Identifying the Effects of Grants on Local Policies in the Presence of Grant Endogeneity and Grant Effect Heterogeneity*

Michihito Ando †

April 2, 2014

PRELIMINARY AND INCOMPLETE

Abstract

Although recent empirical studies on the effects of intergovernmental grants on local policies and other outcomes have increasingly taken into account grant endogeneity, most of them rely on a linear estimation framework with a constant treatment effect or do not explicitly consider treatment effect heterogeneity in their theoretical and empirical models. In this paper, assuming a two-stage grant allocation process and relying on the potential outcome framework, I explicitly consider the case where heterogeneous propensities of local governments for public services induce endogenous grant allocation and heterogeneous grant effects on local policies. Then I discuss how a Regression Kink (RK) design with a kinked grant allocation rule can be utilized to solve the problem of grant endogeneity under the assumption of grant effect heterogeneity. Finally, using Japanese municipality panel data, I examine the causal effects of fiscal equalization grants on local policies with the RK design. Results imply that, for a specific subgroup of relatively affluent municipalities, expenditures for non-personnel education costs are arguably most significantly affected by the grants. Effects on other various expenditure categories and policy indicators are also estimated and interpreted.

JEL classification: C21, H71, H72, H77
Keywords: Intergovernmental grants, Flypaper effect, Treatment effect heterogeneity, Regression Kink Design

---

*I am grateful to Matz Dahlberg, Masayoshi Hayashi, Che-Yuan Liang and Reo Takaku for their comments and suggestions. All mistakes are my own.

†Department of Economics, Uppsala University; UCFS; and Institute for Housing and Urban Research, Uppsala University.

1 Introduction

The effects of intergovernmental grants on local policies and local economy have been extensively investigated since at least early 1950s, when Buchanan (1950) and Scott (1950) were published. The surge of the theoretical and empirical literature is followed by the theoretical discussion of "Bradford-Oates equivalence theorem" in Bradford and Oates (1971a;b) and the empirical results of the "flypaper effects" found in Henderson (1968) and Gramlich (1969).

Although many studies have been produced both from theoretical and empirical perspectives in this field, there is still no clear consensus other than the finding that the effect of intergovernmental grants on local expenditure appears to be positive in most cases and the sizes of estimated effects often imply the existence of the flypaper effect. See, for example, some recent reviews of the flypaper effect such as Hines and Thaler (1995), Bailey and Connolly (1998), Oates (1999), Gamkhar and Shah (2007) and Inman (2008).

Several reasons can be pointed out why the surge of the research has not followed the convergence of debates. First, several competing theories can "explain" the same grant effect or the flypaper effect but we often do not have good empirical devices or data to directly test the superiority of one theory to others.[1] Second, intergovernmental grants are in most cases endogenously allocated and it is often difficult or impossible to obtain credible estimates of grant effects. [2] Third, the effects of grants can also be heterogeneous within a specific grant program and then estimation results can change depending on the sources of variation that are exploited for identification or on the samples that are used for analysis. Fourth, as is pointed out by Hamilton (1983) and other studies, estimation results can be sensitive to model specification.

All of the above problems limit the credibility and generalizability of studies on grant effects. Although it is difficult to completely solve these problems, it is important to explicitly take into account these problems as much as possible in the

[1] This is of course not a peculiar problem in the grant effect literature. DiNardo and Lee (2011), for example, refer to this problem in the context of labor market studies.

[2] Dahlberg et al. (2008) list four possible sources of endogeneity in intergovernmental grants: (1) political negotiations between central and local politicians, (2) central politicians' preferences for specific economic and political characteristics of local governments associated with their spending priorities, (3) socio-economic characteristics of municipalities simultaneously influencing spending, taxation and grant allocation, and (4) unobserved characteristics correlated with both local spending and grant allocation.

estimation and the interpretation of grant effects.

In this paper, I first consider a two-stage grant allocation mechanism where heterogeneous propensities of local governments for public services result in both endogenous grant allocation and heterogeneous grant effects on local policies as results of the nonrandom allocation of grants from the central government (central budgetary stage) and conventional optimization procedures of local governments (local budgetary stage). Based on this setting I then discuss how a Regression Kink (RK) design with a kinked grant allocation rule can be utilized to solve the problem of grant endogeneity under the assumption of grant effect heterogeneity. At the same time, the locality of RK estimation and its implications are also discussed.

In the empirical part, secondly, I examine the causal effects of the grants on local expenditures and policies with the Regression Kink (RK) design using Japanese municipality data and exploiting the kinked grant assignment rule of fiscal equalization grants. With the same data and the same identification strategy, Ando (2013) finds that the effect of the fiscal equalization grants on local expenditure is around one-to-one. In this study, I further investigate grant effects on various expenditures by type (personnel costs, social benefits, construction, etc.) and by function (education, welfare, public work, etc.) and on several policy outcomes such as teacher-student ratio and public assistance recipient ratio.

The main difference between this paper and Ando (2013) is that the focus of this paper is on the causal effects of the fiscal equalization grants on local policies and their theoretical interpretations while the purpose of Ando (2013) is to examine the plausibility of the RK design in the presence of confounding nonlinearity around the kink point with Monte Carlo simulations and empirical applications with Japanese fiscal equalization grant. This paper is based on Ando (2013) in the sense that the credibility of the RK design used in this paper relies on the investigation conducted in Ando (2013).

Estimation results imply that, for a specific subgroup of relatively affluent municipalities, expenditures for non-personnel education costs are arguably most significantly affected by the fiscal equalization grants. On the other hand, grant effects on personnel costs and social-welfare-related variables are not observed or only weakly observed. Grant effects on construction is also not clearly captured although some modest positive effect on expenditure for public work (road) is robustly estimated. These results imply that the strong positive grant effect on total expenditure, or the one-to-one perfect flypaper effect found in Ando (2013), cannot be sufficiently explained by major public-choice theories such as bureaucratic budget-maximizing or slack-maximizing models or the lobbying model of strong political pressure groups because non-personnel education expenses seem not provide great benefits either to public employees or large political pressure groups such as construction companies.

The contributions of this paper are twofold. First, this paper presents simple conceptual and empirical frameworks that explain how grant endogeneity and grant effect heterogeneity arise in a general intergovernmental grant scheme. With a similar two-stage grant allocation program, Knight (2002) also discusses the problem of grant endogeneity, but he considers a more specific grant allocation mechanism at the central (or federal) budgetary stage and also assumes a constant grant effect at the local (or state) budgetary stage. On the other hand, the conceptual framework of this paper does not assume any specific central budgetary process and also allows heterogeneous grant effects at the local budgetary stage. Then under these setups I show that endogeneity bias in the estimation of grant effects may not be solved by the conventional assumption of selection on observables.

My second contribution is to investigates the effects of unconditional fiscal equalization grants with a quasi-experimental framework and local estimation, which could be effective to rule out both statistical and institutional confounding factors. Although recent US studies examined grant effects exploiting some quasi-experimental approaches, most of them investigated the impacts of specific conditional federal transfers on various outcome variables, such as Knight (2002), Gordon (2004), Baicker and Gordon (2006), Conley and Dupor (2011), Suárez Serrato and Wingender (2011), Chodorow-Reich et al. (2012), Wilson (2012) , and Cascio et al. (2013). Because conditional grants based on a specific program considerably differ in many respects from unconditional grants based on a fiscal equalization scheme, empirical results and policy implications for conditional grants cannot be directly applied to unconditional fiscal equalization grants.

Nonetheless, compared with these recent studies on conditional grants in the U.S., where no unconditional fiscal-equalization grants exist at the federal level since General Revenue Sharing was abolished in 1987, there are fewer quasi-experimental studies that examine the effects of unconditional fiscal equalization grants, like Dahlberg et al. (2008) and Lundqvist et al. (2014) in Sweden, Lundqvist (2013) in Finland, Litschig and Morrison (2013) in Brazil, and Ando (2013) in Japan. This paper adds another evidence to this literature. In addition, I discuss the advantage of a local estimator like an RK estimator in ruling out institutional confounding factors which could exist in a fiscal equalization scheme and in making the causal interpretation of estimates more plausible even when an unbiased global estimator is available.

The remainder of the paper is organized as follows. In Section 2 and 3, I discuss my conceptual and empirical frameworks respectively. Section 4 discusses my identification strategy and institutional settings. In Section 5, I describe my dataset and conduct some preliminary analysis. Section 6 provides estimation results and discuss their interpretations. Section 7 concludes.

2 Conceptual framework

In this section, following Knight (2002), I present a two-stage grant allocation procedure where intergovernmental grants are distributed to local public expenditure and private income (via tax reduction) through the central budgetary stage and the local budgetary stage. One important difference from Knight (2002) is that my framework explicitly allows grant effects to be heterogeneous due to different propensities of local governments for local public services whereas Knight (2002) assumes a constant grant effect across local jurisdictions.

2.1 Central budgetary stage

Suppose that the central government decides to allocate a grant based on the vector of socio-economic characteristics $\mathbf{W}_i$ and some random factor ϵ_i. Then a grant allocation function at the central budgetary stage can be denoted as $G_i = G_i(\mathbf{W}_i, \epsilon_i)$. Unlike Knight (2002), I do not assume any specific bargaining model or another grant allocation mechanism. Different grant allocation mechanisms such as programmatic redistribution based on fiscal equalization formulas, which can be observed in many developed countries (Dafflon 2007; Reschovsky 2007; Rodden 2009) and tactical redistribution as a result of central-local political interactions (Lindbeck and Weibull 1987; Dixit and Londregan 1998) could affect G_i. [3]

In this paper, it is rather trivial whether the grant allocation mechanism at the central budgetary stage is better explained by one hypothesis than others. What is important here is the assumption that grants are allocated from the central govern-

[3] See, for example, Solé-Ollé (2013) for a distinction between tactical and programmatic redistribution by intergovernmental grants.

ment to local governments based on some observed and unobserved socio-economic characteristics $\mathbf{W}_i$ of local governments. As is discussed later, this allocation mechanism causes the problem of grant endogeneity in the identification of grant effects on local policies.

2.2 Local budgetary stage

Next, consider a local government i with heterogeneous propensity (or preference) for a privately-provided good C_i and a publicly-provided good Y_i. A propensity parameter of local governments for the publicly-provided good is defined as α_i. Note that I do not impose any micro-economic assumption or interpretation on the sources of this "propensity for public expenditure" at this stage. In other words, this "propensity" can include any factors (except for the budget constraint) that determine or limit the choices of local governments. I also assume that the price of the publicly-provided good is standardized to one and therefore Y_i can also be regarded as the level of local public expenditure.

Based on these settings, once grant G_i is allocated from the central government at the central budgetary stage, each local government is assumed to maximize the following objective function with Cobb-Douglas specification:

$$U_i(C_i, Y_i; \alpha_i) = (1 - \alpha_i) lnC_i + \alpha_i lnY_i, \quad \text{for } i = 1, 2, ...n.$$

where C_i is the amount of a numeraire privately-provided good (or the level of private consumption) for a representative citizen/voter that each government takes into consideration at the local budgetary process and Y_i is the amount of publicly-provided good (or the level of public expenditure). The decision of the local government i is then characterized by the following optimization program:

$$\begin{aligned} \max_{Y_i} \quad & U_i(C_i, Y_i; \alpha_i) \\ \text{subject to} \quad & C_i + \tau_i b_i = I_i, \\ & Y_i = \tau_i B_i + G_i, \end{aligned}$$

where I_i is the income of the representative citizen/voter, b_i is the tax base of the representative citizen/voter, B_i is the total tax base, and τ_i is the local tax rate.[4]

[4]I refer to Le Maux (2009) for this type of model specification.

The first constraint is the budget constraint of the representative citizen/voter and the second one is the the budget constraint of the local government. These two budget constraints can be unified to $C_i + r_i Y_i = I_i + r_i G_i$, where $r_i = b_i/B_i$, that is the ratio of the tax base of the representative voter/citizen to the total tax base.

See Le Maux (2009) for some varieties of this type of model specification with different theoretical assumptions of local-government decision making such as the median voter model, the Leviathan model, the slack-maximizing model, the general bureaucratic model, the partisan politicians model, and the lobbying model. In this paper, however, I refrain from constructing explicit micro-economic behavioral models because it is often impossible to directly test these behavioral assumptions with the data of local governments, which I will also use in my empirical analysis.

A minimal assumption that I adopt is that local governments maximize their objective functions U_i under the above two budget constraints. The maximization procedure results in a public expenditure function as follows:

$$Y_i = \frac{\alpha_i I_i}{r_i} + \alpha_i G_i. \tag{1}$$

In my framework, the amount of the grant G_i is fixed once it is determined at the central budgetary stage. Hence the causal effect of the marginal (or one-unit) increase of G_i at the local budgetary stage can be defined as

$$\beta_i \equiv \frac{dY_i}{dG_i} = \alpha_i. \tag{2}$$

That is, the causal effect of a one-unit increase in G_i on Y_i is equal to the propensity parameter for public expenditure α_i. While this relation is derived from a specific functional form of the objective function, it reflects the intuition that grant effects are heterogeneous across local governments and this heterogeneity comes from heterogeneous local propensities for public expenditure.

3 Empirical framework

3.1 Grant endogeneity

Based on the conceptual framework above, my objective is to identify some average of β_i, namely some average effect of G_i on Y_i, with the observed data of local governments. Because G_i is a function of $\mathbf{W_i}$ and factors in $\mathbf{W_i}$ may be correlated with the unobserved propensity parameter α_i for which in turn affects public expenditure Y_i, it is impossible to identify the average of β_i by simply regressing Y_i on G_i due to endogeniety problem.

In order to clarify this grant endogeneity problem as well as grant effect heterogeneity, I adopt the potential outcome framework or the Rubin Causal Model (Rubin 1974; Holland 1986) rather than relying on commonly used linear estimation models. With the potential outcome framework, I denote $Y_i(D_i)$ and $G_i(D_i)$ as potential outcomes of public expenditure and grants for local government i where D_i is the grant assignment variable that is equal to 1 if a local government receives the grant and otherwise 0.

In addition, I assume that the data generating process of Y_i is consistent with the public expenditure function (1). Although the following discussion can be done without such a specific parametric assumption on Y_i, I keep using this public expenditure function for the theoretical interpretations of derived parameters.

First of all, I redefine the effect of a one-unit increase in the grant on local expenditure as follows:

$$\beta_i \equiv \frac{Y_i(1) - Y_i(0)}{G_i(1) - G_i(0)} = \frac{Y_i(1) - Y_i(0)}{G_i(1)} = \alpha_i \quad \text{for } i = i = 1, 2, ...n. \tag{3}$$

where the first equality holds because $G_i(0) = 0$ by definition and the second equality is derived by inserting the public expenditure function (1) into (3).

As commonly denoted in the causal inference literature with potential outcomes, observed outcome Y_i can be expressed as a function of the grant assignment status D_i and potential outcomes $Y_i(D_i)$, namely $Y_i = (1-D_i)Y_i(0)+D_iY_i(1)$ (Rubin 2005; Imbens and Wooldridge 2009). The "fundamental problem of causal inference" is that both potential outcomes $Y_i(0)$ and $Y_i(1)$ cannot be observed at the same time , implying that the individual causal effect β_i in (3) cannot be observed (Holland 1986).

One straightforward attempt to estimate some average causal effect of β_i is to use the following equation:

$$\beta_{gap} = \frac{E(Y_i|D_i = 1) - E(Y_i|D_i = 0)}{E(G_i|D_i = 1) - E(G_i|D_i = 0)} \quad \text{for } i = 1, 2, ...n, \tag{4}$$

which is the gap of averaged Y_i between grant-receiving governments and no-grant-receiving governments divided by the gap of averaged G_i between them. This equation can be transformed to:

$$\begin{aligned}\beta_{gap} &= \frac{E[Y_i(1) - Y_i(0)|D_i = 1]}{E[G_i(1)|D_i = 1]} + \frac{E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]}{E[G_i(1)|D_i = 1]} \\ &= \frac{E[\beta_i G_i(1)|D_i = 1]}{E[G_i(1)|D_i = 1]} + \frac{E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]}{E[G_i(1)|D_i = 1]} \\ &= \frac{E(\alpha_i G_i|D_i = 1)}{E(G_i|D_i = 1)} + \frac{E(\alpha_i I_i/r_i|D_i = 1) - E(\alpha_i I_i/r_i|D_i = 0)}{E(G_i|D_i = 1)}. \qquad (5)\end{aligned}$$

where the second equality is based on the definition of β_i in (3) and the third equality is obtained by plugging the public expenditure function (1) into (5).

The first term in (5) is an average increase in public expenditure induced by grant allocation, divided by an average grant level. This term can be interpreted as a version of the average causal effect of a one-unit grant increase on public expenditure for grant-receiving governments. The second term represents a selection or endogeneity bias caused by mean difference in $Y_i(0)$ between grant-receiving governments and no-grant-receiving governments. Because the grant assignment variable D_i is not randomly assigned among local governments —it is affected by socio-economic characteristics $\mathbf{W_i}$— this selection or endogeneity bias is generally nonzero if $\mathbf{W_i}$ is dependent of α_i, I_i or r_i. See also Appendix A that provides a simplified graphical explanation of the above discussion.

In particular, because the propensity for public expenditure α_i is unobserved and it is also difficult to reason how α_i is correlated with $\mathbf{W_i}$, it could be difficult to mitigate the bias based on the assumption of selection on observable.

3.2 Regression Kink design

The sample analog of the equation (4) is the simplest nonparametric estimator for a grant effect, but the equation (5) suggests that this is generally not a credible estimator to investigate the average causal effects of endogenous grants. In order to solve this endogeniety problem, I will exploit the Regression Kink (RK) design with a kinked grant assignment rule that exists in Japanese fiscal equalization scheme. [5] The details of the institutional setting of this fiscal equalization scheme are described in the next section and in Ando (2013). Here I focus on the properties

[5] See Card et al. (2012) for theoretical and methodological discussions on the RK design.

and interpretations of the RK estimation with a kinked grant allocation rule.

Suppose that the grant G_i is allocated by the following kinked formula:

$$G_i = \begin{cases} 0 \quad \text{if } V_i \leq 0 \\ \gamma V_i \quad \text{if } V_i > 0, \end{cases} \tag{6}$$

where V_i is an indicator with which the grant level changes proportionally with the positive rate γ if $V_i > 0$. If a grant allocation system includes such a formula, a sharp Regression Kink (RK) design could be utilized to identify grant effects, using V_i as an assignment variable.

Assume that the density function of V_i are smoothly distributed (continuously differentiable) at $V_i = 0$ and other relevant assumptions for the sharp RK design listed in Card et al. (2012) are satisfied. Then I could use the following RK estimand by Nielsen et al. (2010) and Card et al. (2012):

$$\beta_{RK} \equiv \frac{\lim_{e \to 0} \left. \frac{dE(Y_i|V_i = v)}{dv} \right|_{v=+e} - \lim_{e \to 0} \left. \frac{dE(Y_i|V_i = v)}{dv} \right|_{v=-e}}{\lim_{e \to 0} \left. \frac{dE(G_i|V_i = v)}{dv} \right|_{v=+e} - \lim_{e \to 0} \left. \frac{dE(G_i|V_i = v)}{dv} \right|_{v=-e}} \tag{7}$$

This quantity is the counterpart of β_{gap} in (4) but all the terms are not conditional expectation functions but the *slopes* of them with respect to V and they are conditional on $V_i = v$ with $v = \pm e$ and $e \to 0$. The equation (7) captures the change in the slope of $E(Y_i|V_i = v)$ at $V_i = 0$, divided by the change in the slope of $E(G_i|V_i = v)$ at $V_i = 0$.

To see how the RK design works in the context of the conceptual framework in Section 2, I insert the public expenditure function (1) and the kinked grant allocation rule (6) into the equation (7):

$$
\begin{aligned}
\beta_{RK} &= \frac{\lim_{e\to 0} \frac{d}{dv} E\left(\frac{\alpha_i I_i}{r_i} + \alpha_i \gamma V_i \middle| V_i = v\right)\Big|_{v=+e} - \lim_{e\to 0} \frac{d}{dv} E\left(\frac{\alpha_i I_i}{r_i} \middle| V_i = v\right)\Big|_{v=-e}}{\lim_{e\to 0} \frac{d}{dv} E(\gamma V_i | V_i = v)\Big|_{v=+e} - \lim_{e\to 0} \frac{d}{dv} E(0 | V_i = v)\Big|_{v=-e}} \\
&= \frac{\lim_{e\to 0} \frac{d}{dv} [\gamma v \cdot E(\alpha_i | V_i = v)]\Big|_{v=+e}}{\lim_{e\to 0} \frac{d}{dv} (\gamma v)\Big|_{v=+e}} \\
&= \frac{\lim_{e\to 0} [\gamma \cdot E(\alpha_i | V_i = v) + \gamma v \frac{d}{dv} E(\alpha_i | V_i = v)]\Big|_{v=+e}}{\gamma} \\
&= \lim_{e\to 0} E(\alpha_i | V_i = +e) \\
&= E(\alpha_i | \text{unit } i \text{ is a treated and } V_i = 0),
\end{aligned}
$$

where the second equality is derived by the smoothness condition of the pre-determined covariates at $V_i = 0$, which is predicted if the smooth density condition of V_i at $V_i = 0$ is satisfied (Card et al. 2012). Thus β_{RK} can be considered as the average causal effect of the unit-increase in G_i at $V_i = 0$ for the treated. See also Appendix B for the derivation of the average grant effect by the fuzzy RK design when γ differs among local governments.

There are a few perivous studies which examine grant effects using the RK design. Dahlberg et al. (2008) and Lundqvist et al. (2014) utilize a kinked formula of intergovernmental grants in Sweden for RK estimation to identify grant effects on local expenditure, revenue, and public employment. Ando (2013) also exploits a kinked formula of fiscal equalization grants in Japan to investigate the validity of the RK design in the presence of confounding nonlinearity around the cutoff point.

4 Identification strategy

Following Ando (2013), this paper investigates grant effects on local expenditures and other policy variables around a particular cutoff point exploiting the RK design.

The locality of RK estimation may weaken the external validity of the interpretation of estimated causal effects, but strengthen the plausibility of theoretical interpretations because the behaviors of a relatively homogeneous subgroup of municipalities can be investigated. In addition, as I will explain later, my local RK estimator also allows me to exclude some confounding institutional factors which could not be separated out from a global estimator.

4.1 Institutional settings

A major fiscal equalization scheme in Japan, which is called a Local Allocation Tax (LAT) grant, allocates unconditional lump-sum grants to local governments (prefectures and municipalities) in order to compensate for the fiscal gap between the *fiscal need* and the *revenue capacity* of a local government. LAT grants are primarily intended to ensure a certain standard level of local public services to all citizens in Japan regardless of their residential areas. Subsequently, I focus my attention on municipalities although most descriptions can be applied to prefectures.

The detailed allocation rule of LAT grants at the central budgetary stage, which is expressed as $G_i = G(\mathbf{W}_i, \epsilon_i)$ in the last section, is fairly complex. That is, the vector of socio-economic variables W_i explicitly includes a large number of demographic and socio-economic factors and it is expected that unobservable political and bureaucratic factors also affect G_i because grant formulas are annually modified and adjusted at the central budgetary stage.

The central budgetary stage of the Japanese fiscal equalization scheme consists of two steps where in the first step the national-level total amount of LAT grants $\sum_i G_i$ is determined based on the amount of central tax revenues and political and bureaucratic processes. In the second step, the grant eligibility D_i and the amount of the LAT grant G_i for each municipality are determined by various socio-economic, political, and bureaucratic factors.

Although G_i is affected by a large number of observed and unobserved factors, it can also be expressed as a kinked deterministic function as follows:

$$G_i = \begin{cases} 0 & \text{if } V_i \leq 0 \\ V_i & \text{if } V_i > 0, \end{cases} \quad \text{where } V_i = NEED_i - CAP_i. \tag{8}$$

In this equation $NEED_i$ is the *fiscal need* which indicates the amount of local expenditure required to cover the total cost of the standard levels of local public services. CAP_i is the *revenue capacity* index which is calculated based on the potential revenues that each municipality could collect on its own under a standard local tax system. $NEED$ and CAP are officially referred to as "*Standard Fiscal Need*" and "*Standard Fiscal Revenue*" respectively and both are estimated annually by the Ministry of Internal Affairs and Communications (MIC) at the central government. Thus V_i is the "need-capacity gap", which measures to what extent the local expenditure need is larger than the local revenue capacity. Dafflon (2007) discusses fiscal equalization system based on the "need-capacity gap" in a more general context.

The formula (8) implies that the amount of G_i is zero if CAP_i is equal to or larger than $NEED_i$ whereas it compensates the gap betweeen $NEED_i$ and CAP_i if $NEED_i$ is larger than CAP_i. In short, the LAT scheme ensures that each municipality can at least provide a certain level of local public services which is equal to $NEED_i$ by providing the grant that is equal to $NEED_i - CAP_i$.

4.2 Estimation with the RK design

From the viewpoint of the identification strategy, the grant allocation rule (8) is a special case of the kinked grant formula (6) with $\gamma = 1$. Then the sharp RK design can be exploited to estimate β_{RK}, which is the average causal effect for grant-eligible municipalities at $V_i = 0$.

For empirical analysis, I use the following linear and quadratic polynomial models:

$$Y_i = \theta_0 + \theta_1 V + \theta_2 V_i \cdot D_i + \varepsilon_i$$
$$Y_i = \theta_0 + \theta_1 V + \theta_2 V_i \cdot D_i + \theta_3 V^2 + \theta_4 V^2 \cdot D_i + \varepsilon_i,$$

where $D_i = 1$ if $V > 0$ and otherwise 0 and ε_i is an error term.[6] Here the parameter of interest is θ_2, which captures the change in the slope of $E(Y_i|V_i = v)$ at $V_i = 0$. In other wards, θ_2 is the numerator of the equation (7). Because the denominator of the equation (7) is 1 in my application (i.e. the slope change of the LAT grant

[6] I do not use higher order polynomials such as third-order (cubic) or fourth-order (quartic) polinomials in estimation because an RK estiamte generally becomes very imprecise with these model specifications. See Monte Carlo simulations and empirical applications in Ando (2013). As a relevant issue, Note 18 in Card et al. (2012) discusses a substantial cost in variance when local quadratic polynomials are used instead of local linear polynomials.

at $V_i = 0$ is 1), the unbiased estimator of θ_2 can be interpreted as the estimator of β_{RK}.

As Ando (2013) examines, there are both advantages and disadvantages in exploiting the RK design with the kinked assignment formula of the LAT grants. First, one advantage from the econometric standpoint is that local governments cannot manipulate their positions regarding the assignment variable at the central budgetary stage and therefore the problem of endogenous sorting can be ignored. Because the endogenous sorting may cause a serious estimation problem in the RK design, which exploits a relatively subtle variation around the kink point, this property is a great benefit.

Second, on the other hand, as Ando (2013) investigates with Monte Carlo studies and the same data used in this paper, the problem of confounding smooth nonlinearity around the kink point has to be controlled for by additional pre-determined covariates. That is, in a finite sample, it could be difficult to separate out a true kinked relation between an assignment variable and an outcome variable from a quadratic or another smooth nonlinear relation between them. Because in my application the bias from confounding nonlinearity cannot be eliminated only by standard empirical RK strategies such as a smaller bandwidth or a higher-order polynomial regression, I have to rely on additional covariates to control for this confounding nonlinearity and to obtain plausible RK estimates.[7] This is a disadvantage because it weakens the credibility of the RK design, which relies on the idea of local randomization around the cutoff point where confounding factors should be able to be ignored in principle.

Third, however, I have another advantage on the above issue because we could expect around one-to-one effect of the LAT grant on total expenditure from the institutional knowledge and Ando (2013) actually shows that about one-to-one effect is robustly observed once relevant covariates are controlled for to mitigate confounding nonlinear relation around the kink point.[8] The reason why around one-to-one effect is expected is that Japanese municipalities have a relatively homogeneous local tax system regardless of their socio-economic and political differences.[9] Given

[7]See Ando (2013) for details.

[8]Ando (2013) also demonstrates that RK estimation with a fixed-effects model also generates similar results.

[9]It is not entirely clear why Japanese local municipalities have relatively homogeneous local tax system although they have some discretion over local taxation policies. I do not, however focus on this issue in this paper.

this result, this paper can focus on issues about how municipalities allocate grants among different public expenditure categories, rather than between public expenditure and private consumption (via tax reduction) as in conventional studies. I will also discuss the theoretical interpretations of grant effects on expenditure categories.

4.3 Local estimation and its implications

Because the RK estimand is inherently local, the application of the RK design forces me to focus on grant effects for a subgroup of municipalities around $NEED_i = CAP_i$. This is however even preferable in a sense that this subgroup consists of relatively affluent municipalities which are at the margin between grant receivers and non-receivers and have a relatively large amount of discretionary revenues. Because these municipalities are supposed to be able to cover basic fiscal needs by their own revenues even without LAT grants, estimated grant effects at this margin can be considered to reflect municipalities' discretionary policy choices rather than the artifact of the institutional setup of the fiscal equalization scheme.

To understand this issue more clearly, it is important to remember that LAT grants, or arguably fiscal equalization grants in general, are allocated through two stages, namely the central and local budgetary stages. In the conceptual framework, I implicitly assume that local governments *can* maximize their objective functions after they receive "unconditional" and "lump-sum" grants. Under this assumption, once I can take into account the grant endogeneity caused at the central budgetary stage, estimated grant effect at the local budgetary stage can be considered as a consequence of local governments' decision making.

However, although LAT grants are nominally "unconditional" and "lump-sum" and local governments appear to have full discretion in grant allocation at the local budgetary stage, LAT grants also reflect the "fiscal needs" of individual municipalities which are defined and determined at the central budgetary stage. In addition to this centralized feature of fiscal equalization grants, it is often legally mandatory for municipalities to allot their revenues to such centrally-determined fiscal needs via local public services regardless of municipalities' propensities for public services. Then a positive correlations between LAT grants and local expenditures could merely reflect this centrally determined fiscal needs, not the decisions of local governments at the local budgetary stage. In this case it is misleading to interpret estimated grant effects as results of the decision making of local governments, even if the endogeneity problem is properly resolved. This issue is in principle a institutional matter of the Japanese fiscal equalization scheme, but I believe similar problems exist in the estimation and the interpretation of grant effects with fiscal equalization schemes in many other countries.

Local estimates by the RK design could avoid this problem by focusing on relatively rich municipalities which may be able to use LAT grants as purely "unconditional" and "lump-sum" grants. It is because centrally determined fiscal needs, which is defined as $NEED_i$ in my notation, can be covered only by their own fiscal resources around $V_i = 0$ under the Japanese fiscal equalization scheme. In other words, the RK design enables me to focus on a subgroup of municipalities which local budgetary process could relatively match the theoretical discussion of the optimization problem. See Appendix C for further institutional details with a graphical presentation.

This locality of RK estimation also implies that the same causal interpretations cannot be applied to other subgroups such as fiscally poor municipalities which heavily rely on fiscal equalization grants and are faced with different fiscal and institutional restrictions. This lack of the external validity is of course a limitation of this study, but I argue that this limitation stems from the heterogeneity of local governments and the institutional contexts of the fiscal equalization scheme, not from my identification strategy itself.

5 Data and preliminary analysis

5.1 Data

For empirical analysis, I use the same panel data that is used in Ando (2013) but with a wider range of outcome variables. This data set consists of the panel data for cities (*shi*) covering fiscal years 1980-1999. The cities which experienced amalgamation during the sample period are exclude from the sample because merged municipalities follow a special fiscal equalization scheme, and most cities remain in the sample. Date sources are listed in appendix D and briefly described here. First, all of the fiscal variables are from Reports on the Municipal Public Finance (Shichoson-betsu Kessan Jokyo Shirabe), which are published by MIC. Second, various non-fiscal outcome variables are from different data sources. Observed predetermined covariates, which I need to include to control for confounding nonlinearity around the cut off point, consist of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment. Revenue capacity[10] is from Reports on the Municipal Public Finance and the other covariates are from Census data. Census data is available for every 5th year and I impute annual data by linear interpolation.

Figure 1 shows the descriptive statistics of major outcome variables and covariates, where fiscal variables are standardized as per capita values and deflated by Consumer Price Index (CPI: the reference year is 2005) published by MIC. See appendix F for the descriptive statistics of other outcome variables.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Outcome (Thousand yen)					
Total expenditure	12666	308.98	96.58	155.25	1506.90
Expenditure by type					
Personnel costs	12666	67.75	19.02	26.06	260.36
Social benefits	12666	30.62	16.40	5.15	206.99
Construction	12666	85.27	37.54	9.80	616.80
Other expenditure	12666	125.35	49.21	43.10	942.07
Expenditure by field					
Education	12626	45.11	16.14	0.06	467.87
Social welfare	12603	57.12	26.12	15.07	454.56
Public work (total)	12626	62.38	27.61	3.05	423.81
Public work (road)	12280	18.30	9.90	1.38	127.52
Treatment (Thousand yen)					
LAT grant	12623	48.17	46.84	0.00	408.26
Assingment (Thousand yen)					
Need-capacity gap	12666	45.59	50.29	-111.15	408.50
Covariates					
Revenue capacity (modified, thousand yen)*	12666	117.92	40.05	24.02	320.32
Population	12666	102890	103892	6178	810482
Population density (pop/km^2)	12666	1653.98	2306.80	20.35	14131.37
Population ratio (age 0-15, %)	12666	19.35	3.41	9.11	32.47
Population ratio (age 65-, %)	12666	13.10	4.54	3.67	32.42
Sectoral ratio (primary industry, %)**	12666	8.90	7.96	0.10	46.78
Sectoral ratio (tertiary industry, %) ***	12666	57.06	10.01	26.63	85.05

Notes: All fiscal variables are divided by population, meaning that they are per-capita values. The fiscal variables are also deflated by CPI (the reference year is 2005). There are some missing values for the LAT grant. Sources: Reports on the Municipal Public Finance, Census, and CPI.
*See online Appendix E for a precise definition of revenue capacity as a pre-determined covariate.
**The primary Sector consists of agriculture, forestry, fisheries and mining.
***The tertiary sector includes all the sectors that are not included in the primary sector and secondary sectors (construction and mining).

[10]See also appendix E for detailed definitions

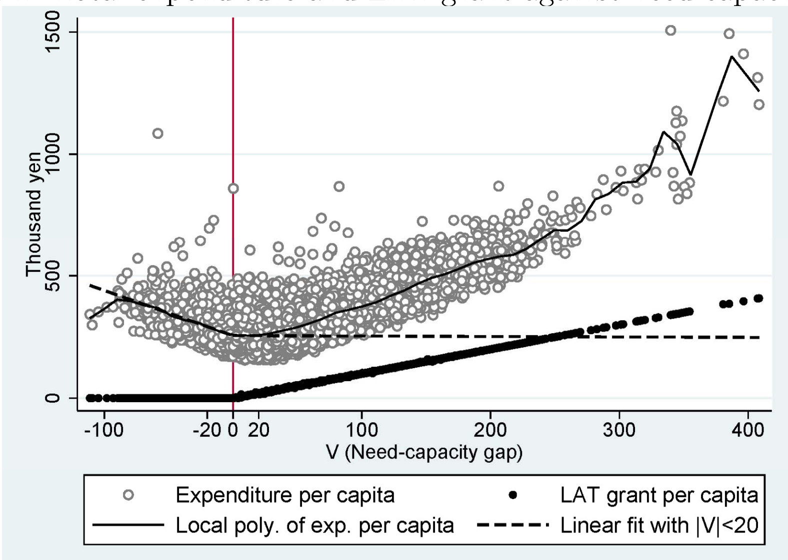
When it comes to expendiutre variables, there are two different categorizations in Japanese local expenditures. One is classified by *type* (*seishitsu-betsu*) such as personnel costs (salary), social benefits (cash and in-kind), and construction (investment projects). The other is classified by *function* (*mokuteki-betsu*) such as education, social welfare, and public work. My primary interest is grant effects on expenditures by type because they indicate how resources are allocated among different types of agents such as bureaucrats, welfare recipients, and the construction companies and therefore have direct theoretical implications. I will further discuss this type-function distinction later. In Appendix F, I present additional descriptive statistics for some outcome variables that I use in the following analysis.

5.2 Preliminary analysis

Figure 1 presents the scatter plots of the LAT grant and total expenditure against the need-capacity gap for municipalities (only cities). This graph indicates that the LAT grant has a clear deterministic kink at the threshold and the size of the grant is not negligible for many LAT-receiving municipalities. The linear fit of total expenditure based on RK estimation with a first-order polynomial with the bandwidth $|V_{i,t}| < 20$ indicates that there appears to be some kink in the total expenditure at the cutoff point. At the same time, the smoothed values of local polynomial regression for the total expenditure show a steeper nonllinear curve around the kink point, implying the existence of some confounding nonlinear relation between the assignment variable and the total expenditure. Ando (2013) shows that neither a quadratic polynomial nor a smaller bandwidth could perfectly eliminate this confounding nonlinearity but the introduction of covariates can resolve, or at least significantly alleviate, the problem.

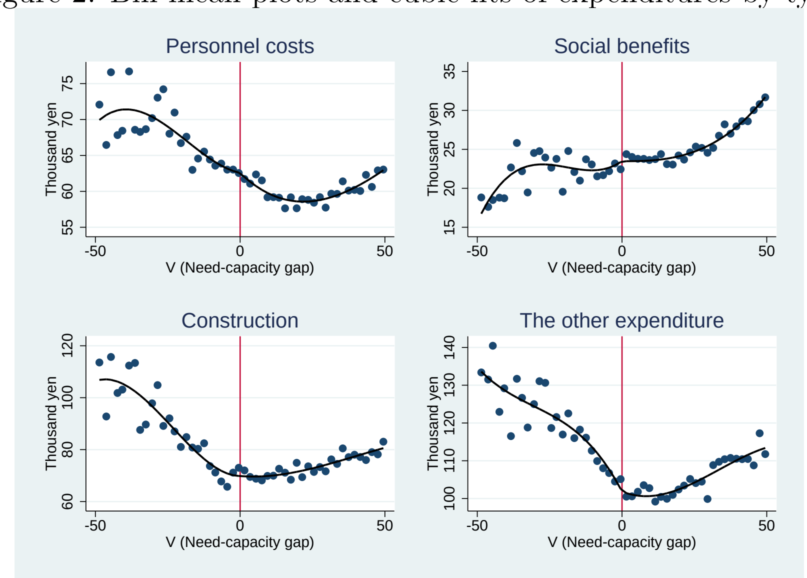
In this paper, I primarily focus on the largest subcategories of expenditures by type and by function. Figure 2 and 3 show the bin-mean plots and cubic fits of expenditures by type and function respectively. In Figure 2, no clear kink at the cutoff point is observed except for "the other expenditure" when I look at both bin-mean plots and cubic fits, although the trend of construction expenditure also may appear to change discontinuously around the cutoff point. In Figure 3, there seem to be kinks at $|V| = 0$ for education and public works (roads).

Figure 1: Total expenditure and LAT grant against need-capacity gap



Notes: All of the variables are per-capita variables. Linear fits of expenditure per capita are obtained by RK estimation with a linear polynomial where the continuity is imposed at $|V| = 0$. Smoothed values with local polinomial regression are based on a kernel-weighted local polynomial regression with the default setting of `lpoly` command in Stata 13. Sources: Reports on the Municipal Public Finance, Census, and CPI.

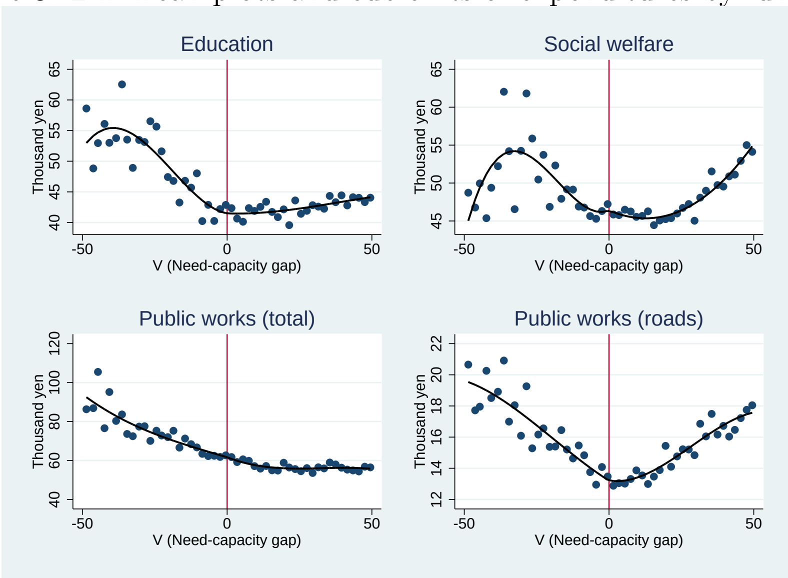
Figure 2: Bin-mean plots and cubic fits of expenditures by type



Notes: All of the variables are per capita variables. Cubic fits are estimated at the both sides of the cutoff point, but continuity at the cutoff point is imposed. Bin size is 2 and bandwidth is $|V| < 50$. Sources: Reports on the Municipal Public Finance, Census, and CPI

In addition, Ando (2013) conducts two preliminary analyses in order to examine the validity of the identification strategy with this data and shows that continuity assumption at the cutoff point seemed valid for the density function of the assign-

Figure 3: Bin-mean plots and cubic fits of expenditures by function



Notes: All of the variables are per capita variables. Cubic fits are estimated at the both sides of the cutoff point, but continuity at the cutoff point is imposed. Bin size is 2 and bandwidth is $|V| < 50$. Sources: Reports on the Municipal Public Finance, Census, and CPI

ment variable and all the covariates. See Appendix G for more details.

6 Results

6.1 Linear OLS estimation

Before examining RK estimates, estimation results with linear regression models are provided where I assume linear and constant grant effects and exogenous grant allocation conditional on covariates. As outcome variables, I use total expenditure, and major three *type-based* expenditure categories (personnel costs, social benefits, and construction) and the sum of the other remaining expenditures. As pre-determined covariates, I use revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment. When it comes to these covariates, the quadratic terms of these covariates are added to the regressors in order to take into account quadratic relations. In addition, I also include the conditional matching grants from the central government and prefectures in control variables because they are expected to be correlated with both LAT grants and expenditures.

From the standpoint of the causal inference framework, to control for these conditional matching grants may be problematic in the following two senses. First, these grants could also be endogenous and might contaminate whole estimation. Because conditional grants tend to be used as tools of tactical redistribution by politicians, this possibility of endogeneity could be high. In the linear OLS estimation , however, I simply assume that these grants are also exogenous like LAT grants.

Second, in some cases, these conditional grants can be interpreted as intermediate variables which can be “crowded in” by LAT grants because a large part of local public services and local investment projects are jointly financed by the general revenues (including LAT grants) of local governments and conditional matching grants from upper-level governments. Intermediate variables should not be, at least in general, included in control variables because it causes estimation bias (Rosenbaum 1984). The bias of an intermediate variable, however, is excluded by assumption in the linear regression framework. That is, if I assume linear and constant effects from the LAT and conditional grants on an outcome variable, the coefficient of the LAT grant variable can be interpreted as a direct effect on an outcome *not through* “crowding in” conditional matching grants (Pearl 2001). Although these additional assumptions as well as the assumptions of exogenous LAT grants and constant grant effects are not realistic, at least some of them are conventional assumptions used in the literature.

Estimation results are shown in Table 2. First, column (1) and (2) present results for the total expendutre with and without fixed effects and both estimates clearly exceed one. It is difficult to interpret these results as causal effects, particularly because I control for the conditional grants, which are arguably the only sources of more than one-to-one “crowding-in” total effect.[11] When it comes to expenditure categories, all estimated coefficients are significantly different from zero and, if I believed estimates with fixed-effects models as causal effects, a grant effect would be the largest on construction among the three major categories, but the effect on “the other expenditures” is larger than on construction.

In practice, because our estimates on total expenditure implies some positive estimation bias, it is also hard to regard the other estimates on expenditure categories as causal effects. In addition, even if the estimated grant effect on total expenditure were in a credible range, there would be another concern that some parts of the results are driven by central institutional regulations, not the decision

[11] Ando (2013) shows similar results but without the covariates of conditional grants

Table 2: OLS estimates for expenditures by type

	Dependent variable									
	Total exp.		Personnel cost		Social benefits		Construction		Other exp.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Estimate	1.618***	1.466***	0.304***	0.148***	0.070***	0.037***	0.271***	0.312***	0.972***	0.969***
	(0.064)	(0.068)	(0.030)	(0.023)	(0.015)	(0.013)	(0.039)	(0.046)	(0.046)	(0.049)
Socio-econ. covar.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other grants covar.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R-squared	0.914	0.886	0.713	0.856	0.707	0.714	0.557	0.516	0.548	0.520
Observations	12,623	12,623	12,623	12,623	12,623	12,623	12,623	12,623	12,623	12,623

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$.

making of municipalities as discussed in Section 4.3. Then the interpretation of estimation results could be difficult.

6.2 RK estimation

6.2.1 Main results

Table 3 provides RK estimates for my main outcome variables with linear and quadratic polynomial specifications and different bandwidths. I also added the set of the control variables used in the OLS estimation except for central and prefectural conditional grants. Column (1) presents the same results as Ando (2013) for reference and implies that the grant effect on total expenditure is more or less close to one. An estimate with a linear polynomial and the bandwidth $|V| < 10$ and estimates with a quadratic polynomial and the bandwidths $|V| < 30$ or smaller are very different from other estimates and their standard errors are also discontinuously higher than the others, implying that RK estimates are highly imprecise with these settings. It simply reflects the fact that the RK estimation is more demanding when the bandwidth is smaller and a polynomial order is higher, particularly when a sample size is not so large.

In column (2)-(5), RK estimates for three major expenditure categories and the remaining expenditures are provided and they show several remarkable differences from OLS estimates in table 2. First of all, most RK estiamtes for personnel costs and social benefits are not statistically different from zero. Second, RK estimates for construction are about 0.5 or more with a linear polynomial, but they tend to be statistically insignificant when I use a quadratic polynomial and relatively small bandwidths. Third, RK estimates for “the other expenditures” are almost always significantly different from zero regardless of polynomial orders and bandwidth sizes. On the other hand, the sizes of estimates are different depending on a polynomial order and estimates are larger and closer to one when a quadratic polynomial is used.

In sum, RK estimation with both linear and quadratic polynomials implies 1.around one-to-one effect on total expenditure, 2. no statistically significant effect on personnel costs and social benefits, and 3.statistically significant effect on “the other expenditures”. On the other hand, it is unclear whether there is any effect on construction. The size of the effect on “the other expenditures” is also somewhat ambiguous. If I believe Akaike Information Criteria (AIC), it supports a quadratic polynomial specification more often than a linear one, but differences in AIC are rather subtle (results not shown in the table). Therefore I refrain from specific conclusions about these matters so far.

From a theoretical point of view, no effect on personnel costs might suggest that the objective function of the subgroup of Japanese municipalities around $|V_i| = 0$ is not a budget-maximizing or slack-maximizing type, although another possible interpretation is that grant effects on administrative costs that are beneficial to bureaus are through more flexible and minor expenditure categories such as outsourcing costs rather than relatively rigid and legally regulated personnel costs. Unfortunately, more detailed expenditure categories, which are now mingled in “the other expenditures”, are not available in the periods of my panel data.

An alternative explanation appears to be possible based on the fact that recurring expenses such as personnel costs and social benefits are generally less sensitive to revenue changes than construction costs or “the other expenditures’. Then municipalities which *happen to* receive a relatively small amount of grants around the threshold could allocate these funds only to some non-recurring expenses. This would be a particularly plausible explanation if I utilized some within-municipality variations with a fixed effects model.

However, considering the fact that my RK estimation relies on cross-municipality variations around $|V_i| = 0$, a municipality just on the right-hand side of the cutoff point *happens to* receive a small amount of the LAT grants and this “accidental grant” is rather permanent unless the fiscal status of this municipality changes. In this sense, there is some room for this municipality to consider its LAT grants as

Table 3: RK estimates for expenditures by type

Polynomial order & bandwidth	Sample size	Dependeint variable				
		Total exp.	Personnel costs	Social benefits	Const-ruction	Other exp.
		(1)	(2)	(3)	(4)	(5)
Lienar polinomial						
No	12,666	0.965***	0.160***	0.059	0.472***	0.274***
		(0.175)	(0.051)	(0.060)	(0.110)	(0.094)
|V|<60	8,721	1.087***	0.103*	0.088*	0.516***	0.380***
		(0.182)	(0.060)	(0.052)	(0.128)	(0.091)
|V|<50	7,750	1.126***	0.069	0.083	0.576***	0.397***
		(0.198)	(0.068)	(0.052)	(0.147)	(0.095)
|V|<40	6,430	1.174***	0.037	0.071	0.620***	0.446***
		(0.242)	(0.083)	(0.059)	(0.182)	(0.111)
|V|<30	5,013	1.266***	0.049	0.083	0.573***	0.560***
		(0.256)	(0.090)	(0.069)	(0.205)	(0.132)
|V|<20	3,451	1.054***	-0.126	0.029	0.463*	0.687***
		(0.337)	(0.109)	(0.088)	(0.276)	(0.187)
|V|<10	1741	-0.071	-0.113	-0.174	-0.449	0.666**
		(0.617)	(0.216)	(0.174)	(0.538)	(0.328)
Quadratic polinomial						
No	12,666	1.492***	0.210**	0.266***	0.710***	0.307*
		(0.277)	(0.086)	(0.091)	(0.221)	(0.163)
|V|<60	8,721	1.289***	-0.106	0.089	0.567*	0.739***
		(0.447)	(0.138)	(0.115)	(0.313)	(0.251)
|V|<50	7,750	1.272***	-0.093	-0.003	0.413	0.955***
		(0.403)	(0.150)	(0.127)	(0.325)	(0.232)
|V|<40	6,430	0.980**	-0.036	-0.078	0.059	1.034***
		(0.479)	(0.178)	(0.150)	(0.394)	(0.276)
|V|<30	5,013	0.060	-0.361*	-0.214	-0.261	0.896**
		(0.657)	(0.209)	(0.180)	(0.540)	(0.352)
|V|<20	3,451	-1.064	-0.144	-0.364	-1.150	0.594
		(1.068)	(0.313)	(0.243)	(0.834)	(0.557)
|V|<10	1741	-0.724	0.527	0.044	-2.022	0.727
		(2.535)	(0.693)	(0.464)	(1.906)	(1.282)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$. All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.

somewhat permanent grants that annually come to its budget and can be used for recurring expenses.

In any case, given the theoretical setup in this paper, it is unlikely that the propensity parameter for public expenditure α_i consists of the propensity for personnel costs or social benefits.

6.2.2 Additional results

The expenditure categories used in the previous analysis are based on the *types* of expenditure. Expenditure categories by type inform me whether local expenditures are used to hire and pay for public employees, to provide social benefits to citizens, or to increase jobs in the construction industry. These categories are useful to understand some aspect of expenditure allocations, but do not provide information about on which *function* (e.g. education, social welfare or roads) these personnel costs, social benefits, and construction costs are spent. For example, one may want to know whether additional expenditure on construction induced by additional LAT grants is used to improve educational facilities or to build more roads.

Ideally it would be the best if municipality expenditure data with *type-function* matrix is available. In reality, however, I have only data with expenditure categories by type and by function respectively at the municipality level. In this subsection, therefore, I use function-based expenditure data to examine on which functions the LAT grants have more influence than on others.

Table 4 presents RK estimates for three major function-based expenditures, that is education, social welfare, and public works (infrastructure). Results show that RK estimates for education are largest among the the three categories and statistically significant with reasonable combinations of a polynomial and a bandwidth. RK estimates for roads also provide relatively robust results and they are about one third or two third of the estimates for education. Results on social welfare and total public works are more ambiguous because their estimates with a quadratic polynomial are always not significantly different from zero if a bandwidth size is equal to or smaller than 60.

There are several implications in these results . First, although I refrained from a clear conclusion about the grant effect on construction expenses in the last subsection, a significant effect on public works for roads implies that there seems to be some grant effect on construction because a large part of road expenses is

Table 4: RK estimates for expenditures by function

Polynomial order & bandwidth size	Dependent variable			
	Education	Social welfare	Public works	
			Total	Roads
	(1)	(3)	(5)	(7)
Linear polynomial				
No	0.274***	0.137*	0.230**	0.084**
	(0.041)	(0.077)	(0.103)	(0.037)
$\lvert V \rvert<60$	0.355***	0.142*	0.239**	0.084**
	(0.054)	(0.077)	(0.112)	(0.038)
$\lvert V \rvert<50$	0.394***	0.167**	0.210*	0.118***
	(0.057)	(0.078)	(0.114)	(0.039)
$\lvert V \rvert<40$	0.417***	0.160*	0.196	0.160***
	(0.066)	(0.091)	(0.136)	(0.044)
$\lvert V \rvert<30$	0.386***	0.175*	0.175	0.153***
	(0.080)	(0.096)	(0.168)	(0.056)
$\lvert V \rvert<20$	0.273**	0.081	0.147	0.175***
	(0.106)	(0.112)	(0.216)	(0.064)
$\lvert V \rvert<10$	-0.001	-0.145	-0.314	0.163
	(0.205)	(0.207)	(0.443)	(0.142)
Quadratic polynomial				
No	0.428***	0.287*	0.315*	0.130**
	(0.075)	(0.154)	(0.170)	(0.062)
$\lvert V \rvert<60$	0.470***	0.214	0.162	0.221***
	(0.123)	(0.171)	(0.266)	(0.081)
$\lvert V \rvert<50$	0.362***	0.162	0.104	0.190**
	(0.140)	(0.161)	(0.287)	(0.092)
$\lvert V \rvert<40$	0.129	0.047	0.179	0.101
	(0.178)	(0.189)	(0.330)	(0.112)
$\lvert V \rvert<30$	-0.012	-0.250	0.077	0.092
	(0.244)	(0.241)	(0.417)	(0.124)
$\lvert V \rvert<20$	0.382	-0.246	-0.862	-0.058
	(0.416)	(0.322)	(0.658)	(0.202)
$\lvert V \rvert<10$	0.080	-0.502	-0.368	-0.055
	(0.696)	(0.674)	(1.434)	(0.400)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$.All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.

categorized in construction expenses in type-based categories. For example, in 1999, 79.8% of road expenses are categorized as construction expenses in the white paper on local public finance 2001 published by MIC. [12]

Second, given no effect on personnel costs as I found in Section 6.2.1, a relatively clear and large effect on education expenses implies that no-personnel-related education costs are increased by the LAT grants. Some of them may be construction expenditure such as school buildings, but it is more strongly expected that they are related to some miscellaneous expenses such as commission fees or equipment costs, which are mixed in "the other expenditures" in the analysis of expenditure categories by type.

To verify that the grant-induced education expenses are not personnel costs of education, I also present RK estimates for teacher-student ratios in Table 5. This table shows that RK estimates for teacher-student ratios are not significantly different from zero in most cases. It could be better to interpret these results as placebo tests because teacher-student ratios are principally determined by the central government and prefectures: The personnel costs of teachers at elementary and junior high schools are paid by prefectures while they are employed by municipalities.[13] Nonetheless these results at least show that municipalities did not (or could not) discretionarily increase the number of teachers using additional LAT grants.

In sum, it is likely that non-personnel education expenses are the most affected expenditure category by the increase in the LAT grants for the municipalities which fiscal gaps are close to zero. From a theoretical standpoint, this results neither support bureaucratic budget-maximization and slack-maximization models nor political lobbying models which are often tied with the political power of construction industry in Japan because both bureaucrats and construction companies could not gain substantial benefits from the increase in non-personnel education expenses. Implications for other hypothesis such as median or representative voter models or citizen-candidate models are still unclear.

[12]Although municipality data with the matrices of type-function expenditure categories is not available in the municipality-level, the white papers on local public finance that are annually published by MIC provide the breakdowns of type-based expenditures by function (and vice versa) in the aggregate level.

[13]In 2000s there are several decentralization reforms in this field, but my sample period is 1980-1999 and therefore not affected by these reforms.

Table 5: RK estimates for teacher-student ratios

Polynomial order & Bandwidth	Dependent variable		
	Kinder-garden	Elementary school	Junior high school
	(1)	(2)	(3)
Linear polynomial			
No	-0.045	0.018	0.030
	(0.033)	(0.018)	(0.022)
$\|V\|<60$	-0.012	0.026	0.035*
	(0.035)	(0.016)	(0.018)
$\|V\|<50$	-0.011	0.023	0.036*
	(0.037)	(0.017)	(0.019)
$\|V\|<40$	0.017	0.013	0.027
	(0.043)	(0.019)	(0.022)
$\|V\|<30$	0.071	0.005	0.014
	(0.053)	(0.022)	(0.024)
$\|V\|<20$	0.033	-0.010	-0.001
	(0.066)	(0.025)	(0.029)
$\|V\|<10$	-0.028	-0.062	-0.013
	(0.114)	(0.054)	(0.057)
Quadratic polynomial			
No	-0.066	0.059*	0.097*
	(0.059)	(0.032)	(0.050)
$\|V\|<60$	0.033	-0.015	0.001
	(0.084)	(0.034)	(0.041)
$\|V\|<50$	0.035	-0.038	-0.021
	(0.099)	(0.039)	(0.043)
$\|V\|<40$	0.115	-0.035	-0.017
	(0.109)	(0.042)	(0.050)
$\|V\|<30$	-0.017	-0.077	-0.035
	(0.125)	(0.051)	(0.058)
$\|V\|<20$	-0.152	-0.072	0.009
	(0.178)	(0.075)	(0.091)
$\|V\|<10$	-0.215	-0.221	-0.007
	(0.366)	(0.181)	(0.212)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$. All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.

6.2.3 Supplementary results

For further investigations, I provide three tables in Appedix H. First, Table 8 provides RK estimates for the major breakdowns of education expenditures. This table suggests grant effects exist in educational expenditures for elementary school, junior high school, and health and physical education although the robustness and statistical significance of estimates are sometimes weaker than the those of estimates for total education expenditure.

Table 9 provides further breakdowns of function-based expenditures for social welfare. Whereas Table 4 does not provide clear evidence of the grant effect on social welfare expenses, this table implies that some effect on "welfare for others" might exist.

Finally, in Table 10, RK estimates for some welfare-related indicators are presented. Because of lack of data, I only provide some policy-related variables in the fields of child welfare and public assistance. Results show that no robust grant effects are found for all indicators, which are compatible with estimation results on social welfare expenditures for children and for public assistance.

7 Conclusion

This paper studies the effects of fiscal equalization grants on local expenditures and other outcomes when grant endogeneity and grant effect heterogeneity are expected to exist.

Using Japanese municipality data and the RK design, I found that approximately 30-40 percents of the arguably "one-to-one" effect of Japanese LAT grants on total expenditure could be explained by the effect on non-personnel education expenditures. Some other expenditures such as road construction and social welfare may also be affected by LAT grants but with lesser extents. These results imply that unconditional lump-sum grants do not stick to the policy fields where bureaucrats or specific vested interests exclusively gain fiscal benefits.

These estimation results are obtained by exploiting cross-municipality variations of LAT grants around the cutoff point of grant eligibility and therefore their policy implications can be primarily applicable only to municipalities around this cutoff point. That is, I cannot simply extrapolate the estimation results to the fiscally poor municipalities which heavily rely on LAT grants or the very affluent municipalities which never receive LAT grants.

This locality of causal interpretation is rather advantageous because I can focus on relatively affluent municipalities which have more discretion in the allocation of additional revenues by the LAT grants. In other words, the exclusion of fiscally poor municipalities from the local RK estimator can be justified by the fact that the nominally "unconditional" fiscal equalization grants for them are in fact strongly tied with centrally determined fiscal needs of specific local services.

Finally, this study did not provide a decisive general conclusion about the grant effects and the flypaper effects. On the contrary, my conceptual and empirical frameworks as well as the example of the institutional setting of Japanese fiscal equalization scheme clarify that intergovernmental grants and their effects can be inherently heterogeneous and it could be misleading to assume away this heterogeneity with somewhat strong theoretical and empirical assumptions. I believe the studies of grant effects and the flypaper effects will be more fruitful if researchers can explicitly incorporate various heterogeneity both in theoretical and empirical frameworks and accumulate case-by-case studies.

References

Ando, Michihito (2013) "How Much Should We Trust Regression-Kink-Design Estimates?," *Working paper, Department of Economics, Uppsala University*, No. 2013:22.

Baicker, Katherine and Nora Gordon (2006) "The Effect of State Education Finance Reform on Total Local Resources," *Journal of Public Economics*, Vol. 90, No. 8-9, pp. 1519–1535.

Bailey, Stephen J and Stephen Connolly (1998) "The Flypaper Effect : Identifying Areas for Further Research," *Public Choice*, Vol. 95, No. 3/4, pp. 335–361.

Bradford, David F. and Wallace E. Oates (1971a) "The Analysis of Revenue Sharing in a New Approach to Collective Fiscal Decisions," *The Quarterly Journal of Economics*, Vol. 85, No. 3, pp. 416–439.

——— (1971b) "Towards a Predictive Theory of Intergovernmental Grants," *The American Economic Review*, Vol. 61, pp. 440–449.

Buchanan, James M. (1950) "Federalism and Fiscal Equity," *The American Economic Review*, Vol. 40, No. 4, pp. 583–599.

Card, David, David Lee, Zhuan Pei, and Andrea Weber (2012) "Nonlinear Policy Rules and the Identification and Estimation of Causal Effects in a Generalized Regression Kink Design," *NBER Working Paper Series*, No. 18564.

Cascio, Elizabeth U., Nora Gordon, and Sarah Reber (2013) "Local Responses to Federal Grants: Evidence from the Introduction of Title I in the South," *American Economic Journal: Economic Policy*, Vol. 5, No. 3, pp. 126–159.

Chodorow-Reich, Gabriel, Laura Feiveson, Zachary Liscow, and William Gui Woolston (2012) "Does State Fiscal Relief During Recessions Increase Employment? Evidence from the American Recovery and Reinvestment Act," *American Economic Journal: Economic Policy*, Vol. 4, No. 3, pp. 118–145.

Conley, Timothy and Bill Dupor (2011) "The American Recovery and Reinvestment Act: Public Sector Jobs Saved, Private Sector Jobs Forestalled," p. http://economics.uwo.ca/images/news/TheAmericanRec.

Dafflon, Bernard (2007) "Fiscal Capacity Equalization in Horizontal Fiscal Equalization Programs," in *R.Boadway and A.Shah (ed.) Intergovernmental Fiscal Transfers*: The World Bank, pp. 361–396.

Dahlberg, Matz, Eva Mörk, Jø rn Rattsø, and Hanna Å gren (2008) "Using a Discontinuous Grant Rule to Identify the Effect of Grants on Local Taxes and Spending," *Journal of Public Economics*, Vol. 92, No. 12, pp. 2320–2335.

DiNardo, John and David S. Lee (2011) "Program Evaluation and Research Designs," *Handbook of Labor Economics*, Vol. 4a, No. 11, pp. 463–536.

Dixit, Avinash and John Londregan (1998) "Fiscal Federalism and Redistributive Politics," *Journal of Public Economics*, Vol. 68, No. 2, pp. 153–180.

Gamkhar, Shama and Anwar Shah (2007) "The Impact of Intergovernmental Fiscal Transfers A Syntesis of the Conceptual and Empirical Literature," in *Intergovernmental Fiscal Transfers: Principles and Practice, ed. by R. Boadway, and A. Shar*: The World Bank, pp. 149–188.

Gordon, Nora (2004) "Do federal grants boost school spending? Evidence from Title I," *Journal of Public Economics*, Vol. 88, No. 9-10, pp. 1771–1792.

Gramlich, Edward M. (1969) "State and local governments and their budget constraint," *International Economic Review*, Vol. 10, No. 2, pp. 163–182.

Hahn, Jinyong, Petra Todd, and Wilbert Van der Klaauw (2001) "Identification and Estimation of Treatment effects with a Regression-Discontinuity Design," *Econometrica*, Vol. 69, No. 1, pp. 201–209.

Hamilton, Bruce W. (1983) "The flypaper effect and other anomalies," *Journal of Public Economics*, Vol. 22, pp. 347–361.

Hayashi, Masayoshi (2000) "Distortionary Effects of Seemingly Lump-sum Intergovernmental Transfers in Japan: A Note," *Meiji Gakuin Review: The Papers and Proceedings of Economics*, Vol. 118, pp. 63–71.

——— (2006) "Chihokohuzei no Keizai Bunseki Genjo to Kadai (The Economics Studies of the Local Allocation Tax in Japan: A Critical Survey)," *Keizai Seisaku Journal (Journal of Economic Policy Studies)*, Vol. 3, No. 2, pp. 6–24 (In Japanese).

Henderson, JM (1968) "Local Government Expenditures: A Social Welfare Analysis," *The Review of Economics and Statistics*, Vol. 50, No. 2, pp. 156–163.

Hines, James R. and Richard H. Thaler (1995) "Anomalies: The Flypaper Effect," *The Journal of Economic Perspectives*, Vol. 9, No. 4, pp. 217–226.

Holland, Paul W. (1986) "Statistics and Causal Inference," *Journal of the American Statistical Association*, Vol. 81, No. 396, pp. 945–960.

Imbens, Guido W. and Joshua D. Angrist (1994) "Identification and Estimation of Local Average Treatment Effects," *Econometrica*, Vol. 62, No. 2, pp. 467–475.

Imbens, Guido W. and Thomas Lemieux (2008) "Regression discontinuity designs: A guide to practice," *Journal of Econometrics*, Vol. 142, No. 2, pp. 615–635.

Imbens, Guido W. and Jeffrey M. Wooldridge (2009) "Recent developments in the econometrics of program evaluation," *Journal of Economic Literature*, Vol. 47, No. 1, pp. 5–86.

Inman, Robert P. (2008) “The Flypaper Effect,” *NEBR Working Paper*, No. 14579.

Knight, Brian (2002) “Endogenous Federal Grants and Crowd-out of State Government Spending: Theory and Evidence from the Federal Highway Aid Program,” *American Economic Review*, Vol. 92, No. 1, pp. 71–92.

Le Maux, Benoît (2009) “Governmental Behavior in Representative Democracy: A Synthesis of the Theoretical Literature,” *Public Choice*, Vol. 141, No. 3/4, pp. 447–465.

Lee, David S. and Thomas Lemieux (2010) “Regression Discontinuity Designs in Economics,” *Journal of Economic Literature*, Vol. 48, pp. 281–355.

Lindbeck, Assar and Jörgen W. Weibull (1987) “Balanced-Budget Redistribution as the Outcome of Political Competition,” *Public choice*, Vol. 52, No. 3, pp. 273–297.

Litschig, Stephan and Kevin M. Morrison (2013) “The Impact of Intergovernmental Transfers on Education Outcomes and Poverty Reduction,” *American Economic Journal: Applied Economics*, Vol. 5, No. 4, pp. 206–240.

Lundqvist, Heléne (2013) “Granting Public or Private Consumption? Effects of Grants on Local Public Spending and Income Taxes,” *International Tax and Public Finance*.

Lundqvist, Heléne, Matz Dahlberg, and Eva Mörk (2014) “Stimulating Local Public Employment: Do General Grants Work? †,” *American Economic Journal: Economic Policy*, Vol. 6, No. 1, pp. 167–192.

Nielsen, Helena Skyt, Torben Sø rensen, and Christopher Taber (2010) “Estimating the Effect of Student Aid on College Enrollment: Evidence from a Government Grant Policy Reform,” *American Economic Journal: Economic Policy*, Vol. 2, No. 2, pp. 185–215.

Oates, Wallace E. (1999) “An Essay on Fiscal Federalism,” *Journal of Economic Literature*, Vol. XXXVII, No. September, pp. 1120–1149.

Pearl, Judea (2001) “Direct and Total Effects,” *Proceedings of the Seventeenth Conference on Uncertaninty in Artificial Intelligence*, No. 2001, pp. 411–420.

Reschovsky, Andrew (2007) "Compensating Local Governments for Differences in Expenditure Needs in a Horizontal Fiscal Equalization Program," in *R.Boadway and A.Shah (ed.) Intergovernmental Fiscal Transfers*, pp. 397–425.

Rodden, Jonathan (2009) "Federalism and Inter-Regional Redistribution," in *N.Bosch, M.Epasa and A. Solé-Ollé (Eds.), The Political Economy of Inter-regional Fiscal Flows: Measurement, Determinants, and Effects on Country Stability.*

Rosenbaum, Paul R. (1984) "The Consquences of Adjustment for a Concomitant Variable That Has Been Affected by the Treatment," *Journal of the Royal Statistical Society. Series A (General)*, Vol. 147, No. 5, pp. 656–666.

Rubin, Donald B. (1974) "Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies.," *Journal of Educational Psychology*, Vol. 66, No. 5, pp. 688–701.

——— (2005) "Causal Inference Using Potential Outcomes," *Journal of the American Statistical Association*, Vol. 100, No. 469, pp. 322–331.

Scott, AD (1950) "A Note on Grants in Federal Countries," *Economica*, Vol. 17, No. 68, pp. 416–422.

Solé-Ollé, Albert (2013) "Inter-regional Redistribution through Infrastructure Investment: Tactical or Programmatic?," *Public Choice*, Vol. 156, No. 1-2, pp. 229–252.

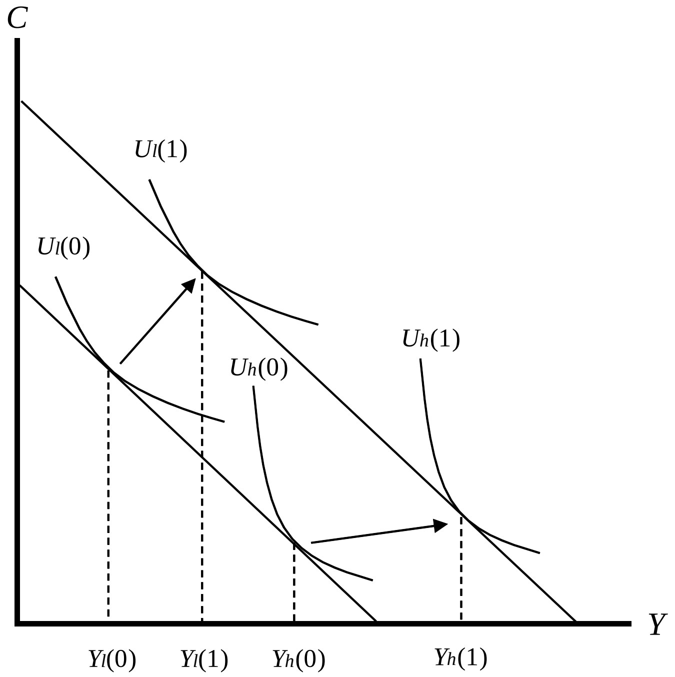
Suárez Serrato, Juan Carlos and Philippe Wingender (2011) "Estimating Local Fiscal Multipliers," p. http://ceg.berkeley.edu/students_9_2583495006.pdf.

Wilson, Daniel J. (2012) "Fiscal Spending Jobs Multipliers: Evidence from the 2009 American Recovery and Reinvestment Act," *American Economic Journal: Economic Policy*, Vol. 4, No. 3, pp. 251–282.

Appendix

A Stylized explanatoin of grant endogeneity bias

Figure 4: Endogenous grant allocation with heterogeneous effects



Consider the case where there are only two local governments: the one with high propensity for public services ($i = h$) and the other one with low propensity ($i = l$). Assume that there is only one unit of grant $G_i(1) = 1$ which one of the two local governments can receive from the central government. Then the potential grant effect on local expenditure can be defined as

$$\beta_i \equiv \frac{Y_i(1) - Y_i(0)}{G_i(1) - G_i(0)} = Y_i(1) - Y_i(0) \quad \text{for } i = l, h.$$

Under this setting, Figure 4 explains how the allocation of the grant G_i would shift the resource allocation of these two local governments. For graphical simplicity I further assume that the both governments have the same budget constraint when they do not receive the grant. Hence the only initial difference between h and l is the shapes of their objective functions that reflect their difference in the propensity for public services. Due to this difference, the levels of public expenditure $Y_i(0)$

differ between h and l. Grant effects β_l and β_h also differ due to the same reason.

Next, I also assume that the central government provides the grant only to the local government with a higher propensity for public services (namely h) at the central budgetary stage. In this case, if I use a gap in observed Y between h and l as a causal parameter, the following biased parameter is obtained:

$$\begin{aligned}\beta_{gap} \equiv \frac{Y_h - Y_l}{G_h - G_l} &= Y_h(1) - Y_l(0) \\ &= Y_h(1) - Y_h(0) + Y_h(0) - Y_l(0) \\ &= \beta_h + Y_h(0) - Y_l(0)\end{aligned}$$

Thus β_{gap} is the sum of β_h and a bias term $Y_h(0) - Y_l(0)$. The bias term can be interpreted as a selection or endogeniety bias because the grant is endogenously allocated to the local government h at the central budgetary stage based on the propensity for public services, which also determines $Y_i(0)$.

Using a similar setting but with a constant effect and a linear estimation model, Knight (2002) also shows how endogeneity bias arises in the estimation of grant effect when an ordinary least squire (OLS) estimation is used.

B Derivation of average grant effect with the fuzzy RK design

Suppose that the constant γ in the grant formula (6) is now replaced with γ_i, implying that the sizes of kinks at the cutoff point differ among local governments. I assume $\gamma_i \geq 0$ (monotonicity assumption). Inserting the public expenditure function (1) and this new kinked grant allocation rule into the equation (7), I can derive the following fuzzy RK parameter:

$$
\begin{aligned}
\beta_{RK} &= \frac{\lim_{e\to 0} \frac{d}{dv} E\left(\frac{\alpha_i I_i}{r_i} + \alpha_i\gamma_i V_i \middle| V_i = v\right)\Big|_{v=+e} - \lim_{e\to 0} \frac{d}{dv} E\left(\frac{\alpha_i I_i}{r_i} + \alpha_i\gamma_i V_i \middle| V_i = v\right)\Big|_{v=-e}}{\lim_{e\to 0} \frac{d}{dv} E(\gamma_i V_i | V_i = v)\Big|_{v=+e} - \lim_{e\to 0} \frac{d}{dv} E(\gamma_i V_i | V_i = v)\Big|_{v=-e}} \\
&= \frac{\lim_{e\to 0} \frac{d}{dv}[v \cdot E(\alpha_i\gamma_i | V_i = v)]\Big|_{v=+e}}{\lim_{e\to 0} \frac{d}{dv}[v \cdot E(\gamma_i | V_i = v)]\Big|_{v=+e}} \\
&= \frac{\lim_{e\to 0} \left(E(\alpha_i\gamma_i | V_i = v) + v \cdot \frac{d}{dv} E(\alpha_i\gamma_i | V_i = v)\right)\Big|_{v=+e}}{\lim_{e\to 0} \left(E(\gamma_i | V_i = v) + v \cdot \frac{d}{dv}[E(\gamma_i | V_i = v)]\right)\Big|_{v=+e}} \\
&= \frac{\lim_{e\to 0} E(\alpha_i\gamma_i | V_i = +e)}{\lim_{e\to 0} E(\gamma_i | V_i = +e)} \\
&= \lim_{e\to 0} E[\alpha_i | \gamma_i(V_i = +e) > 0] \\
&= E(\alpha_i | \text{unit } i \text{ is a complier and } V_i = 0),
\end{aligned}
$$

where the second equality is derived by the smoothness condition of the pre-determined covariates at $V_i = 0$. The fifth equality follows the reasoning of Imbens and Angrist (1994) and Hahn et al. (2001). In the fifth equation, the condition $\gamma_i(V_i = +e) > 0$ implies that i is a *complier* because under this condition the treatment variable G_i is positively increased by nonzero γ_i when $V_i > 0$. The last expression simply paraphrases the fifth equation, following the notations in Imbens and Lemieux (2008) and Lee and Lemieux (2010) for the Regression Discontinuity design. Thus β_{RK}

can be interpreted as the average causal effect of the unit-inrease in G_i at $V_i = 0$ for the subgroup of the compliers.

C Stylized description of Japanese fiscal equalization[14]

In this appendix, I explain the stylized features of the Japanese fiscal equalization scheme and describe how the kink based on the LAT grants is generated in more detail. In order to make this description as concise as possible, throughout this appendix I redefine CAP as follows:

$$CAP_i = Standard\ Tax\ Revenue_i \times \frac{3}{4}.$$

In other words, compared with the actual definition in Appendix E, CAP is simplified by dropping the second term (*Local Transfer Tax* and some miscellaneous revenues), which is actually much smaller than the first term (*Standard Tax Revenue*) in the majority of municipalities.

Then, further assuming that there are no additional revenues other than local tax revenues and LAT grants, the relation between pre-equalization standard revenue (denoted as $PreRev$) and post-equalization standard revenue (denoted as $PostRev$) can be expressed as follows:[15]

$$\begin{aligned} PostRev_i &= PreRev_i, \quad if \;\; V_i \leq 0 \\ PostRev_i &= PreRev_i + G_i, \quad if \;\; V_i > 0. \end{aligned}$$

By inserting $PreRev_i = Standard\ Tax\ Revenue_i$, $V_i = NEED_i - CAP_i$, $G_i = V_i = NEED_i - CAP_i$, and the above definitions of CAP_i into these equations, they can be rewritten as

$$\begin{aligned} PostRev_i &= CAP_i + Standard\ Tax\ Revenue_i \times \frac{1}{4}, \;\; if \;\; CAP_i \geq NEED_i \\ PostRev_i &= NEED_i + Standard\ Tax\ Revenue_i \times \frac{1}{4}, \;\; if \;\; CAP_i < NEED_i \end{aligned}$$

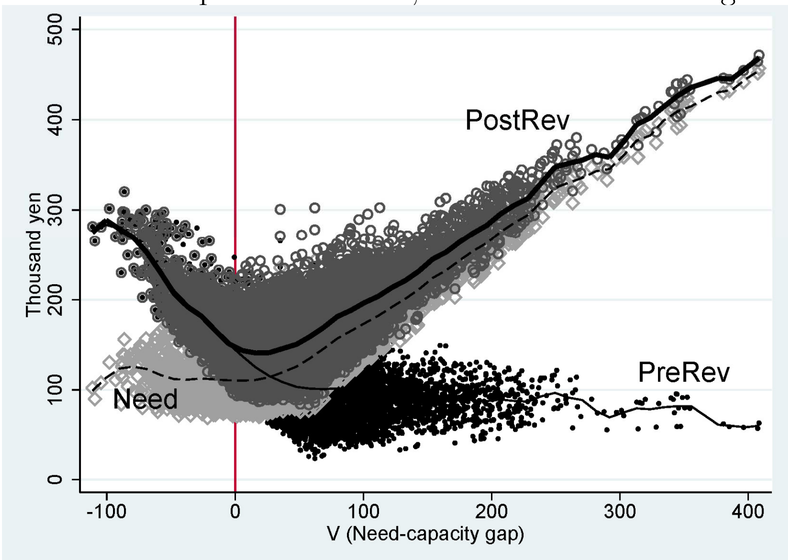
These two equations represent an essential property of the Japanese fiscal equalization scheme. First, if CAP is larger than $NEED$, no LAT grant is distributed and post-equalization standard revenue is identical to the sum of CAP and *Standard*

[14] This part is based on the online appendix of Ando (2013)

[15] I use the phrase "standard" revenue to emphasize that this is not the actual revenue of local municipalities but the estimated revenue that the central government evaluates under some "standard" local taxation setting.

Tax Revenue$\times$ 1/4. Second, when CAP is smaller than $NEED$, the LAT grant ensures that municipalities receive the sum of $NEED$ and *Standard Tax Revenue* $\times$ 1/4. In both cases, this additional amount, *Standard Tax Revenue* $\times$ 1/4, exists due to the fact that CAP is calculated by *Standard Tax Revenue* $\times$ 3/4 and the other 1/4 of *Standard Tax Revenue* is excluded from the fiscal equalization formula. Because of this excluded part of Standard Local Tax Revenue, which is officially referred to as "reserved revenues", a richer municipality is always richer even after fiscal equalization. Figure 5 presents actual scatter plots and local polynomial smoothing of *PreRev*, *PostRev*, and *Need* against the assignment variable V. It graphically illustrates how the LAT grant phases in at the cutoff point $V = 0$.

Figure 5: Scatter plots of *Prerev*, *PostRev* and *Need* against V



Notes: This graph is replicated from the online appendix of Ando (2013). The same sample that is described in subsection 5.1 is used for this scatter plot. All variables are per capita values. The local polynomials are obtained using `lpoly` command in STATA 13 with the default setting. Sources: Reports on the Municipal Public Finance, Census, and CPI

Notice that in this graph *PostRev* is well above *Need* around $V = 0$. This implies that municipalities just after $V > 0$ have ample additional fiscal resources in excess of $NEED$. These additional fiscal resource come from the term Standard Local Tax Revenue$\times$ 1/4 in the above equation of *PostRev*. This fact benefits our empirical analysis because LAT grants, which phase in after V¿0, can be plausibly considered as "unconditional" and "lump-sum" around the threshold, without any difficulties caused by complicated institutional settings of these grants. I conclude this appendix by examining this issue in greater detail.

In the conceptual and theoretical discussion of the local budgetary stage, I implicitly assume that LAT grants are "unconditional" and "lump-sum" and local bodies have full discretion in their decision-making on spending and taxation. In other words, I presuppose that an estimated coefficient can be straightforwardly interpreted as the effect of unconditional lump-sum grants on local spending under the full discretion of local municipalities.

But it could be misleading to simply assume that LAT grants are completely "unconditional" and "lump-sum" as the Bradford-Oates equivalence theorem and some previous empirical studies have done. The LAT grant is nominally a general grant that a local body can spend on whatever it wants, but at the same time the LAT grant is the grant that guarantees every single municipality a sufficient amount of revenues to cover centrally-determined "standard costs" for local public services, which is referred to as Standard Fiscal Needs and denoted as $NEED$ in this paper. It is sometimes pointed out that the central government takes advantage of LAT grants to control local spending by arbitrarily adjusting $NEED$. In addition to these possibly "centralized" aspects of LAT grants, the provision of local public services is often strongly regulated by the central government through various centralized legal frameworks.

In sum, although local bodies do not have to strictly follow these centrally-determined standards, they quite often cannot control their expenditures on some local public services because the basic legal and provisional frameworks of these local services are centrally determined. Hayashi (2000; 2006) provides critical reviews of empirical studies on flypaper effects in Japan and points out that these previous studies do not consider these institutional settings of the Japanese general grant and naively treat it as a "unconditional" and "lump-sum" grant.

In fact, this mandatory and centralized feature of local public services is part of the institutional basis of LAT grants: since the central government forces all local bodies to provide particular levels of local public services, fiscal resources for these services have to be guaranteed by the intergovernmental fiscal transfer which reflects the expected costs of these services. This feature of the LAT grant is officially referred to as a function of "fiscal resource guarantee".

According to the above figure, however, I would argue that LAT grants can be considered to be "unconditional" and "lump-sum" around the threshold V=0 regardless of the centralized features of these grants and local administration. In other words, around the threshold, $PostRev$ is well above $NEED$ and therefore the relatively "mandatory" local public services that are reflected in the calculation of $NEED$ can be financed even without the LAT grant. It is thus possible to assume that the marginal increase in the LAT grant around the threshold affects local bodies' expenditure in exactly the same way that standard "unconditional" and "lump-sum" grants do.

D Description of data arrangement[16]

Japan is a unitary state which has three-tier administrative authorities: the central government, 47 prefectures, and municipalities. Municipalities are classified into four categories: cities (shi), towns (cho), villages (son) and special districts (ku). Cities are generally larger than towns and villages and the minimum population requirement to become a city is 50,000. Even if the population of a city becomes less than 50,000, however, it does not have to become a town or village. The 23 special districts are all located in Tokyo prefecture and have similar duties to other municipalities but follow a different vertical fiscal equalization scheme managed by Tokyo prefecture. Cities and towns/villages have similar duties under the same fiscal equalization scheme (the LAT grant scheme), but cities have more responsibilities in several administrative areas.

In both Ando (2013) and this paper I only use city data. In addition, I drop so-called "designated" cities, which consisted of the 12 largest cities in Japan during the sample period. I exclude these cities from the sample because their response to the marginal increase in their LAT grants might be institutionally different from other cities as a result of the fact that some of the duties normally assigned to prefectures are delegated to them. Their administrative responsibility is thus larger than that of normal cities. Second, I also remove the cities that experienced amalgamation between 1975 and 1999 because the calculation of the LAT grants for these merged cities was affected by special measures. Because this special measure was in effect for 5 years after amalgamation, municipalities which merged before 1975 were not affected by this measure after 1980. Finally, there are some LAT-receiving municipalities whose need-capacity gap is clearly different from the amount of their LAT grant, possibly due to measurement errors or typos. Therefore, I drop 18 observations in which |Need-capacity gap – LAT grant per capita| is larger than 10,000 yen.

[16] This part is based on the online appendix of Ando (2013).

E Description of fiscal variables[17]

Expenditure need: $NEED$

This index measures the cost of a "standard" level of local public services for a municipality. It is officially referred to as "*Standard Fiscal Need*" (Kijun Zaisei Juyo Gaku) and calculated annually by the Ministry of Internal Affairs and Communications. *Standard Fiscal Need* is calculated as follows:

$$NEED_i = \sum_k (Mesaurement\ Unit_{ki} \times Unit\ Cost_k \times Adjustment\ Coefficient_{ki}),$$

where k expresses kth public service. *Measurement Unit* is in most cases the number or size of the beneficiaries of a particular service. *Unit Cost* is a kind of net standard cost per measurement unit for each service item. *Adjustment Coefficient* is a modification ratio that reflects the socio-economic diversity of a local body and modifies the unit cost in order to make it fit the local body's socio-economic circumstances.

Revenue capacity: CAP

CAP is an index that measures the fiscal revenue capacity of a municipality before fiscal equalization. It is officially referred to as "*Standard Fiscal Revenue*" (Kijun Zaisei Syunyu Gaku) and calculated annually by the Ministry of Internal Affairs and Communications. CAP is calculated as follows:

$$CAP_i = Standard\ Tax\ Revenues_i \times \frac{3}{4} + Transfer\ Tax\ revenue, etc_i,$$

where *Standard Tax Revenues* are estimated based on standard tax rates, standard tax collection rates, and estimated tax bases which are calculated using relevant statistics or past tax revenues. *Transfer Tax Revenue, etc.* represents the sum of revenues from *Local Transfer Tax* and *Special Grant for Traffic Safety Measures.* In brief, CAP captures the potential amount of local general revenues before fiscal equalization, which cannot be manipulated by municipalities in the short run.

There are two main reasons that *Standard Tax Revenue* is multiplied by 3/4. First, the remaining 1/4 of *Standard Tax Revenue* is excluded from the fiscal equalization process and left for municipalities so that they can cover some remaining

[17] This part is based on the online appendix of Ando (2013).

fiscal needs that are not taken into account by the *Standard Fiscal Needs* calculation. Second, this portion of tax revenue is excluded from the fiscal equalization process so that municipalities have some incentive to increase their local tax revenues by enhancing local economic growth. In other words, if the exact amount of *Standard Tax Revenue* were taken into account in CAP, LAT-receiving local bodies would have less incentive to enhance local economic growth because the increase in *Standard Tax Revenue* caused by this economic growth would be completely canceled out by the decrease in the LAT grant.

Revenue capacity (modified for a pre-determined covariate)

As is explained above, CAP itself does not represent "real" pre-equalization revenue capacity as it takes into account some policy objectives of the fiscal equalization scheme such as providing economic incentives to municipalities. We can, however, easily recover real pre-equalization revenue capacity by simply replacing 3/4 for 1 in the above definition of CAP.

When I use pre-equalization revenue capacity as a control variable, I use this modified version of revenue capacity that reflects the real pre-equalization revenue capacity of municipalities. However, because available statistics are only CAP and *Local Transfer Tax*, I have to assume that revenue from *Special Grant for Traffic Safety Measures* is negligible. This assumption should not be a major problem because the amount of *Special Grant for Traffic Safety Measures* is in general much smaller than the sum of *Standard Tax Revenues* and *Local Transfer Tax*.

I therefore estimate this "real" CAP as follows:

$$\begin{aligned}
RealCAP_i &= Standard\ Tax\ Revenues_i + Transfer\ Tax\ Revenue, etc._i \\
&= (CAP_i - Transfer\ Tax\ Reveneu, etc._i) \times \frac{4}{3} + Transfer\ Tax\ Reveneu, etc._i \\
&\simeq (CAP_i - Transfer\ Tax\ Revenue_i) \times \frac{4}{3} + Transfer\ Tax\ Revenue_i
\end{aligned}$$

F Descriptive statistics for other outcomes

Table 6: Descriptive statistics for other outcomes

Variable	Obs	Mean	Std. Dev.	Min	Max
Education					
Expenditure breakdowns (1000 yen, per capita)					
Kindergarden	12165	1.97	2.33	0.00	19.66
Elementary school	12280	11.00	7.31	1.78	102.87
Junior high school	12280	7.55	6.65	1.13	97.73
Social education	12270	9.51	8.30	0.56	182.80
Health & physical education	12251	9.83	7.19	0.26	120.16
Teacher-student ratio (per 1000 students)					
Kindergarden	12578	53.78	11.72	3.15	156.25
Elementary school	12616	47.69	11.58	30.34	121.71
Junior high school	12598	55.02	12.06	36.41	156.33
Social welfare					
Expenditure breakdowns (1000 yen, per capita)					
Social welfare for the elderly (estimated)*	12217	15.39	11.40	-29.43	318.48
Social welfare for children	12308	17.39	6.66	2.41	58.43
public asssitance	12236	11.42	11.11	0.54	183.00
Social welfare for others	12308	13.50	7.86	2.50	100.35
Recipients rate (per 1000 people/houshoulds)					
Public assistance recipients	9015	8.10	9.68	0.23	181.34
Public assistance housholds	9218	14.33	14.51	0.58	263.50

*Because the data of "Social welfare for the elderly" is not available until 1997, I estimate this statistic simply subtracting the other three breakdowns from the total social welfare expenditure. Fits are good if I compare the actual ones and the estimated one using the data 1997-2000(R^2 is more than 0.9). However, the minimum values of the estimated expenses are less than zero. I do not fix this inconsistency in the current draft.

G Preliminary analysis[18]

G.1 Continuous Density of the assignment variabel

A key identifying assumption for a valid RK design is that the density of the assignment variable is continuously differentiable at the threshold. Since the LAT grant is calculated by centrally-determined uniform formulas, there is little possibility that municipalities or the central government can precisely manipulate the need-capacity gap around the threshold. It may be suspected, however, that some institutional settings or unknown factors systematically affect the determination of whether or not a given municipality near the threshold becomes an LAT-grant receiver. I therefore conduct a density test analogous to that proposed by McCrary (2008) and presented by CLP (2009) and CLPW(2012) in the context of an RK design. Both estimation results and graphical analysis indicate that the density of the need-capacity gap is smooth at the threshold.

Table 7: RK estimates for need-capacity gap(bin size=2, $|V| < 50$)

	Order of Polynomical			
	(1)	(2)	(3)	(4)
Variables	One	Two	Three	Four
RK esitmates	-2.161***	-0.869	-0.357	0.325
	(0.672)	(1.172)	(2.944)	(5.030)
Observations	50	50	50	50
R-squared	0.901	0.980	0.981	0.981
AIC	494.1	419.3	420.3	423.3

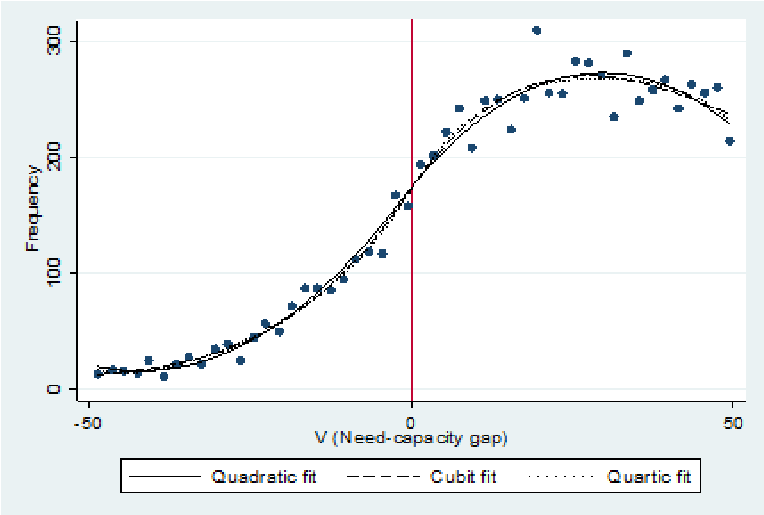
Notes: Heteroscedasticity-robust standard errors are in parenthesis.
***: P<0.01, *:p<0.05, *:p<0.1.

G.2 Conditunous covariates

According to Card et al. (2012), an important implication under the required conditions for a valid RK design is that any pre-determined covariate should have a conditional distribution which evolves smoothly around the threshold. In other words, there should be no kink at the threshold for any pre-determined covariate against the assignment variable.

[18]This part is mostly replicated from the online appendix of Ando (2013).

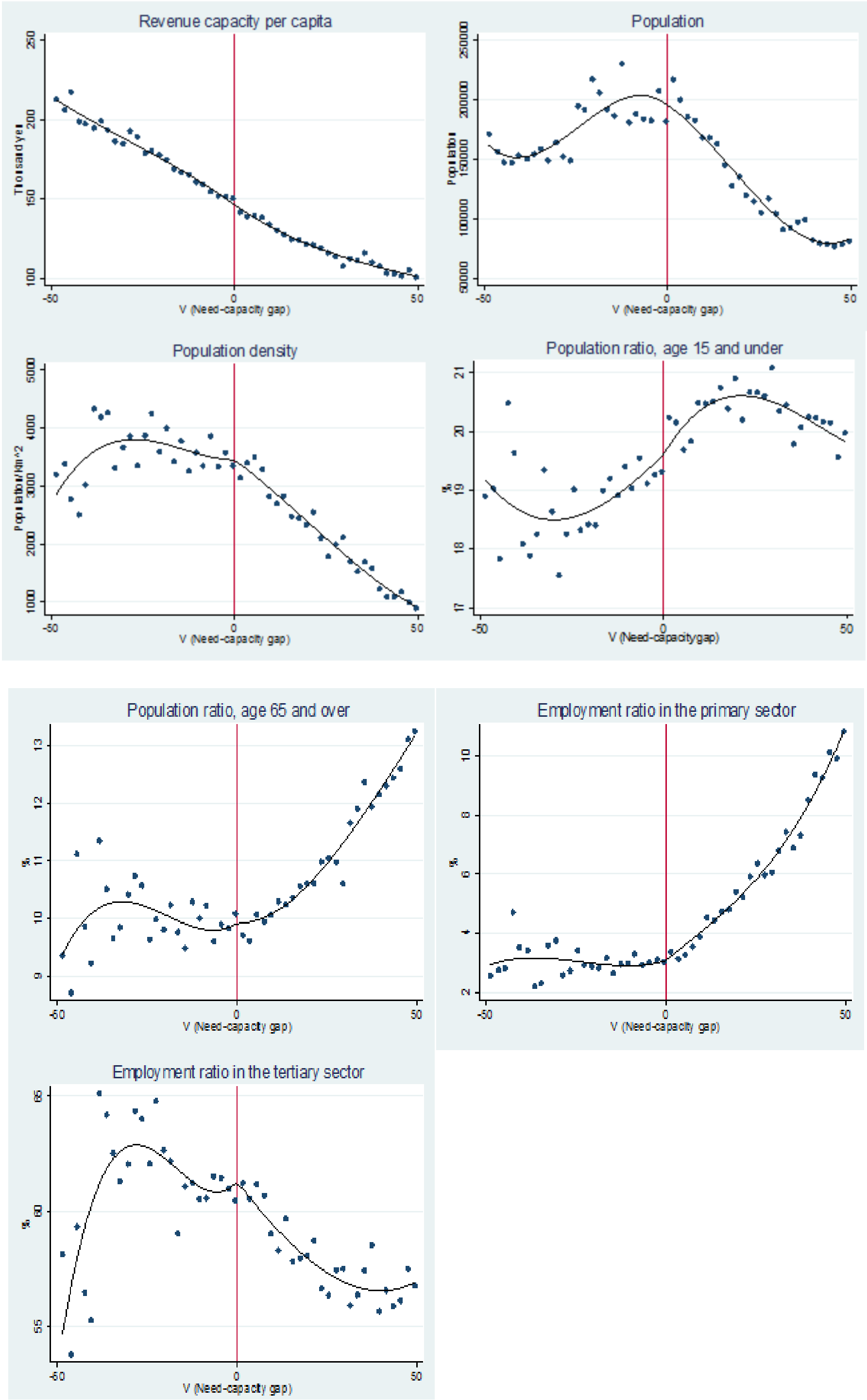
Figure 6: Density of need-capacity gap (bin size=2, bandwidth $|V| < 50$)



Notes: Bin size is 2 and fitted curves are based on RK estimation with local polynomial regressions. Fitted curves are generated based on the estimation with equation (3).

However, smooth nonlinear relation between a covariate and an assignment variable around the kink point could be picked up as a kink in RK estimation (Ando 2013). It may thus be hard to assert that there are no kinks whatsoever at the threshold for any covariate. Figure 7, however, at least indicates that no such kinks are visually apparent in the graphical representation of the data.

Figure 7: Bin-mean plots and cubic fits of covariates



Notes: Cubic fits are estimated at the both sides of the cutoff point, but continuity at the cutoff point is imposed. Bin size is 2 and bandwidth is $|V| < 50$. Sources: Reports on the Municipal Public Finance, Census, and CPI

H Supplementary results

Table 8: RK estimates for education expenditures

Polynomial order & bandwidth	Dependent variable				
	Kinder-garden	Elementary school	Junior high school	Social education	Health & Physical education
	(1)	(3)	(5)	(7)	(9)
Linear polynomial					
No	0.009	0.045**	0.070***	0.038	0.084***
	(0.013)	(0.019)	(0.015)	(0.025)	(0.026)
$\|V\|<60$	0.017	0.067***	0.070***	0.070**	0.116***
	(0.016)	(0.021)	(0.020)	(0.029)	(0.029)
$\|V\|<50$	0.010	0.085***	0.081***	0.062**	0.137***
	(0.016)	(0.022)	(0.022)	(0.029)	(0.033)
$\|V\|<40$	0.002	0.114***	0.089***	0.037	0.147***
	(0.016)	(0.025)	(0.026)	(0.032)	(0.036)
$\|V\|<30$	0.006	0.119***	0.054*	0.053	0.110**
	(0.019)	(0.033)	(0.030)	(0.044)	(0.044)
$\|V\|<20$	-0.007	0.115**	0.025	0.017	0.068
	(0.025)	(0.053)	(0.045)	(0.060)	(0.050)
$\|V\|<10$	0.073	-0.002	0.010	0.046	-0.135
	(0.046)	(0.089)	(0.088)	(0.105)	(0.119)
Quadratic polynomial					
No	-0.002	0.094***	0.099***	0.016	0.132***
	(0.018)	(0.028)	(0.026)	(0.040)	(0.040)
$\|V\|<60$	-0.023	0.137***	0.079*	0.037	0.185***
	(0.030)	(0.051)	(0.046)	(0.065)	(0.064)
$\|V\|<50$	-0.022	0.138**	0.039	0.014	0.117
	(0.037)	(0.061)	(0.053)	(0.074)	(0.076)
$\|V\|<40$	-0.034	0.082	-0.098	0.065	0.005
	(0.040)	(0.080)	(0.077)	(0.091)	(0.095)
$\|V\|<30$	-0.053	0.032	-0.052	-0.044	-0.036
	(0.048)	(0.107)	(0.095)	(0.129)	(0.111)
$\|V\|<20$	0.061	-0.132	0.088	0.113	-0.043
	(0.067)	(0.150)	(0.149)	(0.154)	(0.180)
$\|V\|<10$	0.151	-0.359	0.568	0.134	-0.448
	(0.131)	(0.300)	(0.419)	(0.367)	(0.346)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$. All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.

Table 9: RK estimates for social welfare expenditures

Polynomial order & bandwidth	Dependent variable			
	Welfare for aged	Welfare for children	Public assistance	Welfare for others
	(1)	(3)	(5)	(5)
Linear polynomial				
No	0.046**	-0.009	0.036	0.063***
	(0.020)	(0.028)	(0.041)	(0.022)
$\|V\|<60$	0.026	-0.003	0.072**	0.046**
	(0.020)	(0.032)	(0.032)	(0.023)
$\|V\|<50$	0.033	0.013	0.070**	0.048**
	(0.023)	(0.035)	(0.031)	(0.024)
$\|V\|<40$	0.033	0.010	0.071**	0.053**
	(0.027)	(0.040)	(0.033)	(0.027)
$\|V\|<30$	0.024	0.008	0.086**	0.069**
	(0.029)	(0.046)	(0.037)	(0.033)
$\|V\|<20$	-0.013	-0.038	0.042	0.065
	(0.030)	(0.062)	(0.050)	(0.041)
$\|V\|<10$	-0.027	-0.109	-0.098	0.075
	(0.072)	(0.118)	(0.092)	(0.062)
Quadratic polynomial				
No	-0.060	0.081*	0.156**	0.090***
	(0.101)	(0.047)	(0.070)	(0.031)
$\|V\|<60$	0.056	0.070	0.090	0.100**
	(0.046)	(0.071)	(0.064)	(0.049)
$\|V\|<50$	0.019	0.008	0.048	0.092*
	(0.042)	(0.081)	(0.070)	(0.052)
$\|V\|<40$	-0.047	-0.035	-0.021	0.120*
	(0.051)	(0.098)	(0.083)	(0.065)
$\|V\|<30$	-0.149*	-0.150	-0.104	0.055
	(0.083)	(0.123)	(0.104)	(0.077)
$\|V\|<20$	-0.109	-0.077	-0.222	0.075
	(0.106)	(0.173)	(0.147)	(0.100)
$\|V\|<10$	-0.302	-0.335	0.143	0.114
	(0.264)	(0.354)	(0.262)	(0.270)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$. All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.

Table 10: RK estimates for some welfare-related variables

	Dependent variable			
Polynomial order & bandwidth	Teacher-children ratio (nursery)	Teacher-children ratio (pub. nursery)	Public assistance recipients	Public assistance households
	(1)	(2)	(3)	(4)
Lniear Polynomial				
No	0.005	0.085	-0.051	-0.074
	(0.011)	(0.080)	(0.042)	(0.063)
|V|<60	0.004	0.086	0.047*	0.077*
	(0.015)	(0.098)	(0.027)	(0.040)
|V|<50	0.002	0.114	0.045*	0.078**
	(0.016)	(0.124)	(0.024)	(0.036)
|V|<40	-0.005	0.192	0.047*	0.086**
	(0.017)	(0.183)	(0.025)	(0.039)
|V|<30	-0.023	0.223	0.060*	0.107**
	(0.019)	(0.280)	(0.031)	(0.047)
|V|<20	-0.036	-0.377	0.040	0.097
	(0.026)	(0.264)	(0.041)	(0.063)
|V|<10	-0.040	0.147	-0.137*	-0.165
	(0.054)	(0.682)	(0.078)	(0.119)
Quadratic Polynomial				
No	0.010	0.087	0.177***	0.267***
	(0.017)	(0.130)	(0.066)	(0.092)
|V|<60	-0.036	0.462	0.047	0.102
	(0.031)	(0.307)	(0.057)	(0.086)
|V|<50	-0.046	0.526	0.028	0.080
	(0.034)	(0.399)	(0.062)	(0.094)
|V|<40	-0.088**	0.073	-0.016	0.015
	(0.042)	(0.621)	(0.075)	(0.113)
|V|<30	-0.097*	-0.362	-0.095	-0.081
	(0.052)	(0.717)	(0.090)	(0.135)
|V|<20	-0.051	0.709	-0.269**	-0.337*
	(0.074)	(0.766)	(0.118)	(0.180)
|V|<10	-0.218	1.441	-0.158	-0.040
	(0.169)	(1.589)	(0.223)	(0.333)

Notes: Standard errors are clustered by the municipality level. ***: $P < 0.01$, **:$p < 0.05$, *:$p < 0.1$. All estimation models include the regressors of revenue capacity, population, population density, population ratios of the elderly cohort and the young cohort, and the sectoral ratios of employment.