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Spatial patterns of flypaper effects for local expenditure by policy objective in Japan: A Bayesian approach

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ABSTRACT

The empirical work on local public finance has found that the marginal effect of lump-sum grants on expenditure is larger than that of income, thereby providing evidence of the "flypaper effect". However, most existing studies only employ single equation models to test the flypaper effect. In this paper, we specify a seemingly unrelated regression (SUR) model to examine the flypaper effect in Japan, primarily because other categories of expenditure influence the expenditure on particular policy objectives. We also include spatial interaction in our estimation model and employ a Bayesian approach in estimating our model. Our results show that SUR with a spatial error model is better for this purpose than several other specifications. Using this approach, we observe evidence of the flypaper effect in land development, police, education, and debt expenditure, and spatial interaction in sanitation, police, education, and disaster recovery expenditure.

1. Introduction

In seminal work, Bradford and Oates (1971) showed that the equivalence theorem regarding lump-sum grants and self-procured income is in evidence throughout the world. However, many empirical studies have found instead that the marginal effect of lump-sum grants on expenditure is larger than that of self-procured income. For example, there is voluminous literature on the flypaper effect. For the underlying theoretical framework, see Aronson and Munley (1996) and Brennan and Pincus (1996). In other work, Strumpf (1998) investigates the origins of the flypaper effect and Hines and Thaler (1995) and Turnbull (1998) reviews the theoretical and empirical literature.

In Japan, there is a huge system of grants known as the "local allocation tax grants (LAT grants) system".[1] In recent years, the total amount of LAT grants has exceeded 15 trillion yen accounting for nearly 20% of total local government revenue. The allocation of LAT grants is determined by certain formulations. The formulations are intended to support the expense of local public services. Since LAT grants are calculated by the general revenue, these grants are utilized for any purposes. For such grants system in Japan, there are several previous studies which use municipality-level data. For example, Nagamine (1988, 1995) used these grants to investigate the flypaper effect to total expenditure in Japan. Subsequently, Doi (1996) followed a similar line of inquiry and showed that the LAT grants system leads to a flypaper effect. In an alternative approach, Miyara and Fukushige (2001) used nonparametric methods and found the evidence of a flypaper effect relating to LAT grants. These researches showed that there is a problem in the intergovernmental transfers playing an important role in a centralized system of government as in Japan.

However, there is no existing research about the flypaper effect on the prefecture level (the state-level) in Japan, although there are some researches using the state-level data, for instance Dollery and Worthington (1995) analyzed state-level total expenditure in Australia and found the evidence of a flypaper effect. The reason why the lack of research at the prefecture-level in Japan is "reporting bias", which means that the significant results are easy to report but insignificant results are difficult to report. Thus, we checked this point in our pilot analysis, and failed to find evidence of a flypaper effect in total expenditure. The reason why the flypaper effect is not observed is that the coefficient of personal income includes zero in the 95% credible interval. This is because central government adjusts the dispersion of personal income by fiscal control. Therefore we divide the expenditure into

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[1] The LAT grants system in Japan is explained in Doi and Ihori (2009) and Ichimura and Bahl (2009).

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policy categories because the adjustment of the dispersion of personal income might be different in each policy category.

In addition, when we empirically consider the flypaper effect, we have some things to mention. First, we should notice that the dependent variable is either total expenditure or specific expenditures on certain policy objectives, such as on land development, public welfare, and so on. That is, we guess that each specific expenditure on certain policy objectives has different effects among expenditure by policy objectives. Because Baicker (2001) and Gordon (2004) also considered state-level expenditure in the US and identified flypaper effects in medicaid and education expenditure.[2] Moreover, it is considered that Japan is under the centralized system, and local government budget amount is affected from the central government's policy for each expenditure on policy objectives. Therefore, in this paper we focus on expenditure by policy objectives such as education or public welfare, with prefecture-level data corresponding to the state level in the US, Australia and other countries.

Second, we should take into account the correlation among the expenditure by policy objectives, because the total expenditure is also aggregated expenditure on all policy objectives. Thus, the expenditure on all other policy categories determines the expenditure on a particular policy objective. Consequently, we need to estimate expenditures as a whole expenditure system using a seemingly unrelated regression (SUR) model.

Finally, the spatial dependencies are not introduced in the empirical analysis in Japan. It is not observed directly but reported in the empirical analysis in other countries (see for example Case et al., 1993). Thus, we employ three SUR models with spatial dependencies. First, we use a spatial autoregressive (SAR) model, that the spatial dependencies treated as spillovers. Second, we use a spatial error (SEM) model, we treat them as spatial heterogeneities. Third, we use a spatial Durbin (SDM) model, they are thought as externalities. LeSage and Pace (2009) provide a detailed explanation of the interpretation of the models. In addition, LeSage and Pace (2009) also showed that the spatial model deal with the omitted variables problem. Therefore, in order to investigate of the flypaper effect accurately, we take the spatial dependencies into consideration.

The remainder of the paper is structured as follows. Section 2 explains the basic flypaper model. In Section 3, we present a SUR model with spatial dependencies, which is used in our empirical analysis. Section 4 provides details of the posterior analysis. In Section 5, we examine the empirical results and in Section 6, we discuss a brief conclusion.

2. Model

Following the model specification of Nagamine (1995) and Doi (1996), we estimate linear regression model as:

$$y_i = \beta_1 + \beta_2 w_i + \beta_3 z_i + \epsilon_i,$$

where y_i is public expenditure by the ith local government, w_i is personal income, z_i represents a per capita lump-sum grant and ϵ_i is the error term. In this research, we use the disposal income of ith region as the personal income w_i. If we translate the independent variable as x, our regression model will be:

$$y_i = \beta_1 + \beta_2 x_{i1} + \beta_3 x_{i2} + \epsilon_i.$$

When a flypaper effect exists, the marginal effect of a lump-sum grant on public expenditure is larger than that of personal income.

$$\frac{dy}{dz} > \frac{dy}{dw}$$

Therefore, we compare the coefficient of income, β_2, and that of lump-sum grants, β_3. If there is a flypaper effect, the following will hold:

$$\frac{\beta_3}{\beta_2} > 1.$$

3. Seeming unrelated regression models with spatial dependencies

In this section, we introduce SUR models with spatial dependencies as proposed by Kakamu et al. (2012). However, it first will be useful to describe the SUR model. Let y_{ij} and $\mathbf{x}_{ij} = (1, x_{ij2}, x_{ij3})$ be a dependent variable and a 1×3 vector of covariates on the ith unit ($i = 1, \ldots, n$) and jth equation ($j = 1, \ldots, J$), respectively. Then, the SUR model conditioned on parameters β_j and ω_{js} for $j, s = 1, \ldots, J$ is written as:

$$y_{ij} = \mathbf{x}_{ij}\beta_j + \epsilon_{ij}, \quad \text{with} \quad E\left[\epsilon_{ij} \cdot \epsilon_{is}\right] = \omega_{js}.$$

In matrix form, the equation for each equation j becomes:

$$\mathbf{y}_j = \mathbf{X}_j\beta_j + \epsilon_j, \quad \text{with} \quad E\left[\epsilon_j \cdot \epsilon_s'\right] = \omega_{js}\mathbf{I}_n,$$

where $\mathbf{y}_j$ and ϵ_j are $n \times 1$ vectors, $\mathbf{X}_j$ is a $n \times 3$ matrix of independent variables, and $\mathbf{I}_n$ is a $n \times n$ unit matrix. The equations for time periods 1 to J are combined as:

$$\begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_J \end{bmatrix} = \begin{bmatrix} \mathbf{X}_1 & 0 & \cdots & 0 \\ 0 & \mathbf{X}_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \mathbf{X}_J \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_J \end{bmatrix} + \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \\ \epsilon_J \end{bmatrix},$$

or grouped as:

$$\mathbf{y} = \mathbf{X}\beta + \epsilon, \quad \epsilon \sim N(0, \Omega \otimes \mathbf{I}_n), \tag{1}$$

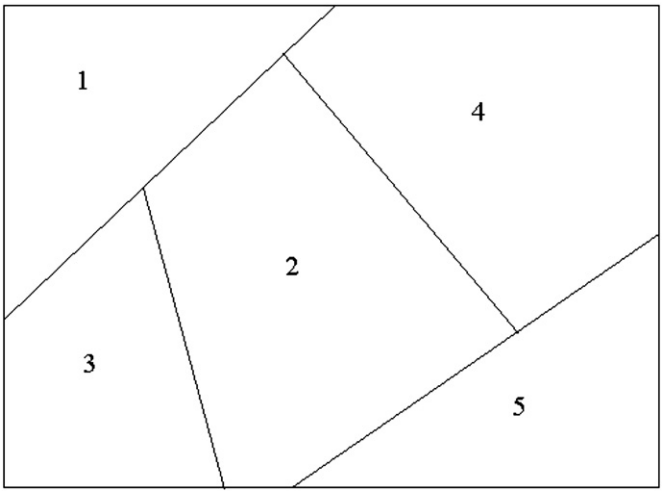

Fig. 1. Spatial unit example.

[2] In recent research, Rockoff (2010) considered flypaper effect on education.