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Abstract

This paper examines the relationship between fiscal policy and regional business cycle fluctuations in Japan. In particular, we focus on the effects of "discretionary" changes in public investment, a portion of investment unrelated to the current state of

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macroeconomic circumstances. The empirical results show that such types of public investment amplify regional business cycle fluctuations.

Keywords : Public investment in Japan; Business cycle fluctuation; Volatility in the regional economy

JEL classification : E32, E62, H30, H54, R53

1 Introduction

If a country enters a recession, regions within that country may suffer separate, individual recessions. In general, then, the government is justified in including region-specific infrastructure investment in economic stimulus packages. Actually, in the wake of the 2008 world financial crisis, governments in many developed countries did so. They invested in public infrastructure to stimulate demand for goods and services, and sometimes earmarked public investment for specific local districts.[1]

However, public investment is not always employed strictly for reasons of economic stabilization. In particular, region-specific public investment may be determined by factors other than macroeconomic conditions. Typically, as Weingast et al. (1981), Cadot et al. (2006), Castells and Sole-Olle (2006), Helland and Sørensen (2009), and Ihori (2011) argue, a central government's motivation to smoothen interregional inequality and politico-economic factors such as political pressure by interest groups also affect public investment. Stoney and Krawchenko (2011) identify politically motivated public investment in several countries' recent stimulus packages. Further, the American

[1]For example, the American Recovery and Reinvestment Act of 2009 provided close to one billion dollars to upgrade drinking water services to rural areas and ensure adequate water supplies in drought-affected western US communities. Furthermore, Australia's third stimulus measure included a provision for local community infrastructure. For details, see OECD (2009), Stoney and Krawchenko (2011), and the website of Recovery.gov (http://www.recovery.gov/).

Recovery and Reinvestment Act of 2009 included competitive grants to state and local governments for transportation investment, half of which were allocated to low-income regions.

In recent decades, Japan has used public investment as a tool of stabilization policy.[2] However, Japanese public investment has also been employed as an instrument to correct regional (prefectural) income disparities and bolster local governments. Actually, these motives may be disguised in an economic stimulus package, as suggested in Hanai et al. (2000), Pascha and Robashik (2001), and Miyazaki (2009). For example, the Japanese government formulated numerous economic stimulus packages throughout the 1990s, which included allocations to rural areas.[3] Furthermore, public investment in Japan may have been affected by political pressure by interest groups, as Kondoh (2008), Doi and Ihori (2009), Mizutani and Tanaka (2010), and Ihori (2011) argue.

Conversely, however, the Japanese government has also reduced regional public investment for reasons related to broader fiscal policy adjustments, notably from 2001 to 2007. Higo (2005), for instance, documents that the government reduced public investment in low-income regions in the 2000s.

[2]For more on this point, please see Ihori (2006), Miyazaki (2009), and Miyazaki (2010).

[3]Doi and Ihori (2009) showed that public investment was more frequent in rural areas than in urban regions such as Kanto and Kansai in the 1990s. For more on this point, see Figure 3.6. in Doi and Ihori (2009, p.49).

Higo (2005) also surmises that reduced public investment might partly explain delayed job recovery in Japan's low-income regions.

Historical evidence from Japan presents telling asymmetries. The central government has employed public investment as a tool for redistributing income among regions as well as for economic stabilization. Nevertheless, it also has reduced regional public investment to advance other fiscal goals. For these reasons, the movement of regional public investment may not necessarily be countercyclical. If that is the case, in each prefecture public investment may amplify business cycle fluctuations rather than smooth them. Here, the question is whether the changes in public expenditure unrelated to the current macroeconomic conditions amplify fluctuations in business cycles, as argued in Fatás and Mihov (2003). If this is true of the regional economy and public investment, public investment, particularly a part of the investment unrelated to the current macroeconomic circumstances, would amplify regional business cycle fluctuations.

As argued before, public investment as a part of stimulus packages in recent developed countries may have an aspect as a support for local regions, and some political factors may also decide the policy. In contrast, because the public financial conditions of these countries have rapidly worsened since the crisis, their governments will be forced to reduce public spending. To meet this policy objective, if a government reduces public investment in its local regions as in the 2000s in Japan, it will lead to a slump in the regional economy. These points tell us that the recent public investment policy and possible spending cuts in the local regions of developed countries are quite similar to the Japanese case, as shown in the former paragraphs. Consequently, an investigation of the relationship between public investment and regional business cycle fluctuations in Japan may be helpful in ascertaining whether the government should plan its stabilization policy by including public investment as a support for the local economies.

To our knowledge, however, no empirical study has examined the relationship between public investment and regional (prefectural) business cycle fluctuations in Japan. Wall (2007), Hayashida and Hewings (2009), Kakamu et al. (2010), and Artis and Okubo (2011) examine regional (prefectural) business cycles in Japan. However, these researches do not focus on the relationship between regional business cycle fluctuations and fiscal policy. Although Brückner and Tuladhar (2009) estimate the size of fiscal multipliers by using prefecture-level data, they do not examine business cycle fluctuations that we would like to examine here. Following these, our research fills that gap in the literature on Japanese business cycle fluctuations.

The objective of this paper is to examine the relationship between fiscal policy and fluctuations in the regional (prefectural) economy in Japan. In particular, we focus on public investment. By doing so, we would like to clarify whether the stabilization policy planned by including regional public investment as recently done in some countries is justified. Working within the framework established by Fatás and Mihov (2003), we first estimate the volatility of public investment for each region (prefecture) of Japan. Next, we regress each region's economic fluctuations on its volatility of public investment and other variables. We use the fluctuations in prefectural GDP (PGDP) as the measure of economic fluctuations in each prefecture.

Section 2 presents the empirical framework underlying this research. Section 3 reports the estimation results and shows that "discretionary" changes in public investment, a portion of the investment that does not reflect the current macroeconomic circumstances, amplifies regional business cycles. This result suggests that the central government should exclude regional public investment from economic stimulus packages because these policies are not useful in terms of smoothing the business cycle fluctuations in a region. Section 4 concludes.

2 Empirical Framework

2.1 Measure of Discretionary Changes in Public Investment

First, we would like to determine whether specific elements of public investment cause fluctuations in a regional economy. Fatás and Mihov (2003) itemize three types of changes in government expenditure: (i) changes associated with automatic stabilizers, (ii) changes in response to current macroeconomic circumstances, and (iii) discretionary changes not explainable as a response to current macroeconomic conditions. Here, public investment is not associated with automatic stabilizers because it doesn't change automatically in accordance with the macroeconomic conditions, and therefore, factor (i) is omitted in this research. We define factor (ii) as "legitimate" changes in expenditure: changes in public investment expenditure as a "proper" response to macroeconomic circumstances.[4] Following Fatás and Mihov (2003), we define factor (iii) as discretionary changes in public investment expendi-

[4] We focus on the effect of public investment for the following reasons. First, the budget deficit and tax revenues are substantially affected by business cycles and it is difficult to determine the discretionary element as we define it. Second, public investment in Japan has been used as a policy instrument to stabilize the macroeconomy as well as to redistribute income among regions. Above all, the second reason tells us that among all public expenditure, public investment may include both the proper response to current economic conditions and the discretionary changes in fiscal policy unrelated to the current macroeconomy.

ture: changes not explainable as a reaction to the current macroeconomy. Fatás and Mihov (2003) show that "discretionary changes" generate significant macroeconomic instability by using cross-country data. In other words, discretionary changes are redundant in terms of smoothing business cycle fluctuations because they amplify them, while legitimate changes contribute to smoothing.

Then, to clarify discretionary changes in public investment expenditure, we estimate the following equation:

$$\log\left(\frac{GI_{it}}{Y_{it}}\right) = \alpha_i + \beta_t + \gamma_i \log\left(\frac{Y_{it}}{N_{it}}\right) + \delta_i \log\left(\frac{GI_{it-1}}{Y_{it-1}}\right) + \epsilon_{it}, \tag{1}$$

where i and t are prefecture and year indices, respectively. α_i is a set of dummies for each prefecture, and β_t is a set of year dummies. In addition, $\log(\frac{GI_{it}}{Y_{it}})$ is the logarithm of real public investment expenditure (or public capital formation) relative to PGDP, and $\log(\frac{Y_{it}}{N_{it}})$ is the logarithm of real PGDP per capita. These specifications follow Fatás and Mihov (2003).[5] $\log(\frac{Y_{it}}{N_{it}})$ is used as an independent variable that captures the proper response to current macroeconomic circumstances. ϵ_{it} is an error term, and we interpret the prefecture-specific volatility of $\hat{\epsilon_{it}}$ as a quantitative estimate of the

[5]We also estimate Equation (1) by using $\log(\frac{G_{it}}{N_{it}})$ instead of $\log(\frac{GI_{it}}{Y_{it}})$ for a dependent variable. The results are basically the same as the ones reported in Section 3.

discretionary policy. We calculate volatility as the standard deviation of $\hat{\epsilon_{it}}$ and denote it as ${\sigma_i}^{\epsilon}$, the discretionary change in public investment expenditure not explainable as a response to the economic situation. Many earlier studies employ this approach, including Perotti (1999), Alesina et al. (2002), and Fatás and Mihov (2003).

Equation (1) contains a one-period lagged value of $\log(\frac{GI_{it}}{Y_{it}})$. Therefore, we estimate Equation (1) using dynamic panel estimation developed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). We use the system GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998). This method avoids the downward bias of the coefficient of the lagged dependent variable even in finite N and T cases such as ours (N = 47 and T = 18), compared to the method developed by Arellano and Bond (1991). It also helps in avoiding the problem of weak instruments.[6] Here the instrument of the level equations is the lagged dependent variable, and the difference in the independent variable is $\log(\frac{Y_{it}}{N_{it}})$.

[6] For details, see Blundell and Bond (1998) and Baltagi (2005).

2.2 Effects of Fiscal Policy on Output Volatility

To examine the link between discretionary public investment and output volatility, we estimate the effect of ${\sigma_i}^{\epsilon}$ on the volatility of PGDP. The volatility of PGDP is the standard deviation of the PGDP growth rate for each prefecture, ${\sigma_i}^{\Delta Y}$. The basic specification is as follows:

$$\log {\sigma_i}^{\Delta Y} = const. + \tilde{\alpha}{\sigma_i}^{\epsilon} + \tilde{\beta} X_i + v_i, \tag{2}$$

where X_i is the independent variable other than ${\sigma_i}^{\epsilon}$ that affects the volatility of PGDP, and v_i is the disturbance term.[7] Equation (2) is estimated by using the residuals of Equation (1) and the standard deviation of the PGDP growth rate. Therefore, when we estimate Equation (2), independent variables are "averages" over the full sample and we conduct a cross-section estimation following Fatás and Mihov (2001) and Fatás and Mihov (2003).

Incidentally, though Fatás and Mihov (2003) only consider the standard deviation of the PGDP growth rate as an indicator of volatility, we also estimate Equation (2) by using (i) the standard deviation of the output gap of PGDP ($\frac{(Y_{it}-\bar{Y_{it}})}{\bar{Y_{it}}}$; $\bar{Y_{it}}$ is potential output) in each prefecture and (ii) the

[7] We use a semi-log specification because we cannot take logarithms for some independent variables.

standard deviation of the change in private consumption $(C_t - C_{t-1})$.[8] The dependent variable in Equation (2) is written as ${\sigma_i}^{Y^*}$ for the output gap case, and written as ${\sigma_i}^{\Delta C}$ for the private consumption case.[9] The output gap is used in order to deal with the deviation from the potential output, and we also examine the effects on private consumption because a major part of the volatility of PGDP may be attributed to the volatility of private consumption. In estimation, we take the logarithms of these two variables as in the case of ${\sigma_i}^{\Delta Y}$.

For X_i, we first use the ratio of government expenditure (the sum of government capital formation and government consumption) per PGDP as the size of each region's government. We do so because the volatility of PGDP may increase as the size of the regional government increases (Fatás and Mihov (2001) and Fatás and Mihov (2003)). Following Fatás and Mihov (2001), we also consider government revenue as a percentage of PGDP, as an alternative measure for the size of the government. Further, per capita PGDP is

[8]To estimate potential output, we adopt the time trend estimation approach proposed by Hodrick and Prescott (1997), following Artis and Okubo (2011). The estimation equation is as follows:

$$\sum_{i=1}^{T}(lnZ_t - lnZ_t^*)^2 + \lambda\sum_{i=2}^{T-1}[(lnZ_{t+1}^* - lnZ_t^*) - (lnZ^* - lnZ_{t-1}^*)]^2,$$

where Z is real output for which we estimate the potential value, and Z^* is real potential output. The weight λ is assumed to be 100, as Hodrick and Prescott (1997) recommend for anural data sets.

[9]Following the earlier works related to the effects on private consumption like Perotti (1999), we use the changes between t and t-1 for private consumption, instead of the growth rate.

added because economic fluctuations may increase in low-income regions.[10]

The industrial structure also may affect business cycle fluctuations. For example, economic fluctuations will increase with an increase in the proportion of manufacturing industries. To capture this effect, we add the yearly output of manufacturing industries as a percentage of PGDP. Moreover, fluctuations may vary according to the characteristics of the industries. To address this issue, we use the specialization index as in Fatás and Mihov (2001).

$\tilde{\alpha}$ is expected to be both positive and negative. If it is estimated to be positive, ${\sigma_i}^{\epsilon}$ increases the amplitude of fluctuations in the business cycles. That is, discretionary changes in public investment cause the regional economy to fluctuate substantially. Conversely, if $\tilde{\alpha}$ is estimated to be negative, the discretionary policy may smooth regional business cycle fluctuations. The size of the government, openness, and proportion of manufacturing industries are expected to be positive, and per capita PGDP is expected to be negative. The coefficient of the specialization index is estimated to be both positive and negative.

[10] Openness is also used in the cross-country case. However, we do not add this variable because in intranational studies, this may not affect business cycles substantially. Actually, the coefficient of this variable is not estimated to be significant.

2.3 Discretionary Factor and Choice of Instrumental Variables

In Equation (2), the variation in $\sigma_i{}^{\epsilon}$ may be more or less affected by output volatility rather than discretionary policy. Further, the government's size may be large during recessions and small during better times. Therefore, possible endogeneity of these two variables is addressed by using instrumental variables. In contrast, however, to avoid the apprehensiveness that the instruments themselves are driven by output volatility, we should select variables linked to the decision of the size of public investment expenditure and government size in each region but unrelated to economic volatility.[11]

Here, following the arguments in Section 1, a discretionary factor of public investment is defined as the portion of the investment determined by some political factors or the central government's desire to redistribute income among prefectures. We do these because as long as public investment policy is implemented not only to stabilize the macroeconomy but also to support the local economy, other factors except for the response to the current macroeconomic conditions are attributed to ones that reflect regional income redistributions and some political factors shown in such theoretical

[11] Fatás and Mihov (2003) include among discretionary factors, a country's political regime and institutional environment (e.g., its electoral system and form of governance). We cannot consider these factors because they do not differ among regions in one country.

works as Weingast et al. (1981), Castells and Sole-Olle (2006), and Ihori (2011).

Above all, Kondoh (2008) and Mizutani and Tanaka (2010) clarify that the size of the public investment in each region of Japan has been affected by interest groups using econometric approaches. Accordingly, we can employ variables that identify the influence of interest groups as one of the instruments. As proxies for interest groups' influence on public investment, we use the average ratio of construction workers to all workers and the ratio of workers in primary industries to all workers. The reasons are threefold. First, as argued in Doi and Ihori's (2009) games between the central and local governments, local-interest groups, who engage in construction and agriculture, which heavily depend on public expenditure at the local level, have had larger turnout rates than other voter groups.[12]; Second, in order to identify the strength of these interest groups in estimating the equation that formulates the public investment policy, Kondoh (2008) uses the ratio of construction workers to all workers, and Mizutani and Tanaka (2010) use the two variables mentioned above.; Third, while both variables are strongly related to the "discretionary" part of public investment and government size following these two arguments, they may not be correlated with economic volatility.

[12]For this point, see Doi and Ihori (2009, p.189).

Incidentally, the industrial structure and population may decide both the public investment policy and government size because these factors are the sources of regional income disparities. To address these, we use the average ratio of the production of primary industries as a percentage of PGDP and average population size. Moreover, the budget conditions of the local government also affect public policy. To identify this, we employ the average of local government debt outstanding in each region (the issue of local government bonds in the prefecture and in the municipalities within a prefecture).[13]Incidentally, we check the validity of instrumental variables by the over identification restriction test and the strength of the correlation between two endogenous variables and instrumental variables in Section 3.

3 Empirical Results

3.1 Data Set

Our annual panel covers the period 1990–2007 for 47 Japanese prefectures. We begin our sample period after the 1990s because the Cabinet Office of

[13]The ratio of the production of regional construction industries to PGDP, dependency ratio, and square measure of the prefecture may also be considered as instrumental variables. However, when we conducted 2SLS estimation by adding these variables as instruments, the correlation between these instruments and ${\sigma_i}^{\epsilon}$ was weak.

Japan does not provide data before the 1990s on the basis of the System of Integrated Environment and Economic Accounting proposed by the United Nations in 1993. Following these, we have no other choice but to set the sample period after 1990.

Moreover, although we obtain the data for 1990–2003 in real terms by using the 1995 deflator, we cannot acquire real term data using the 1995 deflator for 2004–2007. Therefore, we must construct the real data for 2004–2007 by the 1995 deflator.[14]

3.2 Estimation Results

First, we present the results of Equation (1) in Table 1. Before doing so, we must determine the absence of second-order serial correlation for the disturbances in the first difference equation. The results displayed in the table confirm that no serial correlation exists between Δv_{it} and $\Delta v_{i,t-2}$. The lagged value of the dependent variable is set as one period. To avoid the problem of too many instruments (Okui (2009) and Roodman (2009)), we assume the possible lagged values of instrumental variables as at most two periods. The result shows that γ_i is negative but insignificant.[15]

[14]Appendix A offers further details concerning this point and the source of the data.

[15]We cannot perform the overidentification restriction test because standard errors are corrected by Windmeijer's (2005) correction procedure.

As such, we present the results of Equation (2). Before we present the estimation results for the coefficients, we first confirm the correlation between two endogenous variables, ${\sigma_i}^{\epsilon}$ and government size, and the instrumental variables in the 2SLS estimation. The results using ${\sigma_i}^{\Delta Y}$ as the dependent variable appear in Table 2.[16] "Case 1" is the result obtained by using government expenditure as a percentage of PGDP as the indicator of government size, and "Case 2" is the result obtained by using government revenue as a percentage of PGDP. As also shown in Table 2, partial R^2 values are relatively large, and the p-values of the partial F-statistics are ≤ 0.05.[17] Thus, correlations between ${\sigma_i}^{\epsilon}$ and the instrumental variables are sufficiently strong. Second, we determine the validity of the instrumental variables. The results of the Sargan test shown in Table 3 indicate that the null cannot be rejected for all cases. These results validate our choice of instrumental variables.

The estimation results are shown in Table 3.[18] As shown in Table 3, the coefficient of ${\sigma_i}^{\epsilon}$ is positive and significant for all cases. Public investment that is not a response to the current macroeconomic conditions causes fluctuations in the regional economy. In other words, public investment influenced

[16]The results for the cases of two other dependent variables are not shown for brevity because these are the same as the results shown in Table 2.

[17]Following the scenarios for judging weak instruments in Cameron and Trivedi (2005), we employ the methods based on partial R^2 values and partial F-statistics. For details, see Cameron and Trivedi (2005).

[18]For all cases, we confirm that the disturbances are not heteroscedastic by using Breusch and Pagan's (1979) heteroscedasticity test in OLS estimation.

by interest groups and the central government's desire to redistribute income among prefectures amplifies regional business cycle fluctuations.

The proportion of manufacturing industries is estimated to be positive and significant in the cases of ${\sigma_i}^{\Delta Y}$ and ${\sigma_i}^{Y^*}$. The results show that the volatility of regional economies increases with an increase in the proportion of manufacturing industries. However, since the coefficient of the proportion of manufacturing industries is negative in the case of ${\sigma_i}^{\Delta C}$, the dependency on manufacturing industries is useful in smoothing private consumption. Though the coefficient of government size is not always positive and significant in the cases of ${\sigma_i}^{\Delta Y}$ and ${\sigma_i}^{Y^*}$, it is negative and significant in the case of ${\sigma_i}^{\Delta C}$. This suggests that public sector intervention in regional economies contributes to the smoothing of private consumption at least at the prefectural level.

3.3 Robustness Issues

To determine the robustness of the results, we re-estimate Equation (1) by changing the specifications and adding other variables.[19] First, we calcu-

[19]Instruments selected in the estimation of Equations (1) and (2) are valid for all cases, and correlations between endogenous variables and instrumental variables are sufficiently strong. For the sake of brevity, the estimation results of Equation (1), the Sargan test, and correlations between endogenous and instrumental variables are not shown. These results can be obtained from the author upon request.

late $\sigma_i{}^{\epsilon}$ by re-estimating Equation (1) by adding both per capita outstanding lending and per capita tax revenues, and then re-estimate Equation (2). We perform this to clarify $\sigma_i{}^{\epsilon}$ by considering other policy variables such as monetary policy and tax policy. Second, we estimate Equation (1) by using the logarithm of public investment and PGDP, instead of $\log\left(\frac{GI_{it}}{Y_{it}}\right)$ and $\log\left(\frac{Y_{it}}{N_{it}}\right)$. Even if we re-estimate the model by adding or changing variables, we confirm the results shown in Table 3. The results are shown in Tables 4 and 5.

Further, we re-estimate Equation (2) by eliminating per capital PGDP and specialization index that are not estimated to be significant in most cases by applying a consistent general-to-specific approach so as to enhance estimation efficiency.[20] As shown in Table 6, In this case, while the coefficient of government revenue as a percentage of PGDP is estimated to be positive and significant in the cases of $\sigma_i{}^{\Delta Y}$ and $\sigma_i{}^{Y^*}$ contrary to the results shown in Table 3, the coefficient of $\sigma_i{}^{\epsilon}$ is still estimated to be positive and significant.

Finally, we eliminate Tokyo metropolitan area's four prefectures (Saitama, Chiba, Tokyo, and Kanagawa) from our sample and re-estimate Equation (2) by using other 43 prefectures to check the robustness of the results in subsample estimation. This is done because the Tokyo metropolitan area is different from other areas in terms of industry structure and local public finance. As

[20]For the case where the dependent variable is $\sigma_i{}^{\Delta C}$, we eliminate per capital PGDP only in Case 2 because the coefficient of per capita PGDP is estimated to be insignificant in Table 3.

presented in Table 7, for all cases, the coefficient of $\sigma_i{}^{\epsilon}$ is positive and significant.

From these estimations, we confirm the result that discretionary public investment amplifies regional business cycle fluctuations.

4 Conclusions

This paper examined the effect of fiscal policy on business cycle fluctuations of Japanese prefectures. In particular, we focus on public investment. Our empirical results show that "discretionary changes" in public investment, that is, the part of investment decided by the central government's motivation to support the regional economy and by the political pressure of interest groups, may amplify the fluctuations in prefectural business cycles. The results suggest that since the movement of public investment for the support of local economies is procyclical, such investment is superfluous in leaving business cycles. Following these, the government should not make such public investment disguised in economic stimulus packages in terms of smoothing business cycle fluctuations in a region.

However, relations with economic growth also need to be considered, as in Ramey and Ramey (1995), Fatás and Mihov (2001), and Fatás and Mihov (2003). Further, unlike Miyazaki (2009), we do not compare the effects of investment by central and local governments. These issues remain for future research.

A Dataset

Data for prefectural GDP, private consumption, manufacturing output, output of primary industries, government capital formation, government consumption, and population in each prefecture came from the Annual Report on Prefectural Accounts by the Cabinet Office in Japan. The 1990–2003 data are expressed in real terms by using 1995 as the deflator. Since we were unable to acquire real-term data by using the 1995 deflator for 2004–2007, we constructed real term 2004 data by using the 1995 deflator as follows:

$$Y_{i,2004}{}^{*} = Y_{i,2003} + Y_{i,2003} * g_{i,2004-2003}{}^{*}, \tag{3}$$

where $Y_{i,2004}{}^{*}$ is 2004 data expressed in real terms using the 1995 deflator, and $Y_{i,2003}$ is 2003 data expressed in real terms using the 1995 deflator, and $g_{i,2004-2003}{}^{*}$ is the real growth rate of variable Y over the period 2003–2004 (using the 2000 deflator). We also constructed the 2005–2007 real data using the 1995 deflator, following the procedure above.[21]

The ratio of workers in the primary and that in the construction industries were determined by dividing the number of workers in these industries by the total number of workers. These data come from the Labor Force Survey of the Ministry of Internal Affairs and Communications (MIAC).[22] The data for outstanding lending in each prefecture are taken from the Bank of Japan's Financial and Economic Statistics of Prefectures.

The index of specialization is based on Fatás and Mihov (2001), following Krugman (1991). Letting s_{ji} be the share of industry j in prefecture i, we measure specialization as

$$SPEC_i = \sum_{j=1}^{I} |s_{ji} - s_{j,A}|, \tag{5}$$

[21]We cannot acquire real data for outstanding lending, outstanding local government bond issues, and government revenue used in Section 3. We can acquire the deflator from 1990 to 2003 by the deflator of 1995. After 2003, we construct the 2004 deflator from the 1995 deflator as follows:

$$P_{i,2004}{}^{*} = P_{i,2003} + \Delta P_{i,2004-2003}{}^{*}, \tag{4}$$

where $P_{i,2004}{}^{*}$ is the 2004 deflator by the 1995 deflator, $P_{i,2003}$ is the 2003 deflator by the 1995 deflator, and $\Delta P_{i,2004-2003}{}^{*}$ is the change over 2003-2004 of the PGDP deflator in the 2000 deflator. We acquire the deflator for 2005-2007 by using the 1995 deflator, following the procedure above. These deflators render outstanding lending and government revenue expressed in real terms.

[22]The Labor Force Survey data can be obtained at three-year intervals. We construct the average ratios of these two variables based on the data from 1990, 1992, 1995, 1997, 2000, 2002, 2005, and 2007.

where $s_{j,A}$ represents the share of industry j in Japan. There are 11 comparable sectors.[23] All data are from the Annual Report on Prefectural Accounts by the Cabinet Office in Japan.

For government revenue, we add national tax revenue and local government revenue (including transfers from the central government). National tax revenue comprises national taxes withheld in each prefecture from the annual statistical report of the National Tax Agency. Local government revenue data are obtained from the Annual Statistical Report on Local Public Finance published by MIAC. The data for outstanding local government bond issues are taken from the annual statistical reports on local government bonds by MIAC. We calculate this by adding each prefecture's debt outstanding to the debt of all municipalities within a prefecture.

B Another Specification of Equation (1)

As shown in Section 3.3, we check the robustness of the results by changing the specification of Equation (1). First, we re-estimate Equation (1) by adding both per capita outstanding lending and per capita tax revenues.

[23]These are agriculture, forestry and fisheries, mining, manufacturing, construction, utilities, wholesale trade, finance and insurance, real estate, transportation and communications, and services.

The specification of this case is written as follows:

$$\log\left(\frac{GI_{it}}{Y_{it}}\right) = \alpha_i + \beta_t + \gamma_{1i} \log\left(\frac{Y_{it}}{N_{it}}\right) + \gamma_{2i} \log\left(\frac{L_{it}}{N_{it}}\right)$$
$$+\gamma_{3i} \log\left(\frac{TAX_{it}}{N_{it}}\right) + \delta_i \log\left(\frac{GI_{it-1}}{Y_{it-1}}\right) + \epsilon_{it}, \quad (6)$$

where $\log\left(\frac{L_{it}}{N_{it}}\right)$ is the logarithm of per capita outstanding lending and $\log\left(\frac{TAX_{it}}{N_{it}}\right)$ is the logarithm of per capita tax revenues.

Second, we estimate Equation (1) by using the logarithm of public investment and PGDP, instead of $\log\left(\frac{GI_{it}}{Y_{it}}\right)$ and $\log\left(\frac{Y_{it}}{N_{it}}\right)$. The estimation equation of this is as follows:

$$\log GI_{it} = \alpha_i + \beta_t + \gamma_i \log Y_{it} + \delta_i \log GI_{it-1} + \epsilon_{it}, \quad (7)$$

where $\log GI_{it}$ is the logarithm of public investment and $\log Y_{it}$ is the logarithm of PGDP.

The results are shown in Tables A.1 and A.2.

References

[1] Arellano, M., Bover. O., 1995. Another look at the instrumental variables estimation of error component models. Journal of Econometrics 68

(1), pp.29-51.

[2] Artis, M., Okubo, T., 2011. The intranational business cycle in Japan. Oxford Economic Papers 63 (1), pp.111-133.

[3] Alesina, A., Ardagna, F. S., Perotti, R., Schiantarelli, F., 2002. Fiscal policy, profits and investment. The American Economic Review 92 (3), pp.571-589.

[4] Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and application to employment equation. Review of Economic Studies 58 (2), pp.277-297.

[5] Baltagi, B. H., 2005. Economic Analysis of Panel Data, Third Edition. John Wiley & Sons, Ltd., Chichester, UK.

[6] Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87 (1), pp.115-143.

[7] Breusch, T. S., Pagan, T. S., 1979. A simple test for heteroscedasticity and random coefficient variation. Econometrica 47 (5), pp.1287-1294.

[8] Brückner, M., Tuladhar, A., 2009. The effectiveness of government expenditures during crisis: Evidence from regional government spending in Japan 1990-2000. IMF Working Papers 10/110.

[9] Cadot, O., Lars-Hendrik, R., Andreas, S., 2006. Contribution to productivity or pork barrel? The two faces of infrastructure investment. Journal of Public Economics 90(6-7), pp.1133-1153.

[10] Cameron, C. A., Trivedi, P. K., 2005. Microeconometrics: Method and Applications. Cambridge University Press, New York, USA.

[11] Castells, A., Sole-Olle, A., 2006. The regional allocation of infrastructure investment: The role of equity, efficiency and political factors. European Economic Review 49 (5), pp.1165-1205.

[12] Doi, T., Ihori, T., 2009. The Public Sector in Japan. Edward Elgar Publishing, Chelthenham, UK.

[13] Fatás, A., Mihov, I., 2001. Government size and automatic stabilizers: International and intranational evidence. Journal of International Economics 55 (1), pp.3-28.

[14] Fatás, A., Mihov, I., 2003. The case for restricting fiscal policy discretion. The Quarterly Journal of Economics 118 (4), pp.1419-1447.

[15] Hanai, K., Tajika, E., Yui, Y., 2000. Financing growth and local government in Japan: Why does the government keep growing? Hitotsubashi Journal of Economics 41 (1), pp.153-162.

[16] Hayashida, M., G. J. D. Hewings., 2009. Regional business cycles in Japan. International Regional Science Review 32 (2), pp.119-147.

[17] Helland, L., Sørensen, R. J., 2009. Geographical redistribution with disproportional representation: A politico-economic model of Norwegian road projects. Public Choice 139 (1), pp.5-19.

[18] Higo, M., 2005. A current situation and perspective on the local public finance in Japan. Bank of Japan Working Paper No. 05-J-12.

[19] Hodrick, R. J., Prescott, E. C., 1997. Post-war U.S. business cycles: An empirical investigation. Journal of Money, Credit and Banking 29 (1), pp.1-16.

[20] Ihori, T., 2006. Fiscal policy and fiscal reconstruction in Japan. International Tax and Public Finance 13 (4), pp.489-508.

[21] Ihori, T., 2011. Overlapping tax revenue, soft budget, and rent seeking. International Tax and Public Finance 18 (1), pp.36-55.

[22] Kakamu, K., Wago H., Tanizaki, H., 2010. Estimation of regional business cycle in Japan using bayesian panel spatial autoregressive approach. In: Nolin T. P. eds., Handbook of Regional Economics, Nova Science Publishers, pp.555-571.

[23] Kondoh, H., 2008. Political economy of public capital formation in Japan. Public Policy Review 4 (1), pp.77-110.

[24] Krugman, P., 1991. Geography and Trade. MIT Press, Cambridge.

[25] Miyazaki, T., 2009. Public investment and business cycles: The case of Japan. Journal of Asian Economics 20 (4), pp.419-426.

[26] Miyazaki, T., 2010. The effects of fiscal policy in the 1990s in Japan: A VAR analysis with event studies. Japan and the World Economy 22 (2), pp.80-87.

[27] Mizutani, F., Tanaka, T., 2010. Productivity effects and determinants of public infrastructure investment. The Annals of Regional Science 44 (3), pp. 493-521.

[28] OECD, 2009. Policy responses to the economic crisis: Investing in innovation for long-term growth.
http://www.oecd.org/dataoecd/59/45/42983414.pdf.

[29] Okui, R., 2009. The optimal choice of moments in dynamic panel models. Journal of Econometrics 151, pp.1-16.

[30] Pascha, W., Robaschik, F., 2001. The role of Japanese local governments in stabilization policy. Duisburg Working Papers on East Asian Studies 40.

[31] Perotti, R., 1999. Fiscal policy in good times and bad. The Quarterly Journal of Economics 114 (4), pp.1399-1436.

[32] Ramey, G., Ramey, V., 1995. Cross-country evidence on the link between volatility and growth. The American Economic Review 85 (5), pp.1138-1151.

[33] Roodman, D., 2009. A note on the theme of too many instruments. Oxford Bulletin of Economics and Statistics 71 (1), pp.135-58.

[34] Shea, J., 1997. Instrument relevance in multivariate linear models: A simple measure. Review of Economics and Statistics 79 (2), pp.348-352.

[35] Stoney, C., Krawchenko, T., 2011. Transparency and accountability in infrastructure stimulus spending: A comparison of Canadian, Australian and US Programs. Papers presented at Canadian Political Science Association Annual Conference.

[36] Wall, J. H., 2007. Regional business cycle phases in Japan. Federal Reserve Bank of St. Louis Review January/February 2007, pp. 61-76.

[37] Weingast, B., Shepsle, K., Johnson, C., 1981. The political economy of benefits and costs: A neoclassical approach to distributive politics. Journal of Political Economy 89 (4), pp.642-664.

[38] Windmeijer, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics, 126 (1), pp.25-51.

Table 1: Estimation results of Equation (1) (System GMM estimation (two-step GMM estimator); sample size = 799)

$\log\left(\frac{Y_{it}}{N_{it}}\right)$	-0.168 (0.044)
$\log\left(\frac{GI_{it-1}}{Y_{it-1}}\right)$	0.931^{***} (0.045)
constant	0.657 (0.139)
Test statistics for serial correlation (1st stage) p-value	-4.170 0.000
Test statistics for serial correlation (2nd stage) p-value	1.007 0.314

Note: Dummy variables for years are not shown for the sake of brevity. Standard errors corrected by Windmeijer's (2005) correction procedure are in parentheses. Asterisks indicate significance level: $*** = 1\%$.

Table 2: Results of the test for the correlation between endogenous and instrumental variables (with ${\sigma_i}^{\Delta Y}$ as the dependent variable)

	Case 1 (expenditure)	Case 2 (revenues)
Partial R^2 for ${\sigma_i}^{\epsilon}$	0.254	0.244
Partial R^2 for government size	0.607	
Partial R^2 for government size		0.354
Partial F-statistics for ${\sigma_i}^{\epsilon}$ (p-value)	2.73 0.033	2.73 0.033
Partial F-statistics for government size (p-value)	13.01 0.000	
Partial F-statistics for government size (p-value)		4.74 0.002

The results for two other dependent variables are not show for brevity because these results are the same as the results shown in this table. The endogenous variables are ${\sigma_i}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. Partial R^2 is Shea's (1997) partial R^2.

Table 3: Estimation results of Equation (2) by 2SLS (Sample size = 47)

Dependent variable	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$
	Case 1 (expenditure)			Case 2 (revenues)		
${\sigma_i}^{\epsilon}$	2.731*** (0.833)	2.769*** (1.008)	7.519** (3.327)	2.692*** (0.870)	2.753*** (1.039)	8.498** (4.041)
Per capita PGDP (average)	-0.610 (0.084)	-0.012 (0.101)	-0.906*** (0.335)	-0.098* (0.081)	-0.069 (0.077)	-0.397 (0.314)
Government expenditure/PGDP (average)	1.348** (1.018)	1.787** (1.232)	-20.832*** (4.065)			
Government revenues/PGDP (average)				1.208 (1.022)	1.446 (1.221)	-20.182*** (4.748)
Share of manufacturing industries (average)	2.122*** (0.551)	1.999*** (0.667)	-10.340*** (2.200)	2.067*** (0.561)	1.862*** (0.671)	-10.138*** (2.607)
Specialization index (average)	-0.323 (0.491)	-0.393 (0.594)	4.458** (1.961)	-0.292 (0.503)	-0.317 (0.601)	4.332* (2.579)
Constant	-5.253*** (0.562)	-5.744*** (0.680)	19.478*** (2.245)	-5.166*** (0.555)	-5.551*** (2.579)	18.910*** (2.579)
R^2	0.334	0.258	0.144	0.296	0.235	0.225
Sargan statistics (p-values)	0.769 (3) 0.857	0.748 (3) 0.862	2.706 (3) 0.439	0.991 (3) 0.804	1.364 (3) 0.714	2.170 (3) 0.538

The endogenous variables are ${\sigma_i}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses. The standard errors are in parentheses. Asterisks indicate significance levels: $* = 10\%$, $** = 5\%$, and $*** = 1\%$.

Table 4: Estimation results of Equation (2) by 2SLS (Case wherein both per capita outstanding lending and per capita tax revenues are added to Equation (1). Sample size = 47)

Dependent variable	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$
	Case 1 (expenditure)			Case 2 (revenues)		
${\sigma_i}^{\epsilon}$	2.560*** (0.782)	2.602*** (0.953)	7.311** (3.137)	2.506*** (0.820)	2.562*** (0.982)	8.248** (3.757)
Per capita PGDP (average)	-0.062 (0.083)	-0.014 (0.101)	-0.924*** (0.334)	-0.104* (0.069)	-0.075 (0.082)	-0.432* (0.314)
Government expenditure/PGDP (average)	1.556* (0.993)	1.996** (1.210)	-20.317*** (3.982)			
Government revenues/PGDP (average)				1.407* (1.001)	1.651* (1.198)	-19.644*** (4.586)
Share of manufacturing industries (average)	2.261*** (0.535)	2.140*** (0.653)	-9.985*** (2.148)	2.203*** (0.548)	2.002*** (0.656)	-9.754*** (2.510)
Specialization index (average)	-0.304 (0.486)	-0.373 (0.592)	4.536** (1.948)	-0.273 (0.502)	-0.298 (0.600)	4.430* (2.297)
Constant	-5.299*** (0.555)	-5.791*** (0.676)	19.348*** (2.225)	-5.206*** (0.552)	-5.592*** (0.660)	18.791*** (2.526)
R^2	0.351	0.267	0.159	0.303	0.240	0.178
Sargan statistics (p-values)	1.109 (3) 0.775	0.938 (3) 0.816	2.520 (3) 0.472	1.344 (3) 0.719	1.635 (3) 0.652	2.034 (3) 0.565

The endogenous variables are ${\sigma_i}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses. The standard errors are in parentheses. Asterisks indicate significance levels: $*$ = 10%, $**$ = 5%, and $***$ = 1%.

Table 5: Estimation results of Equation (2) by 2SLS (Case of estimating Equation (1) using the logarithm of public investment and PGDP. Sample size = 47)

Dependent variable	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$
	Case 1 (expenditure)			Case 2 (revenues)		
${\sigma_i}^{\epsilon}$	2.638*** (0.795)	2.738*** (0.984)	8.149** (3.360)	2.625*** (0.811)	2.773*** (0.988)	7.582** (3.731)
Per capita PGDP (average)	-0.056 (0.080)	-0.011 (0.098)	-0.935*** (0.336)	-0.081* (0.061)	-0.055 (0.075)	-0.317 (0.282)
Government expenditure/PGDP (average)	1.175 (0.981)	1.588* (1.213)	-21.624*** (4.146)			
Government revenues/PGDP (average)				1.269* (0.962)	1.480 (1.172)	-19.766*** (4.428)
Share of manufacturing industries (average)	2.217*** (0.517)	2.087*** (0.640)	-10.191*** (2.186)	2.256*** (0.518)	2.045*** (0.631)	-9.462*** (2.383)
Specialization index (average)	-0.173 (0.475)	-0.232 (0.588)	5.002** (2.008)	-0.195 (0.482)	-0.205 (0.587)	4.540* (2.218)
Constant	-5.185*** (0.533)	-5.673*** (0.660)	19.693*** (2.255)	-5.229*** (0.524)	-5.615*** (0.639)	18.700*** (2.413)
R^2	0.401	0.302	0.138	0.369	0.288	0.075
Sargan statistics (p-values)	1.800 (3) 0.615	1.069 (3) 0.785	1.878 (3) 0.598	1.131 (3) 0.721	1.635 (3) 0.770	3.382 (3) 0.337

The endogenous variables are ${\sigma_i}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses. The standard errors are in parentheses. Asterisks indicate significance levels: $* = 10\%$, $** = 5\%$, and $*** = 1\%$.

Table 6: Estimation results of Equation (2) by 2SLS (Case wherein some variables are omitted from Equation (2). Sample size = 47)

Dependent variable	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta Y}$	${\sigma_i}^{Y^*}$	${\sigma_i}^{\Delta C}$
	Case 1 (expenditure)		Case 2 (revenues)		
${\sigma_i}^{\epsilon}$	2.527*** (0.724)	2.748*** (0.900)	2.206*** (0.756)	2.416*** (0.879)	6.602** (2.863)
Government expenditure/PGDP (average)	1.909*** (0.600)	1.911** (0.746)			
Government revenues/PGDP (average)			2.334*** (0.800)	2.254** (0.930)	-16.253*** (2.978)
Share of manufacturing industries (average)	2.254*** (0.517)	1.991*** (0.561)	2.374*** (0.517)	2.073*** (0.601)	-8.906*** (1.981)
Specialization index (average)					2.873* (1.711)
Constant	-5.669*** (0.339)	-5.894*** (0.421)	-5.931*** (0.446)	-6.115*** (0.519)	16.551*** (1.615)
R^2	0.364	0.252	0.265	0.245	0.151
Sargan statistics (p-values)	0.445 (3) 0.931	0.507 (3) 0.917	1.127 (3) 0.886	1.635 (3) 0.770	2.933 (3) 0.402

The endogenous variables are ${\sigma_i}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses. The standard errors are in parentheses. Asterisks indicate significance levels: $* = 10\%$, $** = 5\%$, and $*** = 1\%$.

Table 7: Estimation results of Equation (2) by 2SLS (Case wherein 4 Tokyo metropolitan area prefectures are excluded. Sample size = 43)

Dependent variable	$\sigma_i{}^{\Delta Y}$	$\sigma_i{}^{Y^*}$	$\sigma_i{}^{\Delta C}$	$\sigma_i{}^{\Delta Y}$	$\sigma_i{}^{Y^*}$	$\sigma_i{}^{\Delta C}$
	Case 1 (expenditure)			Case 2 (revenue)		
$\sigma_i{}^{\epsilon}$	2.704*** (0.781)	2.738*** (0.934)	6.027** (3.178)	2.711*** (0.831)	2.572*** (0.964)	5.999* (3.894)
Per capita PGDP (average)	0.005 (0.154)	0.041 (0.185)	-1.551*** (0.628)	-0.031 (0.178)	0.059 (0.206)	-1.944** (0.833)
Government expenditure/PGDP (average)	2.016* (1.519)	2.577* (1.819)	-25.405*** (6.186)			
Government revenue/PGDP (average)				2.145 (1.666)	2.582* (1.931)	-27.745*** (7.804)
Share of the manufacturing industries (average)	2.292*** (0.656)	2.342*** (0.786)	-10.115*** (2.674)	1.999*** (0.558)	1.944*** (0.647)	-6.532*** (2.615)
Specialization index (average)	-0.347 (0.498)	-0.457 (0.597)	4.535** (2.030)	-0.284 (0.509)	-0.358 (0.590)	3.813 (2.385)
Constant	-5.707*** (0.954)	-6.170*** (1.142)	23.412*** (3.885)	-5.960*** (1.176)	-6.384*** (1.363)	27.098*** (5.510)
R^2	0.334	0.258	0.144	0.296	0.235	0.225
Sargan statistics (p-values)	0.467 (3) 0.926	0.978 (3) 0.807	3.043 (3) 0.385	1.005 (3) 0.961	1.635 (3) 0.800	0.553 (3) 0.907

The endogenous variables are $\sigma_i{}^{\epsilon}$ and government size. The instruments include the average values of the ratio of workers in primary industries, of the ratio of construction workers, of population, of production by primary industries as a percentage of PGDP, and of the level of outstanding local government debt in each region. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses. The standard errors are in parentheses. Asterisks indicate significance levels: $* = 10\%$, $** = 5\%$, and $* * * = 1\%$.

Table A.1: Estimation results of Equation (1) (Case of adding both per capita outstanding lending and per capita tax revenues to Equation (1). System GMM estimation (two-step GMM estimator); sample size = 799)

$\log\left(\frac{Y_{it}}{N_{it}}\right)$	-0.221*
	(0.149)
$\log\left(\frac{L_{it}}{N_{it}}\right)$	0.017
	(0.046)
$\log\left(\frac{TAX_{it}}{N_{it}}\right)$	0.021
	(0.057)
$\log\left(\frac{GI_{it-1}}{Y_{it-1}}\right)$	0.924***
	(0.050)
constant	0.091
	(0.115)
Test statistics for serial correlation (1st stage)	-4.179
p-value	0.000
Test statistics for serial correlation (2nd stage)	1.019
p-value	0.308

Note: Dummy variables for years are not shown for the sake of brevity. $\log\left(\frac{L_{it}}{N_{it}}\right)$ is the logarithm of per capita outstanding lending and $\log\left(\frac{TAX_{it}}{N_{it}}\right)$ is the logarithm of per capita tax revenues. Standard errors corrected by Windmeijer's (2005) correction procedure are in parentheses. Asterisks indicate significance level: $* = 10\%$ and $*** = 1\%$.

Table A.2: Estimation results of Equation (1) (Case of estimating Equation (1) using the logarithm of public investment and PGDP. System GMM estimation (two-step GMM estimator); sample size = 799)

$\log Y_{it}$	0.088*** (0.054)
$\log GI_{it-1}$	0.858*** (0.024)
constant	0.541 (0.467)
Test statistics for serial correlation (1st stage)	-4.138
p-value	0.000
Test statistics for serial correlation (2nd stage)	1.075
p-value	0.283

Note: Dummy variables for years are not shown for the sake of brevity. Standard errors corrected by Windmeijer's (2005) correction procedure are in parentheses. Asterisks indicate significance level: $*** = 1\%$.