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Spatial Crowding-out and Crowding-in Effects of Government Spending on the Private Sector in Japan

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SPATIAL CROWDING-OUT AND CROWDING-IN EFFECTS OF GOVERNMENT SPENDING ON THE PRIVATE SECTOR IN JAPAN*

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Abstract

Motivated by cross-jurisdictional private activities, this study proposes a fiscal spillovers channel to investigate the spatial crowding-out and crowding-in effects of government spending on the private sector in Japan. We demonstrate that there exist spatial autocorrelations in the private economic variables, intensifying the crowding-out effects of government consumption. On the contrary, when such spatial spillovers are controlled for, the crowding-out effects of public investment are shown to be negligible. Further, our subsample analysis reveals some noticeable regional differences between urban and rural areas, such as the partial crowding-in effects of government consumption on private consumption in Kanto (the Tokyo metropolitan area) and those of public investment on private consumption in Shikoku (a rural island). Our findings imply that policymakers should take into account such spatial spillovers and regional differences to rejuvenate the regional economy by stimulating private demand.

Keywords: Spatial spillover; Government spending; Crowding-out effect; Crowding-in effect

JEL Classification: E62; H30; R10

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1 Introduction

Fiscal policy effectiveness varies greatly depending on the extent of its crowding-out and crowding-in effects on the private sector. Since classic works such as Buiter (1977), whether government economic activity is harmful to private economic activity has been a central question in macroeconomics. Modern macroeconomic models suggest conflicting effects of government spending on private economic activities.[1] For example, owing to a negative wealth effect, the real business cycle (RBC) model suggests that a rise in government spending generates a decline in private consumption (e.g., Aiyagari *et al.*, 1990; Baxter and King, 1993). On the contrary, Galí *et al.* (2007) show that a positive response of private consumption to government spending can occur in a New Keynesian model with non-Ricardian households.[2] With regard to private investment, government spending can have both positive and negative effects depending on the setting of the parameters (e.g., the persistence of the government spending shock). Indeed, contrary to conventional wisdom, Woodford (1990) shows that public debt may crowd in private investment.[3]

Whether government spending harms or stimulates private economic activities is a crucial issue for the Japanese economy, especially for the revitalization of the deteriorating regional economy. Japan faces accelerating demographic aging, a declining population, and an excess concentration of population and industry in the Tokyo metropolitan area. As a result, the economic activity of the private sector is weakened, especially in rural areas, and effective fiscal policy to rejuvenate the regional economy is often discussed. In this context, Japan suffers from the highest debt-to-GDP ratio in the world, and accordingly, the government has to eliminate wasteful spending that harms private demand. Hence, it is desirable to understand whether government spending affects the private demand of not only the national economy but also the regional economy.

While many believe that spatial interactions play an important role in the regional economy, there is little evidence of the spatial fiscal policy effects within a country. When evaluating the government spending effects on the regional economy in Japan, policymakers must pay attention to the fact that the intranational regional economies interact with each other more strongly than do international ones. In other words, a considerable spatial interaction in private economic activities may exist across intranational jurisdictions (i.e., prefectures). Firstly, private consumption is a type of cross-jurisdictional activity at Japanese prefectural levels because the areas of consumption expenditure are borderless and unrestricted by administrative districts (i.e., prefectural borders). In addition to tourists, the residents near prefectural borders would routinely visit the markets in neighboring prefectures. This motivates us to introduce spatial correlations into prefectural private consumption. The introduction of spatial correlations into private consumption is also motivated by formal discussions of "crowding spillovers," as in Conley and Dix (1999) and Solé-Ollé (2006), who suppose that the number of consumers in a jurisdiction includes the residents in neighboring jurisdictions as well as the residents in the jurisdiction.[4] Moreover, as pointed out by Nakajima *et al.* (2012), the geographic location of Japanese firms is concentrated across prefectures. For example, the location pattern for the manufacturing sector is concentrated along the Pacific Belt Zone (i.e., the urban areas of Kanto, Chubu, Kinki, Chugoku, and Kyushu). If a geographic concentration of industrial activities in Japan exists in various industries, we would expect private investment to be positively correlated across neighboring prefectures.[5]

[1]The traditional IS-LM model predicts that government spending has a positive effect on private consumption, whereas it has a negative effect on private investment.

[2]Ganelli and Tervala (2009) theoretically show that the complementarity between government spending and private consumption plays an important role in explaining the positive response of the latter on the former.

[3]Since Aschauer's (1989) seminal work, a substantial number of studies have tested those effects in various countries and over various periods. See Erenburg (1993), Argimon *et al.* (1997), Blanchard and Perotti (2002), Voss (2002), Afonso and Aubyn (2009), Beetsma and Giuliodori (2011), and Ramey (2011).

[4]Bloch and Zenginobuz (2006) study the local public good spillover effects on the population distribution across jurisdictions. Bloch and Zenginobuz (2015) examine households' mobility effects on public good provision.

[5]The concentration of industrial activities has been investigated for many countries. See Ellison and Glaeser (1997, 1999) and Dumais *et al.* (2002) for the United States and Duranton and Overman (2008) for the United Kingdom. Alañon-Pardo *et al.* (forthcoming) demonstrate that in the manufacturing industries in Spain, the location decisions of new establishments depend on the characteristics of neighboring regions.

If such a spatial interaction among private economic activities exists, then a new channel of fiscal spillovers arises. In other words, the government spending effects in a jurisdiction are not exclusive to the private activities within that jurisdiction, but rather spill over to neighboring jurisdictions through the spatial autocorrelation in the private economic variables. When this channel of fiscal spillovers is not negligible, it is useful for policymakers to discriminate the direct crowding effects from the indirect ones caused by spillovers.

In this study, by allowing for spatial interactions between neighboring private sector activities, we explore the extent to which government spending crowds out or crowds in private demand in the Japanese economy. To this end, recent prefectural panel data are used for 2002 to 2013. The empirical model we use is expressed as a spatial autoregressive panel data model, which can isolate the indirect crowding-out and crowding-in effects caused by spillovers from the direct ones. These crowding effects, which are non-linear with the parameters and are complicated, can be estimated by using the Bayesian inference on the Markov chain Monte Carlo (MCMC) method.

Overall, we find that profound overestimation and underestimation are driven by misspecification ignoring the spatial interaction. To be precise, our channel of fiscal spillovers is non-trivial, intensifying the crowding-out effects of government consumption. On the contrary, when such fiscal spillovers are controlled for, public investment is no longer a prominently harmful factor for private demand, suggesting that it is more desirable than government consumption when stimulating the macroeconomy. Further, our subsample analysis reveals some noticeable regional differences. Among the key results, we find the partial crowding-in effects of government consumption on private consumption in Kanto (the Tokyo metropolitan area) and those of public investment on private consumption in Shikoku (a rural island). These results suggest that policymakers should take into account such spatial spillovers and regional differences to rejuvenate the regional economy without harming private demand.

This study contributes to the literature in the following respects. First, this study differs from all previous studies in that we analyze fiscal spillovers through the spatial correlations in private demand emanating from government spending in other jurisdictions. Although a strand of the literature investigates spatial productivity spillovers from government capital (public infrastructure) in neighboring areas, to the best of our knowledge, there is no empirical work in which spatial spillovers in private demand are considered to be crucial for assessing government spending effects.[6] Second, while some authors focus on the relationship between public and private investment and others concentrate on the relationship between public and private consumption, we use both data to uncover the differences between investment and consumption.[7] In particular, in the recent Japanese economy, disaggregated analyses have been necessary to advance our understanding of the effects of government spending on private economic activities and the resultant fluctuation in output.

The present study is closely related to Miyazaki (2016), who examines the crowding-out and crowding-in effects of public investment on private investment in Japan, using a prefecture panel data set.[8] Miyazaki (2016) divides the categories of private investment into multiple specific sectors and estimates a regression model as in Furceri and Sousa (2011), who investigate crowding effects by using panel data on 145 countries from 1960 to 2007. The empirical model we use follows their frameworks, but it is extended to deal with the spatial effects between Japanese intranational regions. This study is also related to Kondoh (2011), Brückner and Tuladhar (2014), and Miyazaki (2017), who use prefectural data to examine the

[6] Only recently has the body of work examining international fiscal spillovers been growing (e.g., Auerbach and Gorodnichenko, 2013). For empirical studies of spatial productivity spillovers from government capital, see Holtz-Eakin and Schwartz (1995) and Boarnet (1998). Li and Li (2013) point out the spillover effect of road investment on firms in neighboring provinces in China. Another strand of the literature investigates spatial autocorrelations in local government expenditure and revenue (e.g., Revelli, 2005).

[7] Exceptions are Beetsma and Giuliodori (2011) and Furceri and Sousa (2011), who consider both private consumption and investment, but they disregard the differences between government consumption and public investment. Furceri and Sousa (2011) focus on government consumption because of data availability. Finn (1998) points out that government goods purchases and government employment have contrasting effects on private activities in the United States. Malizard (2015) pays special attention to defense spending and investigates the effects on private investment in France.

[8] Fujii *et al.* (2013) analyze the effects of public investment on sectoral private investment, using a factor-augmented vector autoregressive model for quarterly macroeconomic data in Japan.

effects of fiscal policy on the regional economy in Japan.[9] Kondoh (2011) presents vector autoregression analyses. Brückner and Tuladhar (2014) provide estimates of local government spending multipliers. Miyazaki (2017) estimates discretionary changes in prefectural public investment in Japan and shows that the estimated changes intensify prefectural business cycle fluctuations.

The remainder of this paper is structured as follows. In Section 2, we set up our spatial autoregressive panel data model, model the effects of government spending spillovers, and define the direct or indirect crowding-out/-in effects. In Section 3, the main results are presented. Section 4 concludes the study and refers to remaining issues.

2 Empirical methodology

2.1 Modeling government spending spillovers

Our approach is based on a panel data model as in Furceri and Sousa (2011) and Miyazaki (2016). Moreover, this study uses the idea of a spatial interaction, because regional economic zones are created in private economic activities that are mutually dependent among neighboring regions. A key point here is that private economic zones are not necessarily within administrative districts. Thus, we estimate the impacts of government spending on the private sector by using panel data models extended with a spatial interaction such as spatial autoregressive panel data models. Since the seminal work of Anselin (1988), spatial autoregressive panel data models have been used in a wide range of economics fields such as environmental economics, urban economics, and industrial organization.[10]

Let y_{it} and x_{it} for $i = 1, \ldots, n$ and $t = 1, \ldots, T$ denote the growth rate of private consumption (investment) and first differences of the share of government expenditure (government consumption and public investment) in prefectural domestic product (PDP) in the ith prefecture at time t (Furceri and Sousa, 2011; Miyazaki, 2016).[11] Applied to the dependence relations between the dependent variable y_{it}, we have following expression:

$$y_{it} = \rho \sum_{j=1}^{n} w_{ij} y_{jt} + \beta x_{it} + \phi x_{i,t-1} + \epsilon_{it}, \quad (1)$$

$$\epsilon_{it} = \mu_i + \sqrt{\lambda_i} z_{it}, \quad z_{it} \sim \mathcal{N}(0, \sigma^2), \quad (2)$$

where β and ϕ are the slope parameters of the simultaneous and one-year lagged exogenous variables.[12] Note that, following Miyazaki (2016), we disregard longer lagged variables to focus on the current interaction between government spending and private economic activities. Since government spending at the end of a fiscal year may influence private economic activities in the next fiscal year, one-year lagged variables are included in (1). μ_i denotes the individual effect and ϵ_{it} follows a normal distribution including heteroskedasticity. λ_i denotes the auxiliary parameter for the heteroskedasticity of the error distribution across regions, and this follows the hierarchical prior distribution:

$$\lambda_i \sim \mathcal{IG}\left(\nu/2,\ \nu/2\right),$$

where $\mathcal{IG}$ and ν represent the inverse gamma distribution and unknown parameters of the degree of freedom, respectively. Then, the error term follows the Student's t-distribution; it is assumed that $\nu > 2$ to satisfy a finite variance. ρ and w_{ij} mean the spatial correlation and weight matrix. Regarding the

[9] With the exception of Kondoh (2011), Brückner and Tuladhar (2014), and Miyazaki (2016, 2017), there is no empirical work in which the short-run impact of Japanese fiscal policy on intranational regions is assessed. On the contrary, a vast empirical literature has studied the effects of Japanese fiscal policy by using macroeconomic data. See Bayoumi (2001) and Ihori *et al.* (2003).

[10] For excellent textbooks and overviews on spatial econometrics, see LeSage and Pace (2009) and Elhorst (2014).

[11] Romer and Romer (2010) adopt a similar model to quantify the effect of tax changes on output.

[12] Auerbach and Gorodnichenko (2013) assume that government spending spillover shocks emanate directly from other regions and thereby examine the cross-country spillover effects of government spending on output. On the contrary, in the present model, fiscal spillovers are mediated indirectly through the spatial correlations between private economic activities.

constant term μ_i, we assume a random effects model to avoid increasing the number of parameters. Thus, μ_i follows a normal distribution with zero mean and variance τ^2.

In spatial econometrics, w_{ij} plays an important role. The weight matrix provides the structure of spatial or geographical relationships. Approaches used to set the elements of the weight matrix include the contiguity dummy, inverse distance, and nearest neighborhood methods, but we do not know the exact form. As Stakhovych and Bijmolt (2009) recommended the contiguity dummy in their numerical experiments, we adopt the same approach.

2.2 Definition of the crowding effect

The estimated parameters have a straightforward interpretation as the partial derivative of the dependent variable with respect to the explanatory variables. In spatial econometric models, the interpretation of the parameters becomes more complicated.

Let $\mathbf{y}_t = (y_{1t}, \ldots, y_{nt})'$, $\mathbf{x}_t = (x_{1t}, \ldots, x_{nt})'$ and $\boldsymbol{\epsilon}_t = (\epsilon_{1t}, \ldots, \epsilon_{nt})'$, respectively. By collecting the weights w_{ij} in an $n \times n$ matrix $\mathbf{W} = \{w_{ij}\}$, the model of (1) is rewritten as

$$\mathbf{y}_t = S_\beta(\mathbf{W})\mathbf{x}_t + S_\phi(\mathbf{W})\mathbf{x}_{t-1} + (\mathbf{I}_n - \rho\mathbf{W})^{-1}\boldsymbol{\epsilon}_t, \tag{3}$$

where $S_\beta(\mathbf{W}) = \beta(\mathbf{I}_n - \rho\mathbf{W})^{-1}$, $S_\phi(\mathbf{W}) = \phi(\mathbf{I}_n - \rho\mathbf{W})^{-1}$ and $\mathbf{I}_n$ denoting the $n \times n$ unit matrix. The simultaneous marginal effects are defined as the derivatives of y_{it} with respect to x_{jt}:

$$\frac{\partial y_{it}}{\partial x_{jt}} = S_\beta(\mathbf{W})_{ij},$$

and the lagged marginal effects are defined as the derivatives of y_{it} with respect to $x_{j,t-1}$:

$$\frac{\partial y_{it}}{\partial x_{j,t-1}} = S_\phi(\mathbf{W})_{ij}.$$

Furthermore, the long-term derivatives of y_i with respect to x_j are given by

$$\frac{\partial y_i}{\partial x_j} = (\beta + \phi)(\mathbf{I}_n - \rho\mathbf{W})^{-1} = S^*(\mathbf{W})_{ij}. \tag{4}$$

Thus, we interpret the degree of the crowding-out or -in effect as the value of $\partial y_i/\partial x_j$. The own derivative for the ith area shown in (4) results in expression $S^*(\mathbf{W})_{ii}$ that measures the impact on the crowding-out/-in effect in that region. On the contrary, the element of the matrix $S^*(\mathbf{W})_{ij}$ ($i \neq j$) represents the effect from neighboring regions. Therefore, the diagonal elements of the matrix $S^*(\mathbf{W})_{ii}$ contain the direct crowding-out/-in effect and the off-diagonal elements denote the indirect crowding-out/-in effect.

As changes in government spending differ by prefecture and region, Pace and LeSage (2006) suggest summary measures such as the average total impacts, average direct impact, and average indirect impact, calculated by

$$\begin{aligned} \bar{M}_{total} &= n^{-1}\boldsymbol{\iota}_n' S^*(\mathbf{W})\boldsymbol{\iota}_n, \\ \bar{M}_{direct} &= n^{-1} trace(S^*(\mathbf{W})), \\ \bar{M}_{indirect} &= \bar{M}_{total} - \bar{M}_{direct}, \end{aligned}$$

where $\boldsymbol{\iota}_n$ is the $n \times 1$ vector of ones. While we introduce the above average impacts in the case of the long-term marginal effects, they can be represented in a similar fashion in the simultaneous and lagged marginal effects as well.

2.3 Estimation approach

In the following empirical analysis, we estimate the above model and the crowding-out/-in effects by using a Bayesian technique such as MCMC for the following reasons.[13]

[13] Details of the Bayesian inference are described in the Appendix.

First, while areal data such as state data are widely used in economic analyses, in the present analysis, the length of time series T is small and the sample size is not sufficiently large. This aspect becomes serious, especially in our subsample analysis below. Maximum likelihood methods depend on their asymptotic properties, whereas the Bayesian method does not because the latter evaluates the posterior distributions of the parameters conditioned on the data.

Second, the MCMC approach takes advantage of drawing the direct and indirect effects by using posterior samples of the parameters and evaluating not only the point estimates but also their distribution inference. While these effects have a non-linear relationship with the parameters of the model, it enables us to show the dispersions and credible intervals on these effects.

Third, while we assume Student's-t errors to allow for fat tails for the heteroskedasticity of the error distribution across regions, the Bayesian method can be applied without difficulty.

3 Empirical analysis

3.1 Data set

Our panel data set comprises recent annual observations of the 47 prefectures in Japan from FY 2001 to FY 2013. The period is limited to after the 2000s to provide useful implications for current Japanese fiscal policies. We obtained all data from the Annual Report on Prefectural Accounts. All data are in real terms and based on the System of National Accounts 1993 (93SNA); they can be retrieved from the website of Japan's Cabinet Office.

[Insert Table 1 around here]

Table 1 reports the dependent and explanatory variables in our application. As stated above, following Furceri and Sousa (2011) and Miyazaki (2016), the dependent variables (i.e., private consumption and investment) are the growth rate and the explanatory variables (i.e., government expenditure, government consumption, and public investment) are divided by PDP and are first differenced.[14] Hence, our sample period begins from FY 2002. Furthermore, we examine whether these data have spatial dependency by using Moran's I test. The null hypothesis of no spatial autocorrelation in private consumption and investment is rejected.

[Insert Figure 1 around here]

Figure 1 plots the series. Compared with private consumption, private investment is more volatile. Notably, private investment fluctuates drastically in several prefectures in FY 2011 because of the Great East Japan Earthquake that occurred in March 2011. In Iwate prefecture, probably because of the post-earthquake recovery, the growth rate of private investment reaches approximately 40% in FY 2011. On the contrary, private investment declines by approximately 10% in FY 2011 in Fukushima prefecture owing to the Fukushima Daiichi nuclear disaster that occurred in the aftermath of the earthquake.

Government expenditure increases because of the economic stimulus packages implemented in the recent financial crisis and subsequent Great Recession. For recovery and reconstruction, sudden increases in FY 2011 are seen in tsunami-hit areas such as Iwate, Miyagi, and Fukushima prefectures. Overall, in the 2000s until the Great Recession, government consumption remains about the same, whereas public investment tends to decrease.

Regarding the spatial weight matrix, we use the contiguity dummy variables (see Anselin, 1988). Excluding the Okinawa region, Japan consists of four major islands: Hokkaido, Honshu, Shikoku, and Kyushu. Although these four islands are geographically separated, we assume that they are connected by trains and roads (see Kakamu *et al.*, 2010).[15] Thus, a spatial weight matrix is used in the row-standardized form.

[14] Note that government expenditure is the sum of government consumption and public investment.

[15] For example, we consider Hokkaido to be contiguous with Honshu through the Seikan Railway Tunnel. Honshu and Shikoku are contiguous through the Awaji and Seto Bridges, and Kyushu is contiguous with Honshu through the Kanmon Tunnel and Bridge.

3.2 Overall estimation results

We perform the MCMC procedure by generating $20,000$ draws in a single sample path and discarding the first $10,000$ draws as the initial burn-in. First, we focus on the results using the full sample and evaluate the models by using the deviance information criterion (DIC) to confirm that spatial correlation improves the performance of the estimation.[16] Table 2 summarizes the results of the DIC to compare the spatial panel model with the non-spatial panel model in which $\rho = 0$. From the table, the values of the DIC of the spatial panel models are lower than those of the models without spatial correlation. This finding implies that it is necessary to consider the spatial interaction to estimate the regional crowding effects.

[Insert Tables 2 and 3 around here]

Table 3 presents the estimated results of the spatial panel models, where Mean, SD, and 95%CI represent the posterior mean, standard deviation, and 95% credible interval, respectively.[17] The results in Table 3 are consistent with those in Table 2. Regardless of the regression type, all the posterior means of ρ are positive and none of the credible intervals contains 0, meaning that both private consumption and investment are spatially correlated. From the results of β, one can note that all the posterior means are negative; however, they differ depending on the components of government spending. The credible intervals of government consumption (types 2 and 5) do not contain 0, whereas those of public investment (types 3 and 6) do. This difference between the components of government spending indicates that government consumption causes larger crowding-out effects than public investment. Excluding the case of type 5, the posterior means of ϕ are close to 0, suggesting that the lagged effects are relatively less than the simultaneous ones. Incidentally, the posterior mean for ν shows that the errors deviate substantially from normality, supporting our flexible modeling for heteroskedasticity across the regions of the error term.

[Insert Table 4 around here]

By calculating the average direct and indirect impacts defined in the preceding section, Table 4 shows the marginal effects in our spatial panel model together with those in the non-spatial panel model. In type 1, all the posterior means of the simultaneous effects are negative and the credible intervals do not contain 0. In the non-spatial model, the value is -0.280, whereas it is -0.410 in the spatial model, calculated by adding the direct effect (-0.201) to the indirect effect (-0.209). This result suggests that the non-spatial model underestimates the crowding-out effect of government expenditure on private consumption. By comparing types 2 (government consumption) and 3 (public investment), our disaggregated analysis reveals that the crowding-out effect on private consumption is attributed to government consumption. The posterior means in type 2 are negative, and an enormous amount of indirect effects are observed. On the contrary, most of the credible intervals in type 3 contain 0.

Turning to the case of private investment, the crowding-out effects of government expenditure are shown to be larger, and a difference between the spatial and non-spatial models exists again. In the non-spatial model, the long-term value is -2.624, whereas it is -3.076 in the spatial model (i.e., the direct effect is -1.477 and the indirect effect is -1.599). From the outcomes of type 5, one can see that the crowding-out effects of government consumption on private investment are the largest in all types of regressions. More interestingly, distinguishing between the government consumption and investment components of government expenditure uncovers the opposite effect due to spatial spillovers. That is, the non-spatial model leads to an underestimation of the crowding-out effects in type 5 (government consumption), whereas it results in an overestimation in type 6 (public investment). Notably, in the spatial model of type 6 (public investment), all the credible intervals contain 0, unlike the case of the non-spatial model.

[16] See Spiegelhalter *et al*. (2002) for the details of this criterion.

[17] We confirm that the random draws generated by using the MCMC method converge to the random draws generated from the target distribution. See Geweke (1992) for a detailed discussion of the convergence diagnostic. All the results in this study are calculated by using Ox version 6.2 (see Doornik, 2006).

This finding implies that we cannot confirm the obvious crowding-out effects of public investment on private investment when taking into account the considerable spatial spillover.

In summary, we conclude that both the overestimation and the underestimation of the marginal effects are driven by misspecification ignoring the spatial interaction. Our spatial model estimation confirms that government consumption crowds out private sector activities, especially private investment. The negative effects of government consumption are consistent with the results of Furceri and Sousa (2011), who examine national-level panel data in a non-spatial panel model.[18] On the contrary, public investment exercises little influence on private demand. These results suggest that the use of public investment rather than government consumption is preferable to boost the Japanese economy through a large fiscal expansion. Given that the marginal effects are evaluated as the average measures, it is likely that being surrounded by many prefectures rather than few increases the indirect effects.

3.3 Regional estimation results

In the next step, we examine the possibility of a regional difference in the marginal effects in our spatial panel model. To the extent that economic structures can differ by region, the key empirical question is how the effects of government spending vary regionally. The answer to this question is interesting to not only academics of public finance, but also government policymakers who should design fiscal policies based on the situation in each region.

The empirical strategy is straightforward. Our data set is divided into seven subsample regions (Hokkaido-Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu), following the classification of the Ministry of Economy, Trade and Industry, and the estimated marginal effects in each region are compared. Table 5 lists the prefectures in each subsample region.

[Insert Tables 5 and 6 around here]

As before, we first check the specification of the models for the subsamples. Table 6 shows the subsample results of the DIC. Except for the case of type 2 for Chubu and type 1 for Shikoku, all the DIC values of the spatial panel models are lower, suggesting that the spatial panel model is selected.

[Insert Tables 7–13 around here]

Tables 7–13 report the estimated results of the spatial panel models for the subsamples. All the posterior means of ρ are positive, none of the credible intervals contains 0, and for the most part these reinforce the above model selection. By comparing the posterior means of ρ, we detect several remarkable differences between the seven subsamples. In most of the subsamples, the spatial correlation of private consumption (types 1–3) appears to be weaker than that of private investment. On the contrary, in Kyusyu, the spatial correlation of private consumption is stronger than that of private investment. The subsample outcome for Shikoku exhibits a relatively weak spatial correlation for private consumption.

[Insert Tables 14–20 around here]

For the seven subsamples, Tables 14–20 display the estimated marginal effects in our spatial panel model and those in the non-spatial panel model. In addition to the overestimation and underestimation of the marginal effects in the non-spatial model, we can confirm some non-negligible regional differences.

In Hokkaido-Tohoku, all the posterior means of type 6 are positive, whereas the credible intervals contain 0. In Kanto, which corresponds to the Tokyo metropolitan area, a partial crowding-in effect can be seen in type 2. To be precise, only in the lagged effects of type 2 does government consumption considerably crowd in private consumption (the posterior means are positive and the credible intervals do not contain 0). In Chubu, the non-spatial model tends to overestimate the crowding-out effects in types 2, 4, 5, and 6. Conversely, it underestimates them in type 3. Our spatial model indicates that it is likely that

[18] As stated by Furceri and Sousa (2011), the negative effects on private consumption are consistent with the basic RBC and New Keynesian models, whereas those on private investment are consistent with the textbook IS-LM model.

in Kinki and Chugoku, private consumption is free of the influence of government expenditure and its two constituents. Moreover, the outcome in Chugoku suggests that the non-spatial model overestimates the crowding-out effects in type 6. As with the case of Kanto, a partial crowding-in effect can be found in the case of type 3 in Shikoku. In other words, public investment crowds in private consumption in Shikoku, although only in the lagged effects. In Kyushu, while the non-spatial model exhibits strong crowding-in effects of public investment on private consumption, the results in the spatial model are shown to be inconsiderable since the credible intervals contain 0. This finding implies that the overestimation of the crowding-in effects is driven by the non-spatial model.

While acknowledging that it is difficult to fully explain why such regional differences are observed, one possible explanation for the partial crowding-in effect in the Tokyo metropolitan area (Kanto) stems from the excess concentration of population. Owing to adequate revenue, the local governments can provide satisfactory administrative services such as public order, public education, and childcare. As suggested by Ganelli and Tervala (2009), if complementarity between private consumption and the above types of government consumption exists, we can expect a positive response of private consumption to government consumption. Another possible explanation might be provided by recent DSGE frameworks. Although the standard RBC model predicts a negative response of private consumption to government consumption through households' dynamic optimization, the adequate revenue of local governments might alleviate such negative responses. Moreover, the partial crowding-in effect in Shikoku might be traced to the role of productive public capital, as shown by Baxter and King (1993) and others. In other words, while Shikoku is a rural mountainous island and a relatively less developed area, more public capital such as roads, ports, airports, and soil and water conservation may improve productivity and therefore increase private consumption in the economy.

4 Concluding remarks

The extent to which fiscal policy affects the private sector is crucial to its effectiveness and relevant to Japanese regional economies. To better understand these effects, this study models a fiscal spillovers channel through the spatial interaction between private economic activities and attempts to quantify the crowding-out and crowding-in effects by using recent Japanese prefectural panel data. This research is fruitful for policymakers as well as for bridging the gaps in the literature on macroeconomics, public economics, and regional economics.

Our fiscal spillover results broadly support the positive correlations of the private economic activities between neighboring prefectures. Consequently, it is suggested that ignoring such spatial correlations leads to misleading conclusions about the fiscal policy effects on the private sector. Moreover, we demonstrate that there exist some remarkable regional differences between urban and rural areas in the crowding-out and crowding-in effects. Understandably, our results have important policy implications for rejuvenating national and regional economies by stimulating private demand. Knowledge on these sizable spatial spillovers and regional differences is beneficial to Japanese policymakers, who must address the urgent task of revitalizing the regional economy and eliminating wasteful spending to ensure fiscal reconstruction.

This study could be extended in a number of directions. First, we used recent data to provide implications for current fiscal policies in Japan. However, it might also be meaningful to extend the sample period and test structural breaks. Second, since our empirical results showed that the spillover effects differ across regions, it is necessary to examine the heterogeneous coefficients spatial autoregressive panel data model proposed by LeSage *et al.* (2017). Moreover, while our focus is limited to Japanese prefectures, the analysis could be applied to other subnational levels such as U.S., Canadian, and German states as well as national levels (e.g., European countries). These topics will be discussed in our future research.

A Bayesian inference

This study estimated the model by using the Bayesian inference (e.g., the MCMC method). First, it is necessary to specify the likelihood of the model. We can rewrite the model in vector form as

$$\mathbf{y} = \rho(\mathbf{I}_T \otimes \mathbf{W})\mathbf{y} + \beta\mathbf{x} + \phi\mathbf{x}_{-1} + \boldsymbol{\epsilon}, \quad \boldsymbol{\epsilon} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{\Omega}),$$

where $\mathbf{y} = (\mathbf{y}_1', \ldots, \mathbf{y}_T')'$, $\mathbf{x} = (\mathbf{x}_1', \ldots, \mathbf{x}_T')'$, $\mathbf{x}_{-1} = (\mathbf{x}_0', \ldots, \mathbf{x}_{T-1}')'$, $\boldsymbol{\epsilon} = (\boldsymbol{\epsilon}_1', \ldots, \boldsymbol{\epsilon}_T')'$ and

$$\boldsymbol{\Omega} = \tau^2(\mathbf{J}_T \otimes \mathbf{I}_n) + \sigma^2\, \mathbf{I}_T \otimes \bar{\boldsymbol{\lambda}},$$

with $\mathbf{J}_T = \boldsymbol{\iota}_T\boldsymbol{\iota}_T'$, $\bar{\boldsymbol{\lambda}} = diag(\lambda_1, \ldots, \lambda_n)$ and $\boldsymbol{\iota}_T$ denoting the $T \times 1$ vector of ones. To simplify the notation, we set $\boldsymbol{\theta} = (\beta, \rho, \phi, \sigma^2)'$, $\boldsymbol{\lambda} = (\lambda_1, \ldots, \lambda_n)$, and $\mathbf{X} = \{\mathbf{x}_t\}_{t=0}^T$. Given the initial explanatory variable $\mathbf{x}_0$, the likelihood of a random effect is as follows:

$$\mathscr{L}(\mathbf{y}|\boldsymbol{\theta}, \nu, \boldsymbol{\lambda}, \mathbf{W}, \mathbf{X}) = (2\pi)^{-\frac{nT}{2}}|\boldsymbol{\Omega}|^{-\frac{1}{2}}|\mathbf{I}_n - \rho\mathbf{W}|^T \exp\left[-\frac{1}{2}\mathbf{e}'\boldsymbol{\Omega}^{-1}\mathbf{e}\right], \tag{5}$$

where $\mathbf{e} = \mathbf{y} - \beta\mathbf{x} - \phi\mathbf{x}_{-1}$.

Since we adopt a Bayesian approach, we complete the model by specifying the prior distribution over the parameters. Thus, we apply the following prior distribution:

$$p(\boldsymbol{\theta}, \nu) = p(\tau^2)p(\sigma^2)p(\boldsymbol{\beta})p(\rho)p(\phi)p(\nu).$$

Given a prior distribution and the likelihood in (5), the joint posterior distribution can be expressed as

$$p(\boldsymbol{\theta}, \nu, \boldsymbol{\lambda}|\mathbf{y}, \mathbf{W}, \mathbf{X}) \propto p(\boldsymbol{\theta}, \nu)p(\boldsymbol{\lambda}|\nu)\mathscr{L}(\mathbf{y}|\boldsymbol{\theta}, \nu, \boldsymbol{\lambda}, \mathbf{W}, \mathbf{X}).$$

Finally, we assume the following proper prior distribution:

$$\begin{aligned}
&\tau^2 \sim \mathcal{IG}(\delta_0/2, s_0/2),\ \sigma^2 \sim \mathcal{IG}(\delta_0^*/2, s_0^*/2),\ \beta \sim \mathcal{N}(\beta_0, \Sigma_{\beta 0}),\\
&\rho \sim \mathcal{U}(\omega_{\min}^{-1}, \omega_{\max}^{-1}),\ \phi \sim \mathcal{N}(\phi_0, \Sigma_{\phi 0}),\ \nu \sim \mathcal{G}(a_0, b_0)I(\nu > 2),
\end{aligned}$$

where $\mathcal{IG}$ and $\mathcal{G}$ denote an inverse gamma distribution and gamma distribution and $I(\cdot)$ is the indicator function that takes one if the condition in the parentheses is satisfied and zero otherwise. $\omega_{\min}$ and $\omega_{\max}$ are the minimum and maximum eigenvalues of the weight matrix $\mathbf{W}$. As shown by Elhorst (2014), if $\mathbf{W}$ is row-standardized, the range of ρ is $(\omega_{\min}^{-1}, \omega_{\max}^{-1})$. Thus, we assign a uniform distribution with support on the interval $(\omega_{\min}^{-1}, \omega_{\max}^{-1})$. For the prior distribution of ν, we assume the truncated gamma distribution to satisfy a finite variance.

The MCMC approach must use multiple iterations to evaluate the marginal posterior distribution in the joint posterior distribution. It is analytically difficult to evaluate the marginal posterior distribution if the joint posterior distribution is complicated. Then, we draw the parameters from the full conditional distributions that use Markov sampling and Monte Carlo integration to approximate the full conditional distribution. This enables us to draw the parameters except ν by using the Gibbs sampler as in Mills and Parent (2014). To draw ν, we employ the acceptance rejection Metropolis–Hastings algorithm, extended by Watanabe (2001).

Finally, we set the hyperparameters to

$$\begin{aligned}
&\beta_0 = 0,\ \Sigma_{\beta 0} = 10,\ \phi_0 = 0,\ \Sigma_{\phi 0} = 10,\ \delta_0 = 4.0,\ s_0 = 0.05,\\
&\delta_0^* = 2.0,\ s_0^* = 0.05,\ a_0 = 1.2,\ b_0 = 0.03.
\end{aligned}$$

These hyperparameters are used in the overall and subsample estimations.

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Table 1: Data set

Abbreviation	Dependent variable	Explanatory variable
Type 1	Private consumption	Government expendeture / Prefectural domestic products
Type 2	Private consumption	Government consumption / Prefectural domestic products
Type 3	Private consumption	Public investment / Prefectural domestic products
Type 4	Private investment	Government expendeture / Prefectural domestic products
Type 5	Private investment	Government consumption / Prefectural domestic products
Type 6	Private investment	Public investment / Prefectural domestic products

Table 2: Model comparison using the DIC and full sample

Model	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Spatial panel	2050.60	2030.92	2061.39	3142.83	3116.00	3169.62
Non-spatial panel	2246.97	2206.37	2268.40	3405.00	3348.51	3494.11

Table 3: Estimated results using the full sample

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.566	0.040	0.487	0.639	0.580	0.034	0.516	0.645
β	-0.179	0.057	-0.291	-0.067	-1.063	0.212	-1.479	-0.646
ϕ	0.064	0.058	-0.047	0.178	-0.245	0.192	-0.621	0.125
σ^2	2.457	0.322	1.851	3.128	21.742	2.738	16.628	27.311
τ^2	0.308	0.136	0.097	0.623	0.032	0.032	0.006	0.116
ν	4.388	1.146	2.560	7.044	4.895	1.289	2.824	7.763
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.547	0.041	0.466	0.624	0.549	0.035	0.477	0.616
β	-0.489	0.108	-0.701	-0.276	-2.538	0.355	-3.229	-1.842
ϕ	0.064	0.058	-0.047	0.178	-0.874	0.336	-1.534	-0.220
σ^2	2.347	0.331	1.745	3.048	20.867	2.619	16.100	26.343
τ^2	0.358	0.145	0.134	0.693	0.040	0.050	0.006	0.170
ν	4.086	1.059	2.389	6.516	4.839	1.279	2.750	7.762
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.582	0.037	0.509	0.649	0.621	0.033	0.554	0.684
β	-0.102	0.091	-0.280	0.074	-0.403	0.306	-0.998	0.192
ϕ	0.092	0.095	-0.092	0.283	-0.066	0.285	-0.624	0.493
σ^2	2.507	0.330	1.904	3.184	22.510	2.880	17.264	28.468
τ^2	0.320	0.143	0.098	0.661	0.041	0.043	0.006	0.160
ν	4.447	1.147	2.543	7.031	4.986	1.389	2.777	8.160

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 4: Estimated marginal effects using the full sample

	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Type 1: Private consumption & Government expenditure									
Simultaneous	-0.201	-0.325	-0.075	-0.209	-0.365	-0.076	-0.280	-0.422	-0.139
Lagged	0.072	-0.053	0.198	0.073	-0.059	0.207	0.206	0.057	0.360
Long term	-0.129	-0.316	0.059	-0.136	-0.346	0.060	-0.074	-0.292	0.147
Type 2: Private consumption & Government consumption									
Simultaneous	-0.543	-0.775	-0.311	-0.527	-0.802	-0.298	-0.872	-1.126	-0.625
Lagged	0.086	-0.139	0.313	0.083	-0.139	0.307	0.196	-0.058	0.457
Long term	-0.457	-0.808	-0.111	-0.444	-0.827	-0.102	-0.676	-1.066	-0.288
Type 3: Private consumption & Public investment									
Simultaneous	-0.116	-0.318	0.083	-0.128	-0.365	0.089	-0.058	-0.282	0.166
Lagged	0.104	-0.105	0.317	0.112	-0.118	0.343	0.343	0.099	0.589
Long term	-0.012	-0.296	0.276	-0.016	-0.337	0.299	0.285	-0.056	0.625
Type 4: Private investment & Government expenditure									
Simultaneous	-1.200	-1.655	-0.738	-1.300	-1.846	-0.804	-2.065	-2.581	-1.545
Lagged	-0.277	-0.702	0.142	-0.299	-0.772	0.161	-0.559	-1.052	-0.069
Long term	-1.477	-2.100	-0.845	-1.599	-2.328	-0.923	-2.624	-3.351	-1.908
Type 5: Private investment & Government consumption									
Simultaneous	-2.821	-3.560	-2.076	-2.748	-3.688	-1.960	-4.469	-5.312	-3.608
Lagged	-0.971	-1.698	-0.246	-0.944	-1.690	-0.242	-1.795	-2.634	-0.963
Long term	-3.793	-4.890	-2.660	-3.692	-5.002	-2.569	-6.265	-7.558	-4.998
Type 6: Private investment & Public investment									
Simultaneous	-0.466	-1.151	0.223	-0.580	-1.451	0.287	-1.193	-1.955	-0.412
Lagged	-0.076	-0.721	0.569	-0.097	-0.927	0.721	-0.137	-0.886	0.613
Long term	-0.543	-1.365	0.299	-0.677	-1.756	0.386	-1.330	-2.271	-0.381

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 5: Contents of regions

Region	Prefectures
Hokkaido-Tohoku	Hokkaido Aomori, Iwate, Miyagi, Yamagata, Fukushima, Niigata
Kanto	Yamanashi, Nagano, Ibaragi, Chiba, Tokyo, Kanagawa
	Gunma, Saitama, Tochigi,
Chubu	Toyama, Ishikawa, Fukui, Shizuoka, Gifu, Aichi, Mie
Kinki	Shiga, Kyoto, Hyogo, Osaka, Nara, Wakayama
Chugoku	Yamaguchi, Tottori, Hiroshima, Okayama, Shimane
Shikoku	Ehime, Tokushima, Kagawa, Kochi
Kyushu	Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, Okinawa

Table 6: Model comparison using the DIC and subsamples

Model	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Hokkaido-Tohoku						
Spatial panel	305.10	298.43	310.87	564.15	545.38	565.94
Non-spatial panel	334.74	319.06	341.19	596.60	575.21	592.52
Kanto						
Spatial panel	379.71	368.46	378.67	568.11	565.36	568.64
Non-spatial panel	396.77	384.08	406.17	616.73	616.93	633.28
Chubu						
Spatial panel	309.79	314.24	310.49	457.59	454.10	465.78
Non-spatial panel	322.04	312.82	328.60	489.04	477.74	517.02
Kinki						
Spatial panel	314.63	317.72	314.43	399.40	395.96	404.54
Non-spatial panel	326.43	327.48	329.73	412.89	409.45	425.67
Chugoku						
Spatial panel	251.35	253.09	250.05	362.52	359.94	372.39
Non-spatial panel	263.32	263.29	264.23	372.23	371.51	381.19
Shikoku						
Spatial panel	216.04	212.25	211.09	271.07	264.37	272.69
Non-spatial panel	215.64	213.94	211.27	277.46	273.94	279.96
Kyushu						
Spatial panel	357.13	346.68	359.76	586.08	580.44	587.75
Non-spatial panel	387.50	397.64	382.49	593.17	588.28	598.14

Table 7: Estimated results using the subsample of Hokkaido-Tohoku

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.614	0.057	0.502	0.719	0.733	0.016	0.701	0.763
β	-0.195	0.073	-0.338	-0.051	-0.405	0.392	-1.142	0.396
ϕ	0.020	0.073	-0.122	0.164	0.175	0.394	-0.600	0.956
σ^2	1.564	0.333	1.014	2.323	29.930	9.667	14.121	52.304
τ^2	0.092	0.110	0.008	0.375	0.082	0.199	0.007	0.437
ν	31.882	35.245	3.289	133.241	4.404	2.824	2.075	10.828
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.584	0.061	0.462	0.696	0.684	0.026	0.633	0.736
β	-0.511	0.145	-0.792	-0.227	-1.734	0.670	-2.995	-0.372
ϕ	-0.008	0.145	-0.297	0.276	-0.084	0.719	-1.471	1.362
σ^2	1.444	0.322	0.921	2.175	25.813	9.029	11.652	46.740
τ^2	0.148	0.162	0.010	0.580	0.082	0.180	0.007	0.460
ν	26.898	30.577	3.036	112.51	3.806	1.950	2.058	8.828
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.637	0.057	0.525	0.748	0.726	0.018	0.692	0.762
β	-0.185	0.115	-0.410	0.043	0.071	0.579	-1.058	1.222
ϕ	0.075	0.121	-0.166	0.311	0.253	0.622	-0.959	1.485
σ^2	1.642	0.34 0	1.077	2.414	30.651	9.772	14.833	52.522
τ^2	0.084	0.104	0.008	0.366	0.072	0.140	0.007	0.386
ν	35.015	37.517	3.567	144.073	4.840	3.189	2.087	13.139

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 8: Estimated results using the subsample of Kanto

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.684	0.046	0.594	0.770	0.828	0.035	0.761	0.893
β	-0.042	0.184	-0.407	0.317	-0.581	0.515	-1.609	0.404
ϕ	0.129	0.173	-0.217	0.458	-0.132	0.42	-0.951	0.706
σ^2	2.268	0.642	1.212	3.749	13.838	3.526	7.792	21.618
τ^2	0.281	0.287	0.013	1.019	0.061	0.105	0.007	0.325
ν	5.486	3.235	2.166	13.786	10.663	13.05	2.269	44.496
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.636	0.049	0.538	0.731	0.828	0.034	0.761	0.892
β	-0.338	0.262	-0.854	0.165	-0.829	0.744	-2.283	0.617
ϕ	0.553	0.254	0.058	1.056	-0.541	0.652	-1.81	0.747
σ^2	2.066	0.598	1.108	3.436	13.567	3.517	7.39	21.353
τ^2	0.347	0.317	0.019	1.152	0.062	0.111	0.006	0.317
ν	5.097	2.866	2.132	12.487	10.528	14.182	2.269	43.15
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.680	0.050	0.579	0.776	0.860	0.022	0.815	0.901
β	0.249	0.297	-0.344	0.816	-0.375	0.719	-1.818	1.012
ϕ	-0.261	0.295	-0.846	0.315	0.098	0.649	-1.172	1.376
σ^2	2.251	0.645	1.218	3.750	13.481	3.603	7.313	21.465
τ^2	0.288	0.296	0.014	1.069	0.06 0	0.097	0.006	0.307
ν	5.474	3.522	2.146	14.287	8.776	9.435	2.227	33.192

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 9: Estimated results using the subsample of Chubu

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.518	0.057	0.409	0.632	0.803	0.032	0.740	0.867
β	-0.227	0.203	-0.632	0.176	-0.891	0.452	-1.767	-0.008
ϕ	-0.242	0.183	-0.609	0.118	0.108	0.427	-0.724	0.935
σ^2	3.115	0.992	1.556	5.426	15.484	3.717	9.215	23.998
τ^2	0.099	0.155	0.007	0.476	0.066	0.126	0.006	0.353
ν	4.554	2.282	2.106	10.618	25.005	29.415	2.833	108.113
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.546	0.056	0.436	0.655	0.774	0.045	0.680	0.861
β	-0.217	0.377	-0.958	0.524	-1.848	0.843	-3.491	-0.222
ϕ	-0.188	0.358	-0.890	0.527	-0.363	0.807	-1.926	1.211
σ^2	3.206	1.028	1.618	5.630	15.408	3.670	8.993	23.649
τ^2	0.156	0.225	0.008	0.749	0.072	0.141	0.007	0.390
ν	4.512	2.253	2.104	10.235	26.222	31.748	2.685	114.221
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.505	0.054	0.398	0.610	0.856	0.026	0.804	0.908
β	-0.325	0.279	-0.884	0.205	-0.633	0.619	-1.841	0.582
ϕ	-0.416	0.269	-0.948	0.107	0.352	0.588	-0.803	1.501
σ^2	3.187	1.037	1.609	5.648	15.705	3.801	9.166	24.288
τ^2	0.084	0.134	0.007	0.418	0.068	0.130	0.006	0.376
ν	4.607	2.302	2.104	10.537	26.161	31.336	2.870	115.045

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 10: Estimated results using the subsample of Kinki

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.531	0.059	0.414	0.646	0.635	0.039	0.558	0.708
β	-0.362	0.339	-1.040	0.297	-1.000	0.693	-2.355	0.377
ϕ	-0.321	0.340	-0.990	0.338	-0.340	0.685	-1.698	0.997
σ^2	6.379	1.917	3.265	10.901	23.746	9.290	10.013	45.747
τ^2	0.118	0.255	0.007	0.753	0.092	0.264	0.007	0.575
ν	15.204	20.789	2.331	67.145	3.849	1.994	2.063	9.167
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.566	0.056	0.453	0.672	0.630	0.040	0.553	0.707
β	-0.307	0.557	-1.398	0.795	-1.797	0.963	-3.673	0.132
ϕ	-0.438	0.534	-1.496	0.609	-0.460	1.033	-2.489	1.573
σ^2	6.508	1.917	3.346	10.882	22.606	8.660	9.664	43.232
τ^2	0.146	0.299	0.007	0.926	0.090	0.232	0.007	0.509
ν	15.458	21.565	2.304	74.018	3.697	1.759	2.060	8.022
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.555	0.060	0.439	0.669	0.702	0.034	0.637	0.768
β	-0.493	0.475	-1.414	0.458	-0.053	1.028	-2.067	1.952
ϕ	-0.247	0.511	-1.272	0.742	-0.598	0.979	-2.539	1.303
σ^2	6.292	1.885	3.181	10.684	24.408	9.516	9.943	47.159
τ^2	0.128	0.260	0.007	0.852	0.094	0.231	0.007	0.570
ν	13.685	19.093	2.256	64.391	3.750	2.058	2.056	8.440

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 11: Estimated results using the subsample of Chugoku

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.527	0.057	0.417	0.637	0.629	0.051	0.526	0.728
β	-0.435	0.272	-0.969	0.101	-1.329	0.724	-2.717	0.104
ϕ	0.140	0.26	-0.378	0.652	-0.142	0.698	-1.523	1.212
σ^2	5.301	1.825	2.524	9.463	36.687	11.445	18.147	62.955
τ^2	0.100	0.204	0.007	0.581	0.090	0.360	0.007	0.508
ν	10.674	13.997	2.184	47.698	18.991	24.553	2.336	89.597
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.516	0.066	0.378	0.640	0.662	0.052	0.560	0.767
β	-0.403	0.475	-1.354	0.516	-2.300	1.091	-4.431	-0.146
ϕ	0.406	0.441	-0.461	1.264	-0.095	1.013	-2.145	1.887
σ^2	5.495	1.886	2.540	9.852	34.372	11.328	15.887	60.503
τ^2	0.106	0.195	0.007	0.597	0.085	0.212	0.007	0.506
ν	12.121	16.687	2.224	55.866	16.626	22.662	2.287	81.592
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.543	0.060	0.426	0.660	0.738	0.045	0.648	0.826
β	-0.622	0.448	-1.488	0.274	-0.426	1.099	-2.574	1.694
ϕ	0.117	0.418	-0.720	0.947	-0.216	1.036	-2.268	1.800
σ^2	5.270	1.910	2.345	9.907	38.652	11.658	20.06	65.101
τ^2	0.108	0.220	0.007	0.596	0.100	0.251	0.007	0.626
ν	8.468	10.594	2.152	33.728	22.684	27.863	2.484	103.933

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 12: Estimated results using the subsample of Shikoku

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.281	0.080	0.128	0.438	0.551	0.071	0.412	0.688
β	-0.498	0.382	-1.243	0.266	-0.576	0.768	-2.094	0.889
ϕ	0.263	0.389	-0.506	1.035	0.008	0.645	-1.268	1.234
σ^2	8.299	3.166	3.597	15.972	26.035	10.526	10.264	51.158
τ^2	0.085	0.242	0.007	0.479	0.090	0.269	0.007	0.529
ν	12.778	17.137	2.192	60.000	12.074	17.148	2.177	62.339
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.313	0.088	0.137	0.480	0.515	0.045	0.425	0.606
β	-0.830	0.596	-2.030	0.324	-1.800	1.004	-3.749	0.216
ϕ	-0.715	0.564	-1.813	0.413	-0.499	0.970	-2.421	1.430
σ^2	7.762	3.089	3.139	15.298	23.172	8.970	9.026	44.262
τ^2	0.087	0.215	0.007	0.494	0.093	0.252	0.007	0.569
ν	9.290	12.174	2.136	41.798	12.512	16.926	2.187	61.925
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.279	0.077	0.122	0.426	0.649	0.063	0.519	0.768
β	-0.898	0.547	-1.980	0.157	0.686	1.090	-1.513	2.786
ϕ	1.291	0.539	0.221	2.344	-0.071	0.924	-1.854	1.757
σ^2	7.394	2.862	3.166	14.344	24.930	9.937	9.840	48.552
τ^2	0.136	0.325	0.007	0.898	0.089	0.258	0.007	0.510
ν	13.367	17.783	2.217	63.309	9.572	12.743	2.149	45.529

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 13: Estimated results using the subsample of Kyushu

	Private consumption				Private investment			
	Type 1				Type 4			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.727	0.044	0.639	0.808	0.160	0.034	0.093	0.227
β	-0.113	0.155	-0.413	0.195	-1.337	0.647	-2.592	-0.039
ϕ	0.127	0.159	-0.183	0.437	-0.372	0.657	-1.663	0.914
σ^2	2.715	0.819	1.432	4.613	47.007	12.230	25.666	75.052
τ^2	0.113	0.186	0.007	0.577	0.079	0.175	0.007	0.46 0
ν	5.623	3.792	2.132	15.322	11.765	14.698	2.354	44.846
	Type 2				Type 5			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.703	0.046	0.612	0.792	0.184	0.028	0.128	0.239
β	-0.643	0.300	-1.226	-0.058	-3.054	1.204	-5.406	-0.710
ϕ	0.138	0.299	-0.448	0.737	-0.960	1.219	-3.362	1.449
σ^2	2.475	0.750	1.271	4.202	44.534	12.065	24.560	71.398
τ^2	0.113	0.156	0.008	0.523	0.079	0.186	0.007	0.444
ν	4.753	2.959	2.106	11.883	8.849	8.560	2.289	28.756
	Type 3				Type 6			
Parameter	Mean	SD	95%CI		Mean	SD	95%CI	
ρ	0.740	0.042	0.654	0.819	0.205	0.041	0.124	0.289
β	0.102	0.229	-0.350	0.547	-0.798	0.897	-2.549	0.976
ϕ	0.079	0.230	-0.367	0.531	-0.448	0.886	-2.218	1.261
σ^2	2.722	0.773	1.472	4.511	47.886	12.752	25.825	76.337
τ^2	0.123	0.193	0.008	0.631	0.077	0.187	0.007	0.394
ν	5.715	4.156	2.149	15.956	10.875	11.181	2.332	41.788

Note: Mean, SD, 95%CI represent the posterior mean, the standard deviation, 95% credible interval, respectively.

Table 14: Estimated marginal effects using the subsample of Hokkaido-Tohoku

Type 1: Private consumption & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.237	-0.410	-0.062	-0.278	-0.538	-0.069	-0.248	-0.422	-0.070
Lagged	0.025	-0.148	0.200	0.029	-0.180	0.244	0.061	-0.117	0.240
Long term	-0.213	-0.469	0.050	-0.249	-0.601	0.055	-0.187	-0.456	0.083

Type 2: Private consumption & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.605	-0.931	-0.275	-0.638	-1.138	-0.271	-0.818	-1.139	-0.488
Lagged	-0.009	-0.354	0.327	-0.011	-0.388	0.361	-0.028	-0.364	0.313
Long term	-0.614	-1.126	-0.099	-0.649	-1.321	-0.102	-0.846	-1.354	-0.328

Type 3: Private consumption & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.230	-0.512	0.054	-0.292	-0.731	0.067	-0.140	-0.441	0.152
Lagged	0.093	-0.204	0.385	0.119	-0.263	0.536	0.174	-0.146	0.492
Long term	-0.137	-0.547	0.266	-0.173	-0.745	0.347	0.034	-0.421	0.491

Type 4: Private investment & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.561	-1.589	0.544	-0.962	-2.751	0.914	-0.271	-1.344	0.793
Lagged	0.244	-0.833	1.336	0.428	-1.403	2.349	-0.026	-1.045	0.971
Long term	-0.317	-1.808	1.260	-0.535	-3.100	2.171	-0.297	-1.820	1.232

Type 5: Private investment & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-2.245	-3.841	-0.497	-3.224	-5.564	-0.750	-3.010	-4.792	-1.180
Lagged	-0.100	-1.880	1.820	-0.109	-2.656	2.839	-1.428	-3.263	0.355
Long term	-2.345	-4.807	0.363	-3.334	-6.818	0.569	-4.437	-7.068	-1.732

Type 6: Private investment & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	0.093	-1.466	1.669	0.140	-2.545	2.766	0.998	-0.464	2.458
Lagged	0.346	-1.326	2.043	0.580	-2.220	3.460	0.445	-1.056	1.923
Long term	0.440	-1.687	2.595	0.719	-2.845	4.277	1.443	-0.530	3.390

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 15: Estimated marginal effects using the subsample of Kanto

Type 1: Private consumption & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.050	-0.490	0.410	-0.066	-0.770	0.716	-0.211	-0.605	0.177
Lagged	0.160	-0.270	0.574	0.258	-0.431	0.988	0.335	-0.066	0.722
Long term	0.110	-0.558	0.765	0.192	-0.877	1.370	0.124	-0.496	0.719
Type 2: Private consumption & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.399	-1.011	0.197	-0.531	-1.428	0.282	-0.652	-1.207	-0.106
Lagged	0.656	0.070	1.242	0.878	0.095	1.814	0.866	0.342	1.394
Long term	0.256	-0.659	1.154	0.347	-0.897	1.663	0.213	-0.621	1.022
Type 3: Private consumption & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	0.312	-0.414	1.040	0.517	-0.615	1.926	0.217	-0.474	0.886
Lagged	-0.318	-1.025	0.398	-0.483	-1.636	0.683	-0.240	-0.947	0.470
Long term	-0.007	-1.119	1.121	0.034	-1.679	2.061	-0.023	-1.092	1.022
Type 4: Private investment & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.880	-2.400	0.707	-2.346	-6.677	2.281	-2.814	-4.014	-1.585
Lagged	-0.202	-1.486	1.154	-0.548	-4.421	3.568	-0.682	-1.861	0.489
Long term	-1.082	-3.022	1.009	-2.894	-8.480	3.260	-3.496	-5.184	-1.791
Type 5: Private investment & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-1.255	-3.395	1.065	-3.344	-9.469	3.453	-4.254	-6.084	-2.406
Lagged	-0.839	-2.844	1.212	-2.333	-8.383	3.624	-1.781	-3.610	0.059
Long term	-2.094	-5.222	1.134	-5.677	-14.801	3.563	-6.035	-8.794	-3.240
Type 6: Private investment & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.621	-3.036	1.793	-1.910	-9.752	6.263	-2.310	-4.208	-0.374
Lagged	0.173	-1.999	2.388	0.579	-6.532	8.118	-0.122	-2.050	1.800
Long term	-0.448	-3.579	2.758	-1.331	-11.480	9.536	-2.432	-5.102	0.312

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 16: Estimated marginal effects using the subsample of Chubu

	Spatial Panel						Non-Spatial Panel		
Type 1: Private consumption & Government expenditure									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.256	-0.706	0.209	-0.202	-0.559	0.196	-0.633	-1.084	-0.195
Lagged	-0.276	-0.694	0.134	-0.233	-0.626	0.111	-0.032	-0.454	0.391
Long term	-0.532	-1.127	0.064	-0.435	-0.960	0.055	-0.664	-1.297	-0.079
Type 2: Private consumption & Government consumption									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.247	-1.093	0.627	-0.208	-0.980	0.633	-1.146	-1.839	-0.445
Lagged	-0.221	-1.045	0.601	-0.214	-1.070	0.531	-0.062	-0.754	0.652
Long term	-0.468	-1.706	0.739	-0.422	-1.635	0.714	-1.208	-2.269	-0.118
Type 3: Private consumption & Public investment									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.365	-0.989	0.236	-0.281	-0.783	0.211	-0.652	-1.423	0.032
Lagged	-0.470	-1.075	0.122	-0.374	-0.906	0.100	-0.282	-1.015	0.433
Long term	-0.834	-1.646	-0.025	-0.655	-1.342	-0.021	-0.934	-2.016	0.076
Type 4: Private investment & Government expenditure									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-1.441	-2.829	-0.014	-3.064	-6.237	-0.030	-3.739	-5.020	-2.447
Lagged	0.189	-1.164	1.590	0.447	-2.479	3.769	-1.368	-2.579	-0.138
Long term	-1.253	-3.063	0.695	-2.617	-6.594	1.630	-5.108	-6.812	-3.343
Type 5: Private investment & Government consumption									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-2.795	-5.033	-0.382	-5.316	-10.108	-0.783	-7.109	-9.185	-4.949
Lagged	-0.527	-2.852	2.002	-0.925	-5.553	4.450	-3.093	-5.160	-0.963
Long term	-3.323	-6.588	0.336	-6.241	-12.820	0.752	-10.202	-13.165	-7.031
Type 6: Private investment & Public investment									
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-1.194	-3.462	1.206	-3.113	-9.463	3.400	-2.713	-4.731	-0.729
Lagged	0.711	-1.529	3.105	1.991	-4.053	9.277	-1.023	-2.939	0.916
Long term	-0.483	-3.367	2.706	-1.122	-8.784	8.065	-3.736	-6.251	-1.176

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 17: Estimated marginal effects using the subsample of Kinki

	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Type 1: Private consumption & Government expenditure									
Simultaneous	-0.412	-1.170	0.345	-0.363	-1.109	0.329	-0.512	-1.237	0.223
Lagged	-0.364	-1.114	0.394	-0.313	-1.008	0.380	-0.625	-1.396	0.150
Long term	-0.775	-1.714	0.198	-0.675	-1.582	0.198	-1.137	-2.143	-0.113
Type 2: Private consumption & Government consumption									
Simultaneous	-0.353	-1.596	0.947	-0.328	-1.579	1.037	-0.663	-1.815	0.490
Lagged	-0.509	-1.735	0.709	-0.497	-1.802	0.739	-0.747	-1.902	0.422
Long term	-0.861	-2.691	0.979	-0.825	-2.695	1.079	-1.409	-3.080	0.288
Type 3: Private consumption & Public investment									
Simultaneous	-0.572	-1.637	0.530	-0.559	-1.748	0.500	-0.436	-1.473	0.620
Lagged	-0.279	-1.443	0.879	-0.238	-1.327	0.983	-0.801	-1.978	0.386
Long term	-0.851	-2.147	0.487	-0.797	-2.149	0.506	-1.238	-2.604	0.188
Type 4: Private investment & Government expenditure									
Simultaneous	-1.228	-2.884	0.479	-1.484	-3.566	0.631	-2.394	-3.955	-0.848
Lagged	-0.419	-2.103	1.224	-0.516	-2.630	1.581	-0.678	-2.184	0.834
Long term	-1.648	-3.898	0.669	-2.000	-4.854	0.880	-3.071	-5.093	-1.062
Type 5: Private investment & Government consumption									
Simultaneous	-2.197	-4.439	0.168	-2.612	-5.421	0.207	-3.692	-5.767	-1.557
Lagged	-0.558	-3.045	2.001	-0.647	-3.725	2.555	-1.513	-3.776	0.701
Long term	-2.755	-6.286	0.912	-3.259	-7.600	1.187	-5.205	-8.364	-1.965
Type 6: Private investment & Public investment									
Simultaneous	-0.049	-2.702	2.712	0.001	-3.859	4.602	-1.301	-3.500	0.923
Lagged	-0.807	-3.430	1.728	-1.257	-5.492	2.629	-0.521	-2.814	1.720
Long term	-0.857	-4.345	2.705	-1.256	-6.758	4.401	-1.822	-4.782	1.124

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 18: Estimated marginal effects using the subsample of Chugoku

	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Type 1: Private consumption & Government expenditure									
Simultaneous	-0.502	-1.120	0.118	-0.423	-1.020	0.105	-0.548	-1.174	0.047
Lagged	0.162	-0.443	0.751	0.136	-0.389	0.677	0.204	-0.371	0.795
Long term	-0.340	-1.117	0.453	-0.287	-1.002	0.397	-0.344	-1.144	0.442
Type 2: Private consumption & Government consumption									
Simultaneous	-0.462	-1.555	0.596	-0.377	-1.380	0.519	-0.644	-1.694	0.366
Lagged	0.461	-0.535	1.425	0.362	-0.504	1.186	0.778	-0.195	1.773
Long term	-0.001	-1.597	1.522	-0.015	-1.454	1.306	0.135	-1.373	1.611
Type 3: Private consumption & Public investment									
Simultaneous	-0.730	-1.759	0.312	-0.660	-1.780	0.270	-0.502	-1.504	0.512
Lagged	0.141	-0.829	1.125	0.141	-0.706	1.132	-0.124	-1.085	0.831
Long term	-0.589	-1.605	0.398	-0.519	-1.493	0.369	-0.626	-1.640	0.404
Type 4: Private investment & Government expenditure									
Simultaneous	-1.672	-3.364	0.133	-1.898	-4.062	0.167	-2.821	-4.461	-1.199
Lagged	-0.172	-1.899	1.559	-0.176	-2.204	1.963	-0.918	-2.500	0.655
Long term	-1.844	-4.059	0.421	-2.074	-4.689	0.536	-3.739	-5.789	-1.682
Type 5: Private investment & Government consumption									
Simultaneous	-3.010	-5.665	-0.202	-3.782	-7.542	-0.273	-4.277	-6.753	-1.704
Lagged	-0.105	-2.777	2.595	-0.073	-3.529	3.725	-1.494	-3.891	0.935
Long term	-3.115	-6.835	0.811	-3.855	-8.881	1.138	-5.771	-9.179	-2.168
Type 6: Private investment & Public investment									
Simultaneous	-0.595	-3.756	2.722	-0.856	-5.990	4.908	-2.216	-4.802	0.363
Lagged	-0.317	-3.411	2.729	-0.496	-5.689	4.579	-0.551	-3.007	1.856
Long term	-0.911	-4.085	2.592	-1.352	-6.603	4.566	-2.767	-5.466	-0.001

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 19: Estimated marginal effects using the subsample of Shikoku

Type 1: Private consumption & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.517	-1.287	0.282	-0.172	-0.512	0.110	-0.658	-1.408	0.085
Lagged	0.273	-0.536	1.072	0.089	-0.218	0.416	0.376	-0.379	1.125
Long term	-0.244	-1.368	0.905	-0.083	-0.558	0.353	-0.282	-1.381	0.814
Type 2: Private consumption & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.869	-2.108	0.350	-0.321	-0.891	0.161	-1.229	-2.410	-0.048
Lagged	-0.755	-1.931	0.430	-0.312	-0.989	0.156	-0.603	-1.722	0.558
Long term	-1.623	-3.432	0.143	-0.633	-1.628	0.063	-1.832	-3.632	-0.035
Type 3: Private consumption & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.931	-2.042	0.164	-0.307	-0.779	0.066	-1.035	-2.124	0.033
Lagged	1.341	0.233	2.431	0.452	0.076	1.006	1.479	0.419	2.520
Long term	0.410	-0.793	1.610	0.146	-0.278	0.665	0.444	-0.712	1.606
Type 4: Private investment & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.671	-2.456	1.154	-0.514	-2.030	1.251	-1.964	-3.521	-0.471
Lagged	0.008	-1.547	1.525	0.004	-1.480	1.418	0.199	-1.282	1.637
Long term	-0.663	-3.142	1.849	-0.510	-2.678	1.870	-1.765	-3.954	0.353
Type 5: Private investment & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-2.094	-4.318	0.259	-1.595	-3.396	0.212	-3.330	-5.503	-1.113
Lagged	-0.583	-2.828	1.683	-0.452	-2.259	1.328	-0.597	-2.756	1.609
Long term	-2.677	-6.007	0.825	-2.047	-4.757	0.684	-3.927	-7.273	-0.515
Type 6: Private investment & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	1.009	-1.924	4.255	1.316	-1.883	5.993	-1.516	-3.877	0.696
Lagged	-0.134	-2.698	2.319	-0.233	-3.606	2.515	1.137	-1.003	3.257
Long term	0.875	-1.971	3.847	1.084	-2.132	5.216	-0.379	-2.779	1.998

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

Table 20: Estimated marginal effects using the subsample of Kyushu

Type 1: Private consumption & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.157	-0.580	0.276	-0.222	-0.871	0.412	0.009	-0.397	0.405
Lagged	0.173	-0.269	0.584	0.234	-0.421	0.818	0.954	0.539	1.354
Long term	0.017	-0.593	0.596	0.012	-0.921	0.836	0.963	0.366	1.522
Type 2: Private consumption & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.867	-1.658	-0.081	-1.140	-2.408	-0.105	-1.045	-1.926	-0.153
Lagged	0.179	-0.624	0.962	0.215	-0.934	1.228	0.953	0.100	1.794
Long term	-0.688	-1.949	0.523	-0.925	-2.825	0.675	-0.092	-1.407	1.211
Type 3: Private consumption & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	0.145	-0.506	0.781	0.214	-0.772	1.230	0.582	0.032	1.125
Lagged	0.108	-0.543	0.747	0.146	-0.874	1.092	1.328	0.738	1.891
Long term	0.253	-0.555	1.060	0.361	-0.904	1.574	1.910	1.137	2.679
Type 4: Private investment & Government expenditure									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-1.350	-2.608	-0.040	-0.204	-0.428	-0.006	-1.562	-2.854	-0.249
Lagged	-0.376	-1.679	0.925	-0.060	-0.293	0.140	-0.356	-1.704	0.972
Long term	-1.726	-3.531	0.026	-0.264	-0.592	0.004	-1.918	-3.741	-0.133
Type 5: Private investment & Government consumption									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-3.094	-5.456	-0.722	-0.555	-1.021	-0.137	-3.287	-5.667	-0.816
Lagged	-0.973	-3.407	1.468	-0.178	-0.639	0.274	-0.965	-3.439	1.504
Long term	-4.067	-7.794	-0.351	-0.733	-1.481	-0.066	-4.252	-8.049	-0.453
Type 6: Private investment & Public investment									
	Spatial Panel						Non-Spatial Panel		
	Direct effect			Indirect effect			Direct effect		
	Mean	95%CI		Mean	95%CI		Mean	95%CI	
Simultaneous	-0.810	-2.583	0.998	-0.153	-0.518	0.231	-1.171	-2.975	0.658
Lagged	-0.456	-2.257	1.276	-0.100	-0.527	0.262	-0.417	-2.234	1.409
Long term	-1.266	-3.512	0.893	-0.253	-0.729	0.199	-1.588	-3.821	0.663

Note: Mean and 95%CI represent the posterior mean and 95% credible interval, respectively.

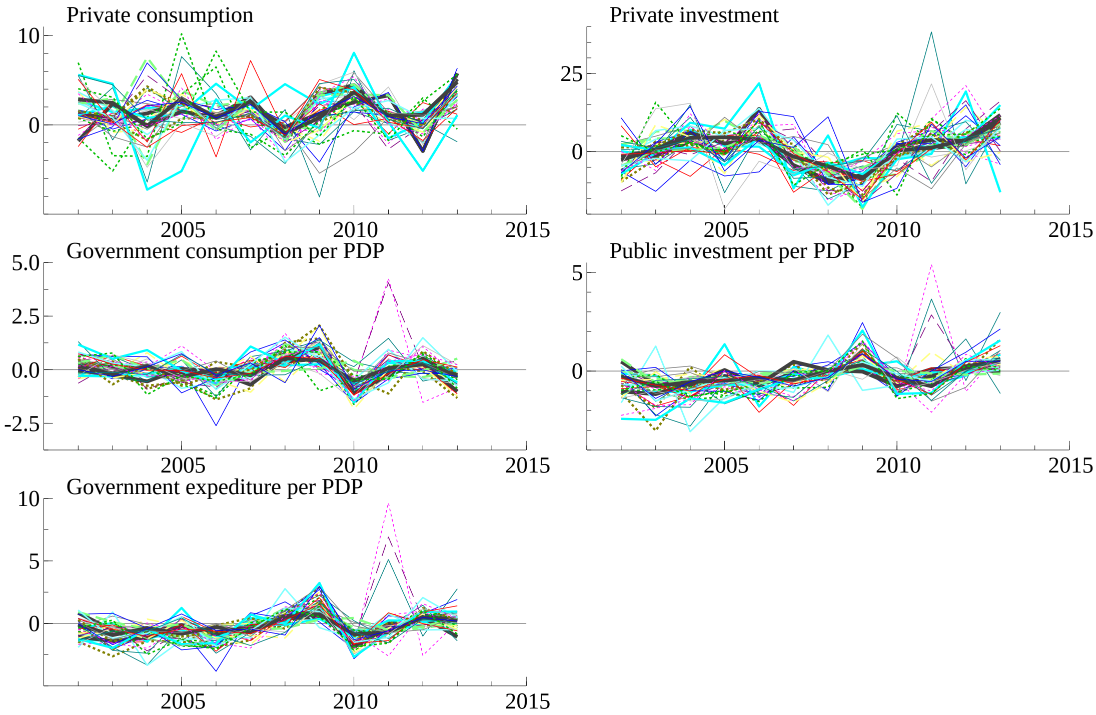

Figure 1: Time series plots of the data set