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This paper examines the relationship between public investment 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 macroeconomic circumstances. The empirical results show that such portions of public investment amplify regional business cycle fluctuations.

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1 Introduction

This paper examines the relationship between public investment and fluctuations in the regional (prefectural) economy in Japan. We use the framework established by Fatás and Mihov (2003), which shows that the changes in public expenditure unrelated to the current macroeconomic conditions amplify fluctuations in business cycles.

Japan has used public investment as a tool of stabilization policy even before the 2008 global financial crisis. At the same time, Japanese public investment has been employed as an instrument to correct regional income disparities and bolster local governments. Actually, these motives might be disguised in an economic stimulus package, as suggested in Hanai et al. (2000) and Miyazaki (2009). Therefore, an investigation of the relationship between public investment and regional business cycle fluctuations in Japan may be helpful in ascertaining whether or not regional public investment amplifies the business cycle fluctuations in the region.

To our knowledge, however, no empirical study has yet examined the relationship between public investment and regional business cycle fluctuations in Japan. For example, Brückner and Tuladhar (2013) estimate the size of regional fiscal multipliers. However, they do not examine business cycle fluctuations that we would like to examine here. Accordingly, our research fills a gap in the literature on the Japanese regional

business cycles.

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. Section 4 concludes.

2 Empirical framework

2.1 Extraction of factors unrelated to current economic conditions

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 does not 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. We define factor (iii) as discretionary changes in public investment expenditure.

To purify discretionary changes in public investment expenditure, we estimate the following equation:

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

where i and t are prefecture and year indices, respectively. β_t is a set of year dummies, which captures the aggregate (country-level) economic conditions. $\log GI_{it}$ is the logarithm of real public investment expenditure (or public capital formation), and $\log Y_{it}$ is the logarithm of real prefectural GDP (RGDP). This is used as an independent variable that captures the "legitimate" changes in expenditure. These specifications follow Fatás and Mihov (2003). ε_{it} is an error term. We calculate volatility as the standard deviation of $\hat{\varepsilon}_{it}$ and denote it as σ_i^{ε}, a discretionary change in public investment expenditure.

Equation (1) contains a one-period lagged value of $\log GI_{it}$. The lagged value of the dependent variable is set as one period, following the specification of Fatás and Mihov (2003). We estimate Equation (1) by taking first-difference and using dynamic panel estimation developed by Arellano and Bond (1991). To avoid the problem of too many instruments (Roodman (2009)), we assume the possible lagged values of instrumental

variables as at most two periods. Here the instruments are $\log GI_{it-2}$, $\log GI_{it-3}$, two valid lags of $\log Y_{it}$, and year dummy variables.

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 σ_i^{ε} on the volatility of RGDP. The volatility of RGDP is the standard deviation of the RGDP growth rate for each prefecture, $\sigma_i^{\Delta Y}$. This means that we use the fluctuations in prefectural GDP (RGDP) as the measure of economic fluctuations in each prefecture. The basic specification is as follows:

$$\log \sigma_i^{\Delta Y} = const. + \widetilde{\alpha} \log \sigma_i^{\varepsilon} + \widetilde{\beta} \log X_i + v_i \qquad (2)$$

where X_i is the independent variable other than σ_i^{ε} that affects the volatility of RGDP, and v_i is the error term. Equation (2) is estimated using the standard deviation of the residuals of Equation (1) and the one of the RGDP growth rate. Therefore, when we estimate Equation (2), independent variables other than σ_i^{ε} are "averages" over the full sample and we conduct a cross-section estimation.

For X_i, we first use the ratio of government expenditure (the sum of government

capital formation and government consumption) per RGDP as the size of each region's government. We do so because the volatility of RGDP may increase as the size of the regional government increases. Following Fatás and Mihov (2001), we also consider government revenue as a percentage of RGDP, as an alternative measure for the size of the government. Per capita RGDP is added because economic fluctuations may increase in low-income regions. Further, economic linkages between different regions may affect the economic volatility even in intranational studies. To capture this, we consider exports per RGDP. Since economic fluctuations will increase with an increase in the proportion of manufacturing industries, we add the yearly output of manufacturing industries as a percentage of RGDP. Moreover, fluctuations may vary according to the characteristics of the industries. To address this issue, we use the specialization index calculated followed by Krugman (1991) as in Fatás and Mihov (2001).[1]

$\tilde{\alpha}$ is expected to be both positive and negative. If it is estimated to be positive, we interpret that discretionary changes in public investment cause the regional economy to fluctuate substantially. Conversely, if this coefficient is estimated to be negative, the discretionary portion of the investment may smooth regional business cycle fluctuations. The size of the government, proportion of manufacturing industries, and export per

[1] There are 11 comparable sectors: agriculture, forestry and fisheries, mining, manufacturing, construction, utilities, wholesale trade, finance and insurance, real estate, transportation and communications, and services.

RGDP are expected to be positive, and per capita RGDP is expected to be negative. The coefficient of the specialization index is estimated to be both positive and negative.

2.3. Discretionary factor and choice of instrumental variables

In Equation (2), the variation in σ_i^{ε} may be more or less affected by output volatility. 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.

The endogenous variables and instrumental variables are summarized in Table 1. “Case 1” is the case obtained by using government expenditure as a percentage of PGDP as the indicator of government size, and “Case 2” is the one obtained by using government revenue as a percentage of PGDP.

Here a discretionary factor of public investment is defined as the portion of the investment whose distribution is 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.

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. Following this, as proxies for interest groups' influence on public investment, the average ratio of construction workers to all workers and the ratio of workers in primary industries to all workers can be the candidates for the instrumental variables.

Incidentally, employment is very sensitive to business cycles. To deal with this, we exclude the cyclical factors from the actual data by using the time trend estimation approach proposed by Hodrick and Prescott (1997). We do so for the number of the workers in each prefecture, the number of workers in construction industries, and the number of workers in primary industries.[2]

We name the potential value of these as the ratio of "potential" construction workers to all "potential" workers and the ratio of "potential" workers in primary industries to all "potential" workers. Thus, we ensure that these two variables are uncorrelated with economic volatility, but remain strongly related to the "discretionary" part of public

[2] For the details on estimation, please see the discussion paper version of this paper downloadable from the author's website: https://sites.google.com/site/tomomisite/research/dp .

investment and government size following the arguments shown in the former paragraph.

Second, a more mountainous region would need larger public investment. To address this, we employ the proportion of forest to land area of each prefecture.[3] Finally, the budget conditions of the local government also affect the size of transfers from the central governments, which share most part of the revenue source of public investment. 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).

3. Empirical results

3.1. Datasets

Our annual panel covers the period 1990-2007 for 47 Japanese prefectures. 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 using the 1995 deflator.

[3] Since this proportion is mostly unchanged through the sample period, we use the value in 2007, which is the latest data period in our sample.

Data for RGDP, production of each industries, manufacturing output, exports, government capital formation, government consumption, and population in each prefecture came from the Annual Report on Prefectural Accounts by the Cabinet Office in Japan.[4] The number of workers in the primary and construction industries and the total number of workers come from the Labor Force Survey of the Ministry of Internal Affairs and Communications (MIAC). The Labor Force Survey data can be obtained for 1990, 1992, 1995, 1997, 2000, 2002, 2005, and 2007. To perform the time trend estimation, we interpolate using the growth rate. The proportion of forest to land area (the proportion of forested land and artificial forest to land area) of each prefecture is made based on the information shown in the website of Forestry Agency of 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

[4] For Aichi prefecture, the exports expressed in real terms are not from the Annual Report on Prefectural Accounts. These variables are downloaded from the official website of the Aichi prefectural government. Incidentally, to express in real terms, we use the deflator of RGDP in Aichi prefecture because we cannot acquire the deflator of exports of Aichi.

government bonds by MIAC. We calculate this by adding each prefecture's debt outstanding to the debt of all municipalities within a prefecture.[5]

3.2. Estimation results

Though we conduct a cross-section estimation for Equation (2), our samples are very small because the sample size is at most 47. Moreover, since the volatility of unexpected local public investment is estimated in the first estimation equation, a problem of generated regressor may be worried. To deal with these, we calculate the standard error by 150 bootstrap replications.

We present the results of Equation (2) in Table 2.[6] First, we determine the validity of the instrumental variables. The results of the Sargan test indicate that the null cannot be rejected for all cases. These results validate our choice of instrumental variables.

The coefficient of σ_i^{ε} is positive and significant for both cases. This means that public investment that is not a response to the current macroeconomic conditions causes fluctuations in the regional economy. While the coefficient of government size is not

[5] For the details on the data, please see the data appendix of the discussion paper version of this paper.

[6] Please see the discussion paper version of the paper for the estimation results of Equation (1). Incidentally, we confirm the correlation between two endogenous variables, σ_i^{ε} and government size, and the instrumental variables in the 2SLS estimation. We confirm that correlations between σ_i^{ε} and the instrumental variables are strong. For more details, please see also the discussion paper version of this paper.

estimated to be significant, the proportion of manufacturing industries is estimated to be positive and significant for both cases.

4. Conclusion

This paper examined the effect of public investment on business cycle fluctuations of Japanese prefectures. Empirical results show that “discretionary changes” in regional public investment amplify the fluctuations in prefectural business cycles.

However, government investments in infrastructure (e.g., roads, bridges, and airports) that are necessary for industry may have a different effect than investments that are more oriented to consumer amenities (e.g., public parks and publicly supported arts). Second, like Miyazaki (2009), it is also assumed that we compare the effects of investment between central and local governments because it may matter whether government investment in the local economy is conducted by the central government or by the local government. These issues remain for future research.

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Table. 1. Endogenous variables and instrumental variables used in 2SLS estimation.

Endogenous variables	Instruments
1. "Discretionary" part of the investment (σ_i^{ε}) 2. Government size (Case1: The average of government expenditure/RGDP) (Case 2: The average of government revenue/RGDP)	I. The average of outstanding local government debt in each region II. The proportion of forest to land area in 2007 III. The average of the ratio of potential construction workers to all potential workers IV. The average of the ratio of potential workers in primary industries to all potential workers

Table 2. Estimation results of Equation (2) by 2SLS estimation
(Dependent variable= $\log \sigma_i^{\Delta Y}$, Observations=47)

	Case1	Case2
σ_i^{ε}	0.683 ***	0.642 **
	(0.263)	(0.257)
Government expenditure/RGDP	0.080	
	(0.250)	
Government revenue/RGDP		0.214
		(0.333)
Export/RGDP	-0.200	-0.205
	(0.264)	(0.236)
Share of manufacturing industries/RGDP	0.550 ***	0.574 ***
	(0.223)	(0.205)
Per capita RGDP	-0.395	-0.364
	(0.339)	(0.354)
Specialization index	0.074	0.064
	(0.085)	(0.092)
Constant	-1.458 ***	-1.427 ***
	(0.709)	(0.770)
R^2	0.311	0.356
Sargan statistics	0.757 (2)	0.832 (2)

Note: We take the logarithm of all independent variables (the average of sample periods except σ_i^{ε}) in estimation. The standard errors with 150 bootstrap replications are in parentheses. The Sargan statistics are chi-square statistics for the overidentification restriction test with the degree of freedom shown in parentheses.

* Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.