorption (2.18) and net exports (-0.44). We can further decompose the RFM on absorption (2.18) into private consumption (0.48), private fixed investment (0.66), and government spending (1.00), and the remaining is changes in inventories (0.04).

We also find that the region-wide effect on expenditure components is statistically and eco-

[20] The sum of the RFM is not exactly equal to the RFM on absorption because of the RFM on changes in inventory. If we estimate the RFM on changes in inventory, the sum of the RFM coincides with the RFM on absorption.

nomically significant in contrast to that on output. Panels (A) – (D) of Table 4 also show the estimates of γ_S. For private consumption, the RFM is 0.48 and the region-wide effect is 0.50. The spillover $\gamma_S (1 - \omega_{r,p})$ takes a value between 0.26 and 0.48. For private fixed investment, the RFM is 0.66, and the region-wide effect is 0.28. The spillover is between 0.14 and 0.27. The estimated region-wide effect of private consumption and private fixed investment are statistically significant at least the ten percent significance level.[21]

The economically and statistically significant region-wide effect is more clearly present in the absorption, as shown in Panel (C) of Table 4. The estimated region-wide effect on absorption is 0.80 and converted into the spillover to absorption that takes the mean of 0.68 and ranges between 0.41 and 0.77. The region-wide effect is precisely estimated with the standard error of 0.19. The p-value for the null hypothesis that $\gamma_S = 0$ is 0.018 even with the wild cluster bootstrap. This statistically significant region-wide effect in absorption sharply contrasts with the spillover in output. In other words, the positive and statistically significant region-wide effect can be supported by the data if we concentrate on expenditure before its leakage to economies outside the region to which prefectures belong.

Finally, the estimation results without the region-wide effect are shown in the second column of each panel of Table 4. The estimated multipliers on expenditure components are positive except for net exports. Recall that the output multiplier without the region-wide effect was 1.59 (See the second column of Panel (B) of Table 3). Using the estimates shown in the second column of Table 4, we decompose the output multiplier of 1.59 into absorption (1.80) and net exports (−0.21). The multiplier on absorption (1.80) is decomposed into private consumption (0.24), private fixed investment (0.53) and government spending (1.00). The remaining is changes in inventory (0.03). In the RFM without the region-wide effect, however, we do not observe strong evidence for the crowding-in effect in private consumption.

[21] In addition to the statistical significance based on the standard errors in the table, we reconfirm that the statistical significance of γ_S from the wild cluster bootstrap. In particular, the p-value of the null hypothesis that $\gamma_S = 0$ is 0.020 in the regression of private consumption and the corresponding p-value for the regression of private fixed investment is 0.058.

4.3 Relationship to the national fiscal multiplier

In this subsection, we interpret the estimated RFM in the context of the national fiscal multiplier. Consider a time-series regression to estimate the national fiscal multiplier β:

$$\frac{Y_t - Y_{t-2}}{Y_{t-2}} = \beta \frac{G_t - G_{t-2}}{Y_{t-2}} + \alpha + \varepsilon_t, \tag{11}$$

where Y_t and G_t denote the national-level per capita output and government spending, respectively. In the above equation, α is a constant term, rather than the entity fixed effect. Note also that we do not have the time fixed effect, because of the colinearity with national government spending. Next, consider a variant of (1):

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} = \beta_R \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \beta_S \frac{G_t - G_{t-2}}{Y_{t-2}} + \alpha_r + v_{r,t}. \tag{12}$$

In this equation, there is no time fixed effect δ_t because of the colinearity with national government spending. Therefore, $v_{r,t}$ includes all macroeconomic factors other than $(G_t - G_{t-2})/Y_{t-2}$ (e.g., monetary policy and the national tax change). We interpret the parameter β_S as *the nation-wide effect*, using the same logic as the region-wide spillover. Thus, under the approximation assumption, the national fiscal multiplier β can also be decomposed into β_R and β_S. Of course, the regression taking $v_{r,t}$ as the error term may suffer from severe endogeneity bias, due to unobserved macroeconomic factors. Therefore, in general, it is difficult to estimate β_R and β_S, unless fully exogenous government spending is available.[22]

We could still perform the back-of-envelope calculation to evaluate the nation-wide effect by comparing β_R in our analysis and β estimated by the previous studies on national fiscal multipliers. For example, Watanabe et al. (2010) estimate the national fiscal multipliers using the structural VAR approach similar to Blanchard and Perotti (2002). Their impulse responses give rise to the aggregate two-year cumulative fiscal multipliers of 1.56.[23] This national fiscal multiplier is close to our RFM estimates of 1.74. Thus, based on our RFM estimate, the nation-wide effect may be

[22] The study that circumvents possible endogeneity bias is Dupor and Guerrero (2017) who use the national- and state-level defense spending to estimate the interstate spillover.

[23] We thank Arata Ito for providing us the point estimates of the impulse response functions. To be consistent with our estimates of the two-year cumulative fiscal multiplier, we compute two-year cumulative fiscal multipliers from their impulse response function. We obtain the value of 1.56 under the assumption that the GDP and the government spendings at the national level has a deterministic trend.

small: $\beta_S = \beta - \beta_R \simeq -0.18$. A more recent work by Miyamoto et al. (2016) estimate the national fiscal multipliers under the zero lower bound. They define the zero lower bound period as the period after 1995:Q4. They estimate two-year cumulative fiscal multiplier over this period to be 1.70. Comparing our RFM and their estimate of the national fiscal multiplier, we could say that the nation-wide effect is small, -0.04.

We can reconfirm the small nation-wide effect from the estimates from structural simultaneous equation models. For example, Hamada et al. (2015) find that the aggregate two-year cumulative fiscal multiplier is 1.24 under the assumption that the short-term nominal interest rate is constant. Likewise, Bank of Japan (2016) also reports that the two-year cumulative fiscal multiplier is 1.4 under the fixed nominal interest rate. These point estimates suggest that the nation-wide effect may be negative ranging between -0.50 and -0.34.

5 Robustness

In this section, we discuss the robustness of our results. To conserve the space, we will report only multipliers on output and absorption.

5.1 Adding control variables

Table 5 reports the results of the robustness checks to the introduction of additional control variables. In Panel (A), we follow Acconcia et al. (2014) and introduce the lagged dependent variables (e.g., $\left(y_{r,p,t-2} - y_{r,p,t-4}\right)/y_{r,p,t-4}$) into the regression. In Panel (B) – (D), we also add the two-year growth rate of the prefectural population and/or the two-year growth rate of the regional population into the regressions. We include these additional control variables because the decomposition of the RFM into the PFM and region-wide effect relies on the assumption that the distribution of population within the region is stable.

Overall, the results are robust to adding control variables. The RFM on output takes a value ranging between 1.83 and 1.99 so that the estimated RFM are slightly larger than those in the benchmark regression. The region-wide effect is estimated to be positive. The estimated region-wide effect is statistically insignificant in output, but the region-wide effect is economically and statistically significant. The spillover that can be calculated from the region-wide effect is large if we focus on absorption, rather than output.

5.2 Dropping possible outliers

We next explore whether possible outliers may influence the results in Table 6. Panels (A) – (C) drop possible outliers in cross-sectional dimension. Panels (D) and (E) exclude the samples in the time-series dimension.

In Panel (A), we first drop the northern-end prefecture (Hokkaido islands) and the southern-end prefecture (Okinawa islands) from the 47 sample prefectures. We remove these prefectures because they are separated geographically from the largest main island of Japan. We observe the robustness to dropping these prefectures. In Panel (B), we eliminate Tokyo, the most economically important prefecture, from the samples, because the tax revenue collected in Tokyo may have a strong influence on the national tax revenue as a whole. Nevertheless, our robustness check reveals no substantial changes in the estimated multipliers and the region-wide effect. In Panel (C), we drop the samples in which $D^E_{r,p,t}$ in (9) equals unity. In other words, we drop the four prefectures (Iwate, Ibaraki, Fukushima, and Miyagi) after the year of the Great East Japan Earthquake. Once again, our results are robust to dropping the samples.

Panel (D) removes the sample periods between 2009 and 2012 to allow for possible heterogeneous impacts of the global financial crisis. While the time-fixed effect could control for the impact of the global financial crisis, the crisis may have different effects on prefectural net exports that are subject to shocks from foreign countries. In this case, the time fixed effect may not fully control for the impact of the global financial crisis. In these specifications, the estimated RFM on output is 1.87, slightly larger than the benchmark estimate of 1.74 in Table 3, because the region-wide effect on output is 0.88, somewhat larger than the benchmark estimate of 0.30. Nevertheless, as before the RFM on absorption is larger than that on output, and the spillover is statistically significant only in the regression of absorption. Finally, we limit the data to the sample period after the fiscal year 1995 in Panel (E). Miyamoto et al. (2017) define the period after 1995:Q4 as the period of the zero lower bound on nominal interest. Again, while the time-fixed effect could control for this aggregate effect, we allow for the possibility that the zero lower bound may have heterogeneous effects on prefectural output. In this case, we estimate the RFM to be 1.53 with the small region-wide effect close to zero. However, the RFM on absorption remains larger than the RFM on output, and the region-wide effect on absorption remains economically and statistically significant, reconfirming the robustness of our results.

5.3 Cumulative multipliers

In the benchmark regression, we followed Nakamura and Steinsson (2014) to estimate the two-year cumulative multipliers, using the two-year growth rate of output and the two-year change in government spending scaled by output. In this subsection, we discuss the results using different time horizons of cumulative multipliers.

Let us first consider the one-year (impact) multiplier. In regressions, we replace the dependent variables by the one-year growth rate of output or the one-year change in absorption. Similarly, we replace the regressors by the one-year changes in government spending. With the replacement, the resulting coefficients correspond to the impact multiplier. Unfortunately, the regression results for impact multipliers are somewhat unstable depending on the sample period. In particular, when we use the whole sample period over 1990 – 2012 for regression of output growth, the regression coefficients are imprecisely estimated. This result may arise due to large swings in output and net exports after the global financial crisis and the earthquake in 2011. Such large swings in the data may affect the regression fit for the impact multiplier more strongly than that for the two-year cumulative multiplier because changes in output (and net exports) are not smoothed out in the one-year change relative to the two-year change. For this reason, we drop the sample period after 2009 as we did in Panel (D) of Table 6. To take the large swings into account, we also use a slightly different instruments consisting of $\Delta s_{r,p,t}/y_{r,p,t-1}$, $\Delta S_{r,t}/Y_{r,t-1}$, $\Delta s_{r,p,t-1}/y_{r,p,t-2}$, and $\Delta S_{r,t-1}/Y_{r,t-2}$.[24] We similarly consider the cumulative multipliers for three and five years. In these specifications, we use the whole sample period including the periods during the global financial crisis, and the instruments are the same as those in the benchmark regression.

Table 7 reports cumulative multipliers with different time horizons. In the table, we compare the cumulative multipliers for one, three, and five years. Panel (A) of Table 7 shows the results with these modifications. The estimated RFM on output is 1.98. The magnitude is slightly larger than the benchmark two-year cumulative RFM of 1.74 (shown in the first column of Panel (B) of Table 3) but is close to the two-year cumulative RFM of 1.87 based on the sample periods before 2009 (shown in Panel (D) of Table 6). Turning to the one-year change in absorption, we observe

[24] Another reason to change the instruments is the possibility of weak instruments when the regressors are the one-year change. Under the benchmark instruments, the Angrist–Pischke F statistic for the first-stage regression of $(g_{r,p,t} - g_{r,p,t-1})/y_{r,p,t-1}$ reduces to 3.74, while the Angrist–Pischke F statistic for the first-stage regression of $(G_{r,t} - G_{r,t-1})/Y_{r,t-1}$ is 28.9. Under the new instruments, however, the Angrist–Pischke F statistics are 47.4 for the first-stage regression of $(g_{r,p,t} - g_{r,p,t-1})/y_{r,p,t-1}$ and 67.0 for the first-stage regression of $(G_{r,t} - G_{r,t-1})/Y_{r,t-1}$, respectively.

that the estimated coefficients are similar to the estimated coefficients in the two-year changes in absorption. That is, the RFM is estimated to be around two, and the region-wide effect is positive and large in magnitude (0.74). However, in this specification of the one-year change in absorption, the region-wide effect is not significantly different from zero.

Panel (B) reports the multipliers on output and absorption for the three-year change, and Panel (C) provides those for the five-year change. In point estimates, these RFM on output are slightly larger than in the benchmark case of the two-year change. The region-wide effect on output tends to be larger in the specification of the three-year and the five-year changes, whereas they continue to be statistically insignificant. The RFM on absorption and the region-wide effect on absorption are very similar to each other, regardless of the specification in time horizon.

6 Conclusion

This paper investigated local fiscal multipliers, using the data of the "prefectural accounts" and local public finance in Japan. We estimated the local fiscal multipliers for regions and decomposed the regional fiscal multiplier into the prefectural fiscal multiplier and the region-wide effect. We identify the former from the prefecture-specific variations of government spending and the latter from the common variations of government spending across prefectures within the same region. The region-wide effect is converted into the spillover across prefectures. The regional fiscal multiplier on output in the benchmark regression is 1.7. The region-wide effect on output is estimated to be positive but not very strong. Based on the estimated region-wide effect, the spillover is less than 0.3, out of the regional fiscal multiplier of 1.7.

The data of the "prefectural accounts" allow us to decompose the regional fiscal multiplier on output into that on expenditure components of aggregate demand. We find the crowding-in effects in private consumption and private fixed investment. We also found that the regional fiscal multiplier on absorption is 2.2, implying a substantial leakage of aggregate demand to other prefectures and regions through net exports. Moreover, in contrast to the region-wide effect on output, the region-wide effect on absorption is economically and statistically significant, suggesting the positive spillover in the aggregate expenditure within the region.

A Appendix: Estimation equation and weighted average

This appendix derives (3) and (8) from (2) under the assumption that the distributions of prefectural output and population are stable over time.

A.1 Derivation of (3)

Let $Y^*_{r,t}$, $G^*_{r,t}$ and $N^*_{r,t}$ be GDP, government spending, and population in region r. Because we use the per capita output and government spending, we have $Y_{r,t} = Y^*_{r,t}/N^*_{r,t}$, $G_{r,t} = G^*_{r,t}/N^*_{r,t}$. Similarly, define GDP, government spending, and population in prefecture p by $y^*_{r,p,t}$, $g^*_{r,p,t}$, and $n^*_{r,p,t}$, respectively. We can similarly write $y_{r,p,t} = y^*_{r,p,t}/n^*_{r,p,t}$, $g_{r,t} = g^*_{r,p,t}/n^*_{r,p,t}$. We also note that the regional output $Y^*_{r,t}$ is the sum of the prefectural output $y^*_{r,p,t}$: $Y^*_{r,t} = \sum_{p \in r} y^*_{r,p,t}$. Likewise, the regional government spending is the sum of the prefectural government spending: $G^*_{r,t} = \sum_{r \in p} g^*_{r,p,t}$.

Let

$$\begin{aligned} \omega_{r,p} &= E\left(\frac{y^*_{r,p,t}}{Y^*_{r,t}}\right), \\ \omega^n_{r,p} &= E\left(\frac{n^*_{r,p,t}}{N^*_{r,t}}\right). \end{aligned}$$

Here, $\omega_{r,p}$ ($\omega^n_{r,p}$) are the time-series mean of the GDP (population) share of prefecture p in region r. We assume that the distributions of the prefectural GDP and population are stable over the sample periods. By these assumptions, we mean that $y^*_{r,p,t}/Y^*_{r,t} \simeq \omega_{r,p}$ and $n^*_{r,p,t}/N^*_{r,t} \simeq \omega^n_{r,p}$.

Let us consider the numerator and the denominator of $(y_{r,p,t} - y_{r,p,t-2})/y_{r,p,t-2}$ and $(g_{r,p,t} - g_{r,p,t-2})/y_{r,p,t-2}$, respectively. These terms appear in (2). First, the numerator is

$$\begin{aligned} y_{r,p,t} - y_{r,p,t-2} &= \frac{y^*_{r,p,t}}{n^*_{r,p,t}} - \frac{y^*_{r,p,t-2}}{n^*_{r,p,t-2}} \\ &= \frac{N^*_{r,t}}{n^*_{r,p,t}}\frac{y^*_{r,p,t}}{N^*_{r,t}} - \frac{N^*_{r,t-2}}{n^*_{r,p,t-2}}\frac{y^*_{r,p,t-2}}{N^*_{r,t-2}} \\ &\simeq \frac{1}{\omega^n_{r,p}}\frac{y^*_{r,p,t}}{N^*_{r,t}} - \frac{1}{\omega^n_{r,p}}\frac{y^*_{r,p,t-2}}{N^*_{r,t-2}}. \end{aligned} \tag{13}$$

The denominator is

$$\begin{aligned} y_{r,p,t-2} &= \frac{y^*_{r,p,t-2}}{n^*_{r,p,t-2}} = \frac{y^*_{r,p,t-2}}{Y^*_{r,t-2}} \frac{N^*_{r,t-2}}{n^*_{r,p,t-2}} \frac{Y^*_{r,t-2}}{N^*_{r,t-2}} \\ &\simeq \frac{\omega_{r,p}}{\omega^n_{r,p}} Y_{r,t-2}. \end{aligned} \tag{14}$$

Then, the growth rate of $y_{r,p,t}$ is

$$\frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} = \frac{\frac{y^*_{r,p,t}}{N^*_{r,t}} - \frac{y^*_{r,p,t-2}}{N^*_{r,t-2}}}{\omega_{r,p} Y_{r,t-2}} \tag{15}$$

Taking the weighted average of output growth with the GDP share yields

$$\begin{aligned} \sum_{p \in r} \omega_{r,p} \frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} &\simeq \frac{\frac{\sum_{p \in r} y^*_{r,p,t}}{N^*_{r,t}} - \frac{\sum_{p \in r} y^*_{r,p,t-2}}{N^*_{r,t-2}}}{Y_{r,t-2}} \\ &= \frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}}. \end{aligned} \tag{16}$$

We repeat this calculation on $(g_{r,p,t} - g_{r,p,t-2}) / y_{r,p,t-2}$. The resulting equation is

$$\begin{aligned} \sum_{p \in r} \omega_{r,p} \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} &\simeq \frac{\frac{\sum_{p \in r} g^*_{r,p,t}}{N^*_{r,t}} - \frac{\sum_{p \in r} g^*_{r,p,t-2}}{N^*_{r,t-2}}}{Y_{r,t-2}} \\ &= \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}}. \end{aligned} \tag{17}$$

Finally, taking the weighted average of both sides of (2), we have

$$\sum_{p \in r} \omega_{r,p} \frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} = \gamma_P \sum_{p \in r} \omega_{r,p} \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} + \gamma_S \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \sum_{p \in r} \omega_{r,p} \eta_{r,p} + \delta_t \sum_{p \in r} \omega_{r,p} + \sum_{p \in r} \omega_{r,p} \varepsilon_{r,p,t}.$$

By simplifying this equation, we have

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} \simeq (\gamma_P + \gamma_S) \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \alpha_r + \delta_t + \varepsilon_{r,t},$$

which is (3) in the main text.

A.2 Derivation of (8)

To derive (8), it suffices to show that

$$\sum_{p' \neq p} \tilde{\omega}_{r,p',p} \frac{g_{r,p',t} - g_{r,p',t-2}}{y_{r,p',t-2}} = \frac{G_{r,-p,t} - G_{r,-p,t-2}}{Y_{r,-p,t-2}}, \tag{18}$$

because we can easily derive (6) and (7) from (3). Using the definitions of $Y_{r,-p,t}$, $G_{r,-p,t}$, $Y^*_{r,-p,t}$, $G^*_{r,-p,t}$, $N^*_{r,-p,t}$, we can derive an equation similar to (15):

$$\frac{g_{r,p',t} - g_{r,p',t-2}}{y_{r,p',t-2}} = \frac{\frac{y^*_{r,p',t}}{N^*_{r,-p,t}} - \frac{y^*_{r,p',t-2}}{N^*_{r,-p,t-2}}}{\tilde{\omega}_{r,p',p} Y_{r,-p,t-2}}. \tag{19}$$

By taking the sum of both sides of the equation with the weight $\tilde{\omega}_{r,p',p}$, we obtain (18).

References

[1] Acconcia, A., G. Corsetti and S. Simonelli (2014). "Mafia and Public Spending: Evidence on the Fiscal Multiplier from a Quasi-Experiment," *American Economic Review*, 104 (7), pp. 2185-2209.

[2] Auerbach, A. J. and Y. Gorodnichenko (2017). "Fiscal multipliers in Japan," *Research in Economics*, 71 (3), pp. 411-421.

[3] Auerbach, A. J., Y. Gorodnichenko, D. Murphy (2018). "Local Fiscal Multipliers and Fiscal Spillovers in the United States," Unpublished manuscript.

[4] Bank of Japan (2016). "Outlook for Economic Activity and Prices, October 2016," `https://www.boj.or.jp/en/mopo/outlook/gor1610a.pdf`.

[5] Bessho, S. (2016). "Case Study of Central and Local Government Finance in Japan," Asian Development Bank Institute Working Paper Series No. 599.

[6] Blanchard, O. and R. Perotti (2002). "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output', *Quarterly Journal of Economics*, 117 (4), pp. 1329-1368.

[7] Brückner, M. and A. Tuladhar (2014). "Local Government Spending Multipliers and Financial Distress: Evidence from Japanese Prefectures," *The Economic Journal*, 124 (581), pp. 1279-1316.

[8] Cameron, A. C. and D. L. Miller (2015). "A Practitioner's Guide to Cluster-robust Inference," *Journal of Human Resources*, 50 (2), pp. 317-372.

[9] Cameron, A. C., J. B. Gelbach and D. L. Miller (2008). "Bootstrap-based Improvements for Inference with Clustered Errors," *The Review of Economics and Statistics*, 90 (3), pp. 414-427.

[10] Chodorow-Reich, G., L. Feiveson, Z. Liscow and W. G. Woolston (2012). "Does State Fiscal Relief During Recessions Increase Employment? Evidence from the American Recovery and Reinvestment Act," *American Economic Journal: Economic Policy*, 4 (3), pp. 118-145.

[11] Chodorow-Reich, G. (2018). "Geographic Cross-Sectional Fiscal Multipliers: What Have We Learned?," *American Economic Journal: Economic Policy*, forthcoming.

[12] Clemens, J. and S. Miran (2012). "Fiscal Policy Multipliers on Subnational Government Spending," *American Economic Journal: Economic Policy*, 4 (2), pp. 46-68.

[13] Cohen, L., J. Coval and C. Malloy (2011). "Do Powerful Politicians Cause Corporate Downsizing?,"' *Journal of Political Economy*, 119 (6), pp. 1015-1060.

[14] Conley, T. G. and B. Dupor (2013). "The American Recovery and Reinvestment Act: Solely a Government Jobs Program?," *Journal of Monetary Economics*, 60 (5), pp. 535-549.

[15] Dupor, B. and R. Guerrero (2017) "Local and Aggregate Fiscal Policy Multipliers," *Journal of Monetary Economics*, 92 (C), pp. 16-30.

[16] Dupor, B. and P. B. McCrory (2017). "A Cup Runneth Over: Fiscal Policy Spillovers from the 2009 Recovery Act," *The Economic Journal*, 128 (611), pp. 1476-1508.

[17] Fishback, P. and V. Kachanovskaya (2015). "The Multiplier for Federal Spending in the States During the Great Depression," *Journal of Economic History*, 75 (1), pp. 125-162.

[18] Galí J., J. D. Lóez-Salido and J. Vallés (2007). "Understanding the Effects of Government Spending on Consumption," *Journal of the European Economic Association*, 5 (1), pp. 227-270.

[19] Guo, Q., C. Liu and G. Ma (2016). "How Large is the Local Fiscal Multiplier? Evidence from Chinese Counties," *Journal of Comparative Economics*, 44 (2), pp. 343-352.

[20] Hamada, K., M. Hori, T. Hanagaki, R. Yokoyama, T. Kameda, K. Iwamoto (2015). "The ESRI Short-Run Macroeconomic Model of the Japanese Economy (2015 version): Basic Structure, Multipliers, and Economic Policy Analyses," ESRI Discussion Paper Series No. 314.

[21] Kraay, A. (2012). "How large is the Government Spending Multiplier? Evidence from World Bank Lending', *Quarterly Journal of Economics*, 127 (2), pp. 829-887.

[22] Ministry of Internal Affairs and Communications (2014). Heisei 26 Nendoban Chiho Zaisei Hakusho (*White Paper on Local Public Finance 2014).*

[23] Miyamoto, W., T. L. Nguyen and D. Sergeyev (2016). "Government Spending Multipliers under the Zero Lower Bound: Evidence from Japan," forthcoming, *American Economic Journal: Macroeconomics*.

[24] Morita, H. (2015). "Japanese Fiscal Policy under the Zero Lower Bound of Nominal Interest Rates: Time-Varying Parameters Vector Autoregression," IER Discussion Paper A No.627, Hitotsubashi University.

[25] Nakamura, E. and J. Steinsson (2014). "Fiscal Stimulus in a Monetary Union: Evidence from US Regions," *American Economic Review*, 104 (3), pp. 753-792.

[26] Ramey, V. A. (2011). "Can Government Purchases Stimulate the Economy?," *Journal of Economic Literature*, 49 (3), pp. 673-685.

[27] Roodman D., J. G. MacKinnon, M. Ø Nielsen, and M. D. Webb (2018). "Fast and Wild: Bootstrap Inference in Stata Using boottest," QED Working Paper 1406, Queen's University.

[28] Shoag, D. (2016). "The Impact of Government Spending Shocks: Evidence on the Multiplier from State Pension Plan Returns," unpublished paper, Harvard University.

[29] Suárez-Serrato, J. C. and P. Wingender (2016). "Estimating Local Fiscal Multipliers," unpublished manuscript, Duke University.

[30] Watanabe, T., T. Yabu, and A. Ito (2010). "Seidojyouhou wo mochiita zaiseijyosu no keisoku," In *Zaiseiseisaku to Syakaihosyo*, Keio University Press.

[31] Webb, M. D. (2014). "Reworking wild bootstrap based inference for clustered errors," QED Working Paper 1315, Queen's University.

[32] Wilson, D. J. (2012). "Fiscal Spending Jobs Multipliers: Evidence from the 2009 American Recovery and Reinvestment Act," *American Economic Journal: Economic Policy*, 4 (3), pp. 251-282.

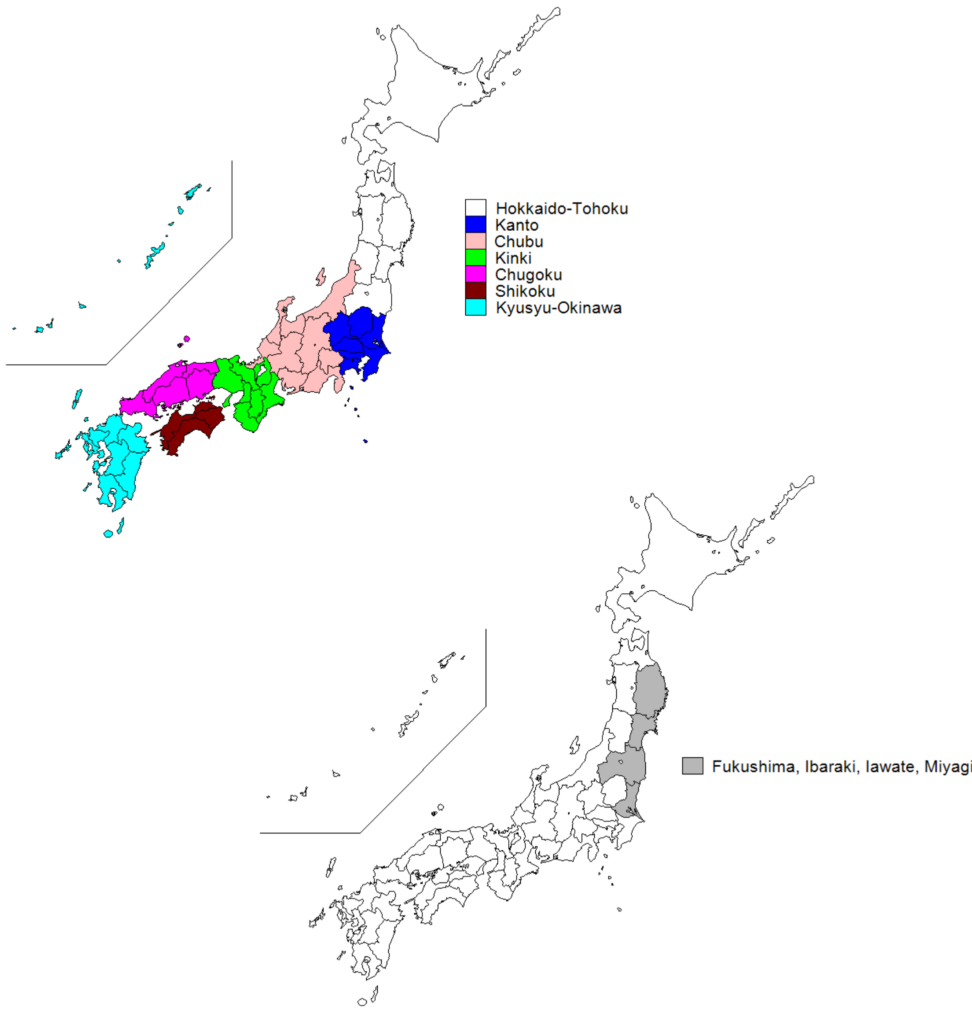

Figure 1: Regions in Japan and the pefectures strongely damaged by Great East Japan Earthquake in 2011

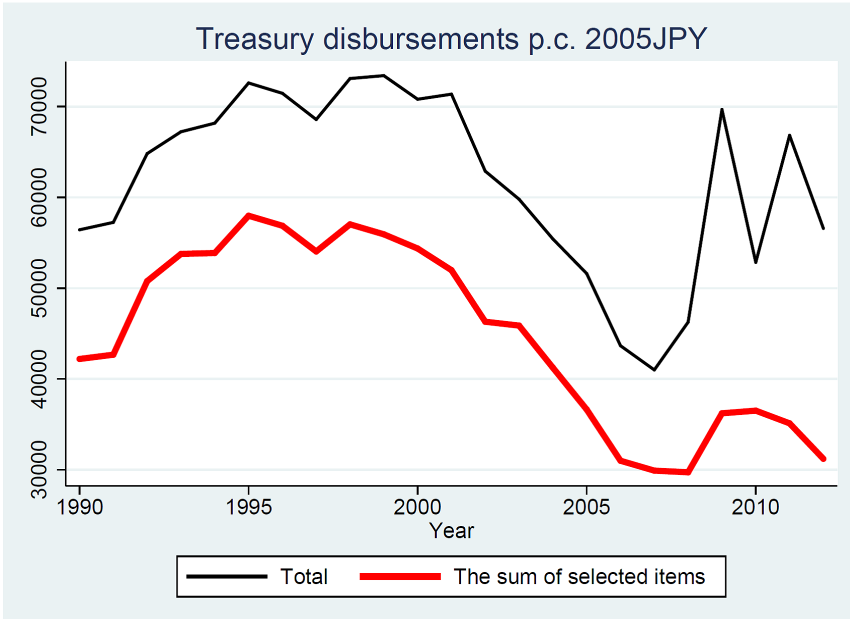

Figure 2: Treasury disbursements per capita (constant 2005 JPY)

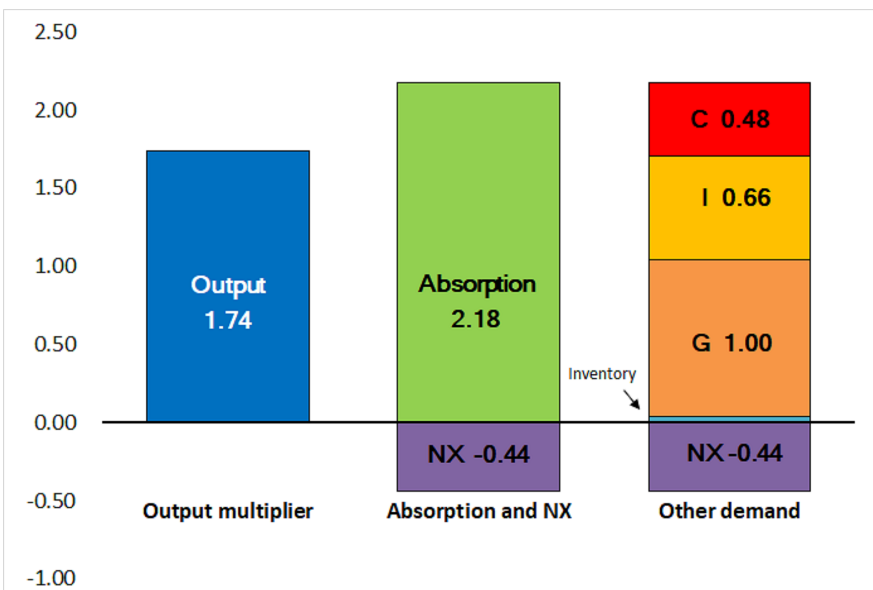

Figure 3: Decomposition of the RFM into demand components

Table 1: Components of treasury disbursements used in the construction of instruments

Category	Fractions	Included in IV?
Education (30.3%)		
Conpulsory education	23.2%	Y
Subsidies for private senior high schools	1.7%	Y
Grants for tuition non-collecting at public senior high school	3.4%	Y
Grants for financial support for senior high school attendance	2.0%	Y
Construction (21.3%)		
Ordinary construction	11.8%	Y
Grants for comprehensive infrastructure development	9.5%	Y
Grants and subsidies related to local business cycles/counter-cyclical policy (12.3%)		
Livelihood protection	2.2%	N
Child protection	2.0%	N
Subsidies for self-support of the disabled	1.1%	N
Grants for regional autonomous strategies	7.0%	N
Unemployment measures	0.0%	N
Disaster (9.2%)		
Disaster restoration	5.8%	N
Grants for recovery from Great East Japan Earthquake	3.4%	N
Other earmarked transfers (3.6%)		
Money in trust	2.0%	Y
Finance subsidy	0.1%	Y
Grants for area locating electric power plants	1.4%	Y
Grants for locating petroleum reserving facilities	0.1%	Y
Transfers whose purposes of grants are not reported (23.3%)		
Others	23.3%	N

Notes: Components of the treasury disbursements. The fraction of each component is based on the data as of fiscal year 2012. Categories with "Y" are included in the construction of the instruments while those with "N" are not included in the instruments.

Table 2: First-stage regressions

Dependent variable	$(g_{r,p,t} - g_{r,p,t-2})/y_{r,p,t-2}$	$(G_{r,t} - G_{r,t-2})/Y_{r,t-2}$
$\Delta s_{r,p,t-1}/y_{r,p,t-2}$	2.033***	-0.212
	(0.438)	(0.197)
$\Delta s_{r,p,t-2}/y_{r,p,t-3}$	0.820**	0.0671
	(0.332)	(0.0555)
$\Delta S_{r,t-1}/Y_{r,t-2}$	0.831	3.660***
	(0.446)	(0.604)
$\Delta S_{r,t-2}/Y_{r,t-3}$	1.372	2.550**
	(1.032)	(1.030)
Angrist-Pischke F-value	39.311	540.510
Observations	940	940
R-squared	0.639	0.824

Notes: Estimated coefficients of the first-stage regressions. The first column corresponds to the first-stage regression where the dependent variable is the two-year change in the prefectural government spending divided by the prefectural output. The second column corresponds to the first-stage regression where the dependent variable is the two-year change in the regional government spending divided by the regional output. The regions are defined in the main text. The numbers in parentheses below the estimates are standard errors clustered by regions. The Angrist-Pischke F-values are calculated from to the cluster-robust estimate of the variance matrix clustered by regions. Coefficients are statistically significant at the *10% significance level, **5% significance level or ***1% significance level, based on the t distribution with $M - 1$ degrees of freedom, where M is the number of regions.

Table 3: Benchmark estimates of the local fiscal multipliers

	(A) OLS		(B) 2SLS		(C) LIML	
	(1)	(2)	(1)	(2)	(1)	(2)
Regional fiscal multiplier (β_R)	1.068***	0.595***	1.738***	1.593***	1.741***	1.604***
	(0.221)	(0.110)	(0.272)	(0.359)	(0.274)	(0.363)
Prefectural fiscal multiplier (γ_P)	0.449***	0.595***	1.434**	1.593***	1.441**	1.604***
	(0.120)	(0.110)	(0.567)	(0.359)	(0.570)	(0.363)
Region-wide effect (γ_S)	0.618*	–	0.304	–	0.299	–
	(0.263)	–	(0.485)	–	(0.487)	–
P-value of overidentifying restrictions	–	–	0.479	0.319	0.479	0.318
Observations	987	987	940	940	940	940
Adj. R-squared	0.524	0.516	0.475	0.458	0.474	0.456

Note: Regressions for local fiscal multipliers. In each column, the dependent variable is a two-year change of the per capita GDP divided by the initial value. All regressions include the time fixed effect and the entity fixed effect at the prefectural level. The benchmark regressions are 2SLS shown in Panel (B) where we use the treasury disbursements at prefectural and regional levels as instruments. The regions are defined in the main text. The numbers in parentheses below the estimates are standard errors clustered by regions. In computing the standard errors, we make the finite-sample corrections to mitigate the downward bias arising from a small number of clusters. Panel (A) reports OLS results for comparisons. In each panel, Specification (2) assumes no region-wide effect, implying $\beta_R = \gamma_P$ so that we present the same estimate in each row. Panel (C) reports the multipliers estimated by the limited information maximum likelihood (LIML) with the instruments used in the benchmark estimations. The p-values of overidentifying restrictions are calculated from the cluster-robust estimate of the variance matrix by regions. Coefficients are statistically significant at the *10% significance level, **5% significance level or ***1% significance level, based on the t distribution with $M - 1$ degrees of freedom, where M is the number of regions.

Table 4: Regressions of expenditure components

Dependent variable	(A) Private consumption		(B) Private fixed investment	
	(1)	(2)	(1)	(2)
Regional fiscal multiplier (β_R)	0.475**	0.239	0.663***	0.530***
	(0.169)	(0.127)	(0.0900)	(0.119)
Prefectural fiscal multiplier (γ_P)	-0.021	0.239	0.385**	0.530***
	(0.123)	(0.127)	(0.135)	(0.119)
Region-wide effect (γ_S)	0.496**	–	0.278*	–
	(0.136)	–	(0.129)	–
P-value of overidentifying restrictions	0.412	0.134	0.105	0.219
Observations	940	940	940	940
Adj. R-squared	0.206	0.181	0.572	0.557

Dependent variable	(C) Absorption		(D) Net exports	
	(1)	(2)	(1)	(2)
Regional fiscal multiplier (β_R)	2.178***	1.798***	-0.440	-0.205
	(0.142)	(0.174)	(0.230)	(0.344)
Prefectural fiscal multiplier (γ_P)	1.380***	1.798***	0.0535	-0.205
	(0.196)	(0.174)	(0.481)	(0.344)
Region-wide effect (γ_S)	0.797***	–	-0.493	–
	(0.193)	–	(0.362)	–
P-value of overidentifying restrictions	0.128	0.293	0.293	0.484
Observations	940	940	940	940
Adj. R-squared	0.581	0.558	0.118	0.142

Note: Regressions of the aggregate demand components on government spending. In each panel, the dependent variable is the two-year change of the per capita aggregate demand component divided by the per capita GDP. The absorption is defined as the sum of private consumption, government consumption, and the gross capital formation (including the inventory investment). In each panel, specification (1) assumes the region-wide effect while specification (2) does not assume the region-wide effect. All parameters are estimated by 2SLS. For the other details, see the footnote of Table 3.

Table 5: Robustness: Additional control variables

	(A)		(B)	
Dependent variable	Output	Absorption	Output	Absorption
Regional fiscal multiplier (β_R)	1.992***	2.387***	1.934***	2.304***
	(0.379)	(0.182)	(0.365)	(0.198)
Prefectural fiscal multiplier (γ_P)	1.621**	1.536***	1.595**	1.499***
	(0.633)	(0.215)	(0.620)	(0.214)
Region-wide effect (γ_S)	0.370	0.851***	0.340	0.805***
	(0.460)	(0.152)	(0.472)	(0.143)
Lagged dependent variable	Yes	Yes	Yes	Yes
Prefectural population growth	No	No	Yes	Yes
Regional population growth	No	No	No	No
P-value of overidentifying restrictions	0.205	0.548	0.190	0.541
Observations	893	893	893	893
Adj. R-squared	0.474	0.606	0.480	0.614

	(C)		(D)	
Dependent variable	Output	Absorption	Output	Absorption
Regional fiscal multiplier (β_R)	1.829***	2.193***	1.838***	2.218***
	(0.463)	(0.284)	(0.466)	(0.280)
Prefectural fiscal multiplier (γ_P)	1.593**	1.490***	1.585**	1.478***
	(0.621)	(0.217)	(0.619)	(0.218)
Region-wide effect (γ_S)	0.236	0.703***	0.253	0.739***
	(0.419)	(0.176)	(0.420)	(0.160)
Lagged dependent variable	Yes	Yes	Yes	Yes
Prefectural population growth	No	No	Yes	Yes
Regional population growth	Yes	Yes	Yes	Yes
P-value of overidentifying restrictions	0.221	0.532	0.201	0.533
Observations	893	893	893	893
Adj. R-squared	0.482	0.614	0.483	0.617

Note: The left (right) column of each panel is the regression results when the dependent variable is output (absorption). In Panel (A), we add the lagged dependent variables into the regressions. In Panels (B)-(D), we include population growth rates in addition to lagged dependent variables. All parameters are estimated by 2SLS. For the other details, see the footnote of Table 3.

Table 6: Robustness: Dropping possible outliers

	(A)		(B)		(C)	
Dependent variable	Output	Absorption	Output	Absorption	Output	Absorption
Regional fiscal multiplier (β_R)	1.803***	2.127***	1.804***	2.211***	1.691***	2.203***
	(0.311)	(0.161)	(0.257)	(0.148)	(0.206)	(0.142)
Prefectural fiscal multiplier (γ_P)	1.494**	1.342***	1.460**	1.398***	1.415**	1.412***
	(0.549)	(0.195)	(0.572)	(0.189)	(0.410)	(0.155)
Region-wide effect (γ_S)	0.308	0.785**	0.344	0.812***	0.276	0.791***
	(0.480)	(0.235)	(0.494)	(0.199)	(0.436)	(0.165)
P-value of overidentifying restrictions	0.492	0.138	0.635	0.729	0.796	0.476
Observations	900	900	920	920	932	932
Adj. R-squared	0.481	0.597	0.479	0.584	0.498	0.563

	(D)		(E)	
Dependent variable	Output	Absorption	Output	Absorption
Regional fiscal multiplier (β_R)	1.866***	2.095***	1.527***	1.881***
	(0.304)	(0.154)	(0.340)	(0.277)
Prefectural fiscal multiplier (γ_P)	0.984**	1.274***	1.544*	1.245***
	(0.355)	(0.120)	(0.656)	(0.260)
Region-wide effect (γ_S)	0.882	0.821**	-0.0169	0.635***
	(0.540)	(0.249)	(0.490)	(0.154)
P-value of overidentifying restrictions	0.941	0.201	0.365	0.839
Observations	752	752	846	846
Adj. R-squared	0.428	0.543	0.523	0.604

Note: The left (right) column of each panel is the regression results when the dependent variable is output (absorption). Each specification estimates the multipliers after dropping possible outliers. Panel (A) drops Hokkaido and Okinawa prefectures (i.e., the northern-end and the southern-end prefectures) from the sample. Panel (B) drops Tokyo, the economically largest prefecture, from the sample. Panel (C) drops the post-2011 data of the four prefectures that were severely damaged by the Great East Japan Earthquake. Panel (D) reestimates the model using the sample period before 2009. Panel (E) uses the sample period corresponding to the period of zero lower bound specified by Miyamoto et al. (2017). All parameters are estimated by 2SLS. For the other details, see the footnote of Table 3.

Table 7: Robustness: Different time horizons in cumulative fiscal multipliers

Dependent variable	(A) One-year changes in:		(B) Three-year changes in:		(C) Five-year changes in:	
	Output	Absorption	Output	Absorption	Output	Absorption
Regional fiscal multiplier (β_R)	1.977***	2.013***	2.191***	2.251***	2.074***	2.295***
	(0.453)	(0.312)	(0.475)	(0.198)	(0.503)	(0.207)
Prefectural fiscal multiplier (γ_P)	0.888**	1.270***	1.181**	1.336***	1.186**	1.298***
	(0.268)	(0.261)	(0.436)	(0.175)	(0.341)	(0.179)
Region-wide effect (γ_S)	1.089	0.742	1.010	0.915**	0.889	0.996**
	(0.642)	(0.426)	(0.711)	(0.266)	(0.721)	(0.286)
P-value of overidentifying restrictions	0.192	0.902	0.384	0.808	0.799	0.363
Observations	799	799	940	940	846	846
Adj. R-squared	0.438	0.452	0.440	0.584	0.297	0.602

Note: The cumulative fiscal multipliers with different time horizons. Panel (A) shows the estimated impact (one-year) multipliers on output and absorption. In this panel, we use the sample period covering the period before 2009 and use the instruments $\Delta s_{r,p,t}/y_{r,p,t-1}$, $\Delta S_{r,t}/Y_{r,t-1}$, $\Delta s_{r,p,t-1}/y_{r,p,t-2}$, and $\Delta S_{r,t-1}/Y_{r,t-2}$. Panel (B) shows the estimates of the three-year cumulative multipliers on output and absorption. Panel (C) presents the estimates of the five-year cumulative multipliers on output and absorption. In the specifications shown in Panels (B) and (C), the instruments are the same as those used for the benchmark estimation for the two-year cumulative multipliers. All parameters are estimated by 2SLS. For the other details, see the footnote of Table 3.