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The effects of public investment smoothing as a stimulus measure on construction industry in Japan

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Abstract

Using Japanese macroeconomic data over 1980:Q1-2010:Q1, we estimate their time-varying seasonal components and investigate the impact of public investment smoothing on the construction industry. It is shown that the seasonal fluctuations of public investment had faded away after the collapse of the bubble economy in the early 1990s, and they are positively correlated to the seasonal fluctuations of production in the construction industry. Moreover, it is suggested that the seasonal fluctuations of public investment affect the seasonal patterns of production in the construction industry through the adjustment of the cash earnings and employees. These findings imply that public investment smoothing can be effective for decreasing the implementation lag of fiscal policy and thereby for fine-tuning.

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1. Introduction

Beginning with Bayoumi (2001), earlier empirical literature on Japanese public spending aimed at stimulating the economy points out that the effects of fiscal stimulus after the 1990s are limited (e.g., Ihori *et al.*, 2003; Brückner and Tuladhar, 2010). At the same time that such skeptical outcomes for fiscal stimulus are reported, other evidence regarding fiscal deficit is provided. The so-called non-Keynesian effects found by Giavazzi and Pagano (1990, 1995), Perotti (1999), and Giavazzi *et al.* (2000) suggest that expansionary fiscal policy diminishes consumption when fiscal deficit is large or rises.

In this context, the Japanese economy has been facing serious fiscal deficit and fiscal reconstruction is a hot political issue in recent years. There is a growing appreciation of the need to evaluate the sustainability of the mounting government debt (e.g., Doi *et al.*, 2011). To date, various discussions about how the fiscal reconstruction will be attained are conducted. With respect to public expenditures, the Japanese government actually has been trying to cut them. [1]

The government debt to GDP ratio, the public investment to GDP ratio, and the government consumption to GDP ratio are depicted in Figure 1. The figure shows that the government debt to GDP ratio keeps increasing after the burst of the bubble economy in the beginning of 1990s. [2] We moreover notice that the public investment to GDP ratio has a negative tendency since about 1996, and it is negatively correlated with the government debt to GDP ratio. By contrast, as regards the government consumption, the reverse nexus holds approximately. These facts preindicate that the scale of public investment is suppressed in the future as well to meet increased social security costs under declining birthrate and aging society. [3]

In addition, as for macroeconomic stabilization, caused by a string of monetary easing after the collapse of the bubble economy in the early 1990s, Japan also has been suffering from the zero bound of nominal interest rates since the late 1990s.

[1] In the near future, the public investment will transiently and rapidly increase in order to rehabilitate the affected areas of the Great East Japan Earthquake in March 2011 as soon as possible, but it should be based on long-run project to grow the economic activities and is not for mitigating the business fluctuations.

[2] Incidentally, temporal calmness is seen in the vicinity of FY 2006 because the primary balance is improved due to the cut in public investment and the increase in tax revenues in the protracted boom, etc.

[3] Presumably, under such circumstances, the fiscal policy authorities cannot create large stimulative package through public investment as they did in the 1990s.

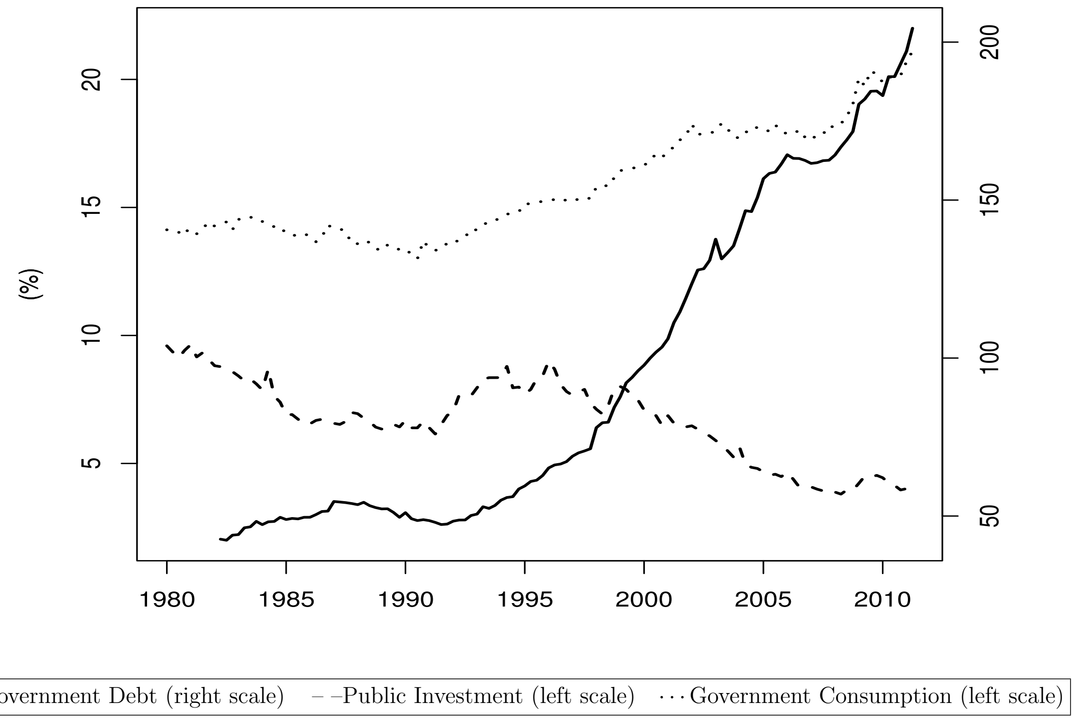

Figure 1: Government Debt and Public Spending (to GDP ratio)

Source: Cabinet Office, Government of Japan, the System of National Accounts 1993 (93SNA), The Bank of Japan's Web site

[4] Consequently, the monetary policy authorities cannot address the traditional monetary policy through the adjustment of the call rate, and are obliged to execute some last resorts (i.e., non-traditional monetary policies) such as the quantitative monetary-easing policy. [5]

All told, Japan's policymakers do not have a range of tools available for the macroeconomic stabilization. To search for other options of fiscal policies, this paper seeks to empirically explore the possible effects of public investment smoothing,

[4]See Miyao (2000, 2002) for the effects of Japanese monetary policy. Based on a vector autoregressive model, Miyao (2000) shows that the monetary policy lost the controllability of the real output in the 1990s.

[5]The first empirical study of the quantitative easing policy is Honda *et al.* (2007), which find the stock price channel that the Bank of Japan current account balances have an impact on the stock price, and thereby the aggregate output (the index of industrial production) changes significantly. However, it is partly impossible for researchers to present some robust statistical analysis, since the quantitative monetary-easing policy is only from March 2001 to March 2006 and the sample period is short.

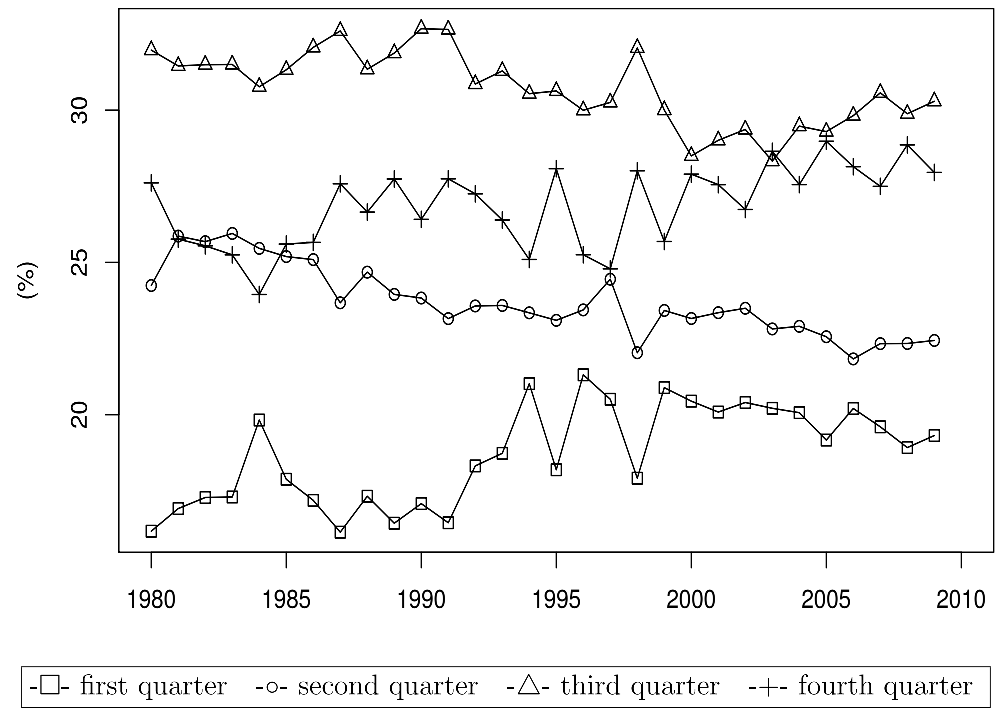

Figure 2: Quarterly Share of Public Investment over Fiscal Year

Source: Cabinet Office, Government of Japan, the System of National Accounts 1993 (93SNA)

which can be one of remaining stimulative means even when fiscal deficit is serious. In doing so, we disregard the scale or trend of public investment (i.e., seasonally adjusted data). Instead we focus on the quality or timing of public investment within a year (i.e., seasonal fluctuations).

The public investment smoothing, defined as the moderation of seasonal fluctuations in public investment in any given year, is relevant to the implementation lag that is crucial for whether or not public investment becomes counter-cyclical. This is because the off-season of public investment is the first quarter of fiscal year (April-June) as shown in Figure 2. [6] As stated in Lane (2003), public investment may optimally be counter-cyclical in accordance with changes in the relative price of public investment over business cycles, although the policymakers draw out the plans for a long-run focus. Given the scale of stimulative packages, even if it is large or small, the authorities can operate their execution to be counter-cyclical.

The rest of the article is organized as follows. Section 2 outlines a statistical

[6] The off-season arguably stems from the fact that Japan's budget system is on a single-year basis, and in the first quarter of a fiscal year much time is almost always devoted to preparation for starting construction, that is, designing, bits, estimates, etc.

method for obtaining time-varying seasonal components from original data. After seeing the details of data set assembled for this study in Section 3, in Section 4 we estimate the time-varying seasonal components of Japanese public investment, and review the resultant transition with some plausible interpretations. Section 5 extracts the time-varying seasonal components of output and labor data in Japanese construction industry, and investigates the causal relationship between the estimated seasonal patterns of public investment and the related ones of construction industry. Section 6 concludes.

2. Estimation of Time-varying Seasonal Components

Let y_t denote the natural log of a certain variable of interest for $t = 1, \cdots, T$. Consider a basic structural model (hereafter BSM) with Gaussian noise in which all components are allowed to vary over time (see, e.g., Durbin and Koopman, 2001). In the BSM, the series y_t is assumed to be composed of the trend component, μ_t, the seasonal component, γ_t, and the irregular component, ε_t:

$$y_t = \mu_t + \gamma_t + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2),$$

and the trend component follows

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t, \quad \eta_t \sim N(0, \sigma_\eta^2),$$
$$\beta_t = \beta_{t-1} + \zeta_t, \quad \zeta_t \sim N(0, \sigma_\zeta^2),$$

where β_t refers to the slope component, and η_t and ζ_t refer to error terms of which each is independently distributed. With regard to the seasonal component, it is assumed to change slowly over time, such that

$$\sum_{i=0}^{m-1} \gamma_{t-i} = \omega_t, \quad \omega_t \sim N(0, \sigma_\omega^2),$$

where m stands for the integer of observations per year.

To estimate the parameters and these unobservable components, we adopt the classic Kalman filter methodology (see, e.g., Hamilton, 1994; Durbin and Koopman, 2001). The above BSM in linear Gaussian state space representation can be expressed as:

$$y_t = \boldsymbol{h}'\boldsymbol{\xi}_t + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2), \tag{1}$$
$$\boldsymbol{\xi}_t = \boldsymbol{F}\boldsymbol{\xi}_{t-1} + \boldsymbol{\nu}_t, \quad \boldsymbol{\nu}_t \sim N(\boldsymbol{0}, \boldsymbol{Q}), \tag{2}$$

where Eq. (1) is called the observation equation, Eq. (2) is called the state equation, and the $(m+1)\times 1$ state vector $\boldsymbol{\xi}_t$ and the $(m+1)\times 1$ error vector $\boldsymbol{\nu}_t$ could be defined as:

$$\boldsymbol{\xi}_t = \begin{bmatrix} \mu_t & \beta_t & \gamma_t & \gamma_{t-1} & \cdots & \gamma_{t-m+2} \end{bmatrix}', \quad \boldsymbol{\nu}_t = \begin{bmatrix} \eta_t & \zeta_t & \omega_t & 0 & \cdots & 0 \end{bmatrix}'.$$

Then, the $(m+1)\times 1$ vector $\boldsymbol{h}$, the $(m+1)\times(m+1)$ matrix $\boldsymbol{F}$, and the $(m+1)\times(m+1)$ matrix $\boldsymbol{Q}$ are explicitly written as follows:

$$\boldsymbol{h} = \begin{bmatrix} 1 & 0 & 1 & 0 & \cdots & 0 \end{bmatrix}',$$

$$\boldsymbol{F} = \left[\begin{array}{cc|ccc} 1 & 1 & 0 & \cdots & 0 \\ 0 & 1 & 0 & \cdots & 0 \\ \hline 0 & 0 & & & \\ \vdots & \vdots & & \boldsymbol{G} & \\ 0 & 0 & & & \end{array}\right], \quad \boldsymbol{Q} = \begin{bmatrix} \sigma^2_\eta & 0 & 0 & \cdots & & 0 \\ 0 & \sigma^2_\zeta & 0 & \cdots & & 0 \\ 0 & 0 & \sigma^2_\omega & 0 & \cdots & 0 \\ \vdots & \vdots & 0 & 0 & & \vdots \\ & & \vdots & & \ddots & \\ 0 & 0 & 0 & \cdots & & 0 \end{bmatrix},$$

where $\boldsymbol{G}$ is an $(m-1)\times(m-1)$ matrix,

$$\boldsymbol{G} = \begin{bmatrix} -1 & -1 & -1 & \cdots & -1 \\ 1 & 0 & 0 & \cdots & 0 \\ 0 & 1 & 0 & \cdots & 0 \\ \vdots & \ddots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 1 & 0 \end{bmatrix}.$$

3. Data

Aseasonal models and seasonally adjusted data are inherent in many of empirical analyses so far, except for only a handful of studies (e.g., Barsky and Miron, 1989; Krane and Wascher, 1999; Christiano and Todd, 2002). In telling contrast to this line, our estimates use quarterly observations for original series to address the assignment presented in our introduction.

Firstly, as a proxy variable of public investment (PI), we adopt quarterly estimates of GDP (i.e., $m = 4$ in the preceding general model), also called public fixed capital formation, which can be retrieved from the Cabinet Office of the Japanese government's Web site. Because of the availability of data on the System of National Accounts 1993 (93SNA), the sample period is over 1980:Q1-2010:Q1.

For the purpose of achieving our objective as a first approach, we also select four key variables of activities in the construction industry, for which public investment directly operates: the total hours worked (THW), the regular employees (RE), the total cash earnings (TCE), and the industrial production (IP). The details of each series are as follows.

The total hours worked (THW), the regular employees (RE), and the total cash earnings (TCE) in the construction industry are on Monthly Labour Survey of Japan by the Ministry of Health, Labour and Welfare. All the series are with 30 or more employees including part-time workers, under which data are available over the above sample. The total hours worked (THW) is sum of scheduled and non-scheduled hours worked. In this statistics, the regular employees (RE) is defined as persons who were hired for an indefinite period or for longer than one month, or who were hired by the day or for less than one month and who were hired for 18 days or more in each of the two preceding months. The total cash earnings (TCE) concern the amount before deducting income tax, social insurance premium, trade union dues or purchase price, etc.

Finally, the industrial production (IP) is also not of the aggregate industry but of construction goods, and it can be taken from the Ministry of Economy, Trade and Industry of Japan's Web site.

4. The Seasonal Patterns of Public Investment

Prior to our main investigation, in this section we estimate the seasonal patterns of public investment, and attempt to interpret the results. In estimating Eqs. (1) and (2) by way of the Kalman filter, we employ diffuse initialization: $\boldsymbol{\xi}_1 \sim N\left(\mathbf{0}_{5\times1}, 10^6 \cdot \boldsymbol{I}_5\right)$ where $\mathbf{0}_{5\times1}$ is an 5×1 zero vector, and $\boldsymbol{I}_5$ is an 5×5 identity matrix.

Figure 3 reports the estimates of the trend component, μ_t, the slope component, β_t, and the seasonal component, γ_t. [7] As for the estimated seasonal components, we first notice that a remarkable decline of the seasonal fluctuations is confirmed in the early 1990s. More detailed evidence regarding the estimated seasonal component is exhibited in Figure 4. As expected from Figure 2, the level of public investment is relatively high in the latter half of the fiscal year. Furthermore, while the level

[7] The trend roughly has three phases corresponding to historical transition of the Japanese economy, i.e., stable-growth period (from 1974 to 1990), the so-called lost decade (over the 1990s), and reduction in public investment for fiscal reconstruction (over the 2000s albeit expanded again after Lehman's fall).

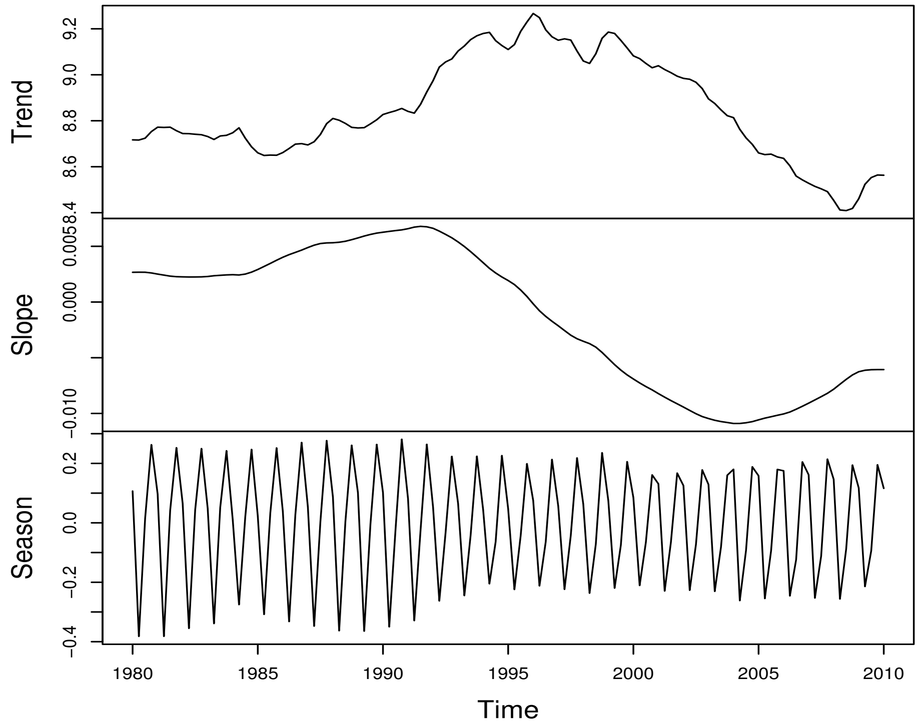

Figure 3: Decomposition of Public Investment

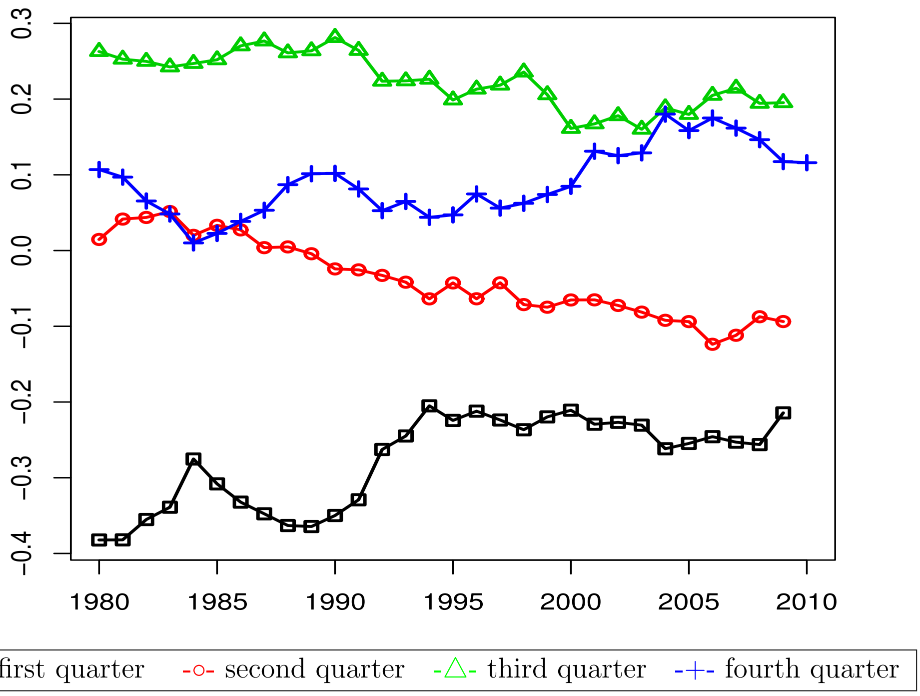

Figure 4: Quarterly Seasonal Components of Public Investment over Fiscal Year

of public investment in the third quarter (October-December) is higher than in the fourth quarter (January-March), it might have roots in avoiding the construction in winter when it snows in the northern part of Japan.

Table 1: Correlation Matrix of the Estimated Time-varying Seasonal Components

	PI_γ	THW_γ	RE_γ	TCE_γ	IP_γ
PI_γ	1.0000	0.0914	−0.1992	0.3033	0.7962
THW_γ	0.0914	1.0000	0.8324	0.9491	0.4341
RE_γ	−0.1992	0.8324	1.0000	0.7021	0.1077
TCE_γ	0.3033	0.9491	0.7021	1.0000	0.5744
IP_γ	0.7962	0.4341	0.1077	0.5744	1.0000

Next, and most important, Figure 4 suggests that a remarkable increase in the first quarter (April-June), i.e., the off-season, occurs in the early 1990s, and it gets stuck at some high levels during the last two decades. As a result, the amplitude of seasonal fluctuations is moderated, and it lasts in the 2000s. [8] The reason why the seasonal fluctuations of public investment is alleviated in the early 1990s would be in the front-loading of public works through a string of supplementary budgets after the burst of the bubble economy. In fact, it is often said that not only the Japanese central government but also the local governments have been accelerating the public works through their supplementary budgets after the 1990s. Accordingly, at the present day, it seems that their attempts for public investment smoothing are prevalent in Japan. [9]

5. Empirical Results

The econometric investigation resorts to a simple vector autoregressive (hereafter VAR) framework in which five variables mentioned in Section 3 are included. [10] Unlike many of our predecessors, all the series are not seasonally adjusted series, but the estimated time-varying seasonal components which are distinguished by subscript γ. As before we apply the BSM model described in Section 2 and adopt diffuse initialization to measure their seasonal components, etc.

[8]This outcome can support evidence in favor of Keynesian counter-cyclical policy in Japanese public investment, such as that presented in Funashima (2012), although pro-cyclicality of public investment is often found even in OECD countries in previous works (e.g., Lane, 2003).

[9]We also conjecture that the Japanese fiscal authorities are compelled to continue front-loading of public works aimed at devising for stimulative measures all the more for the sharp retrenchment of public investment in the 2000s.

[10]See, e.g., Hamilton (1994) for VAR model.

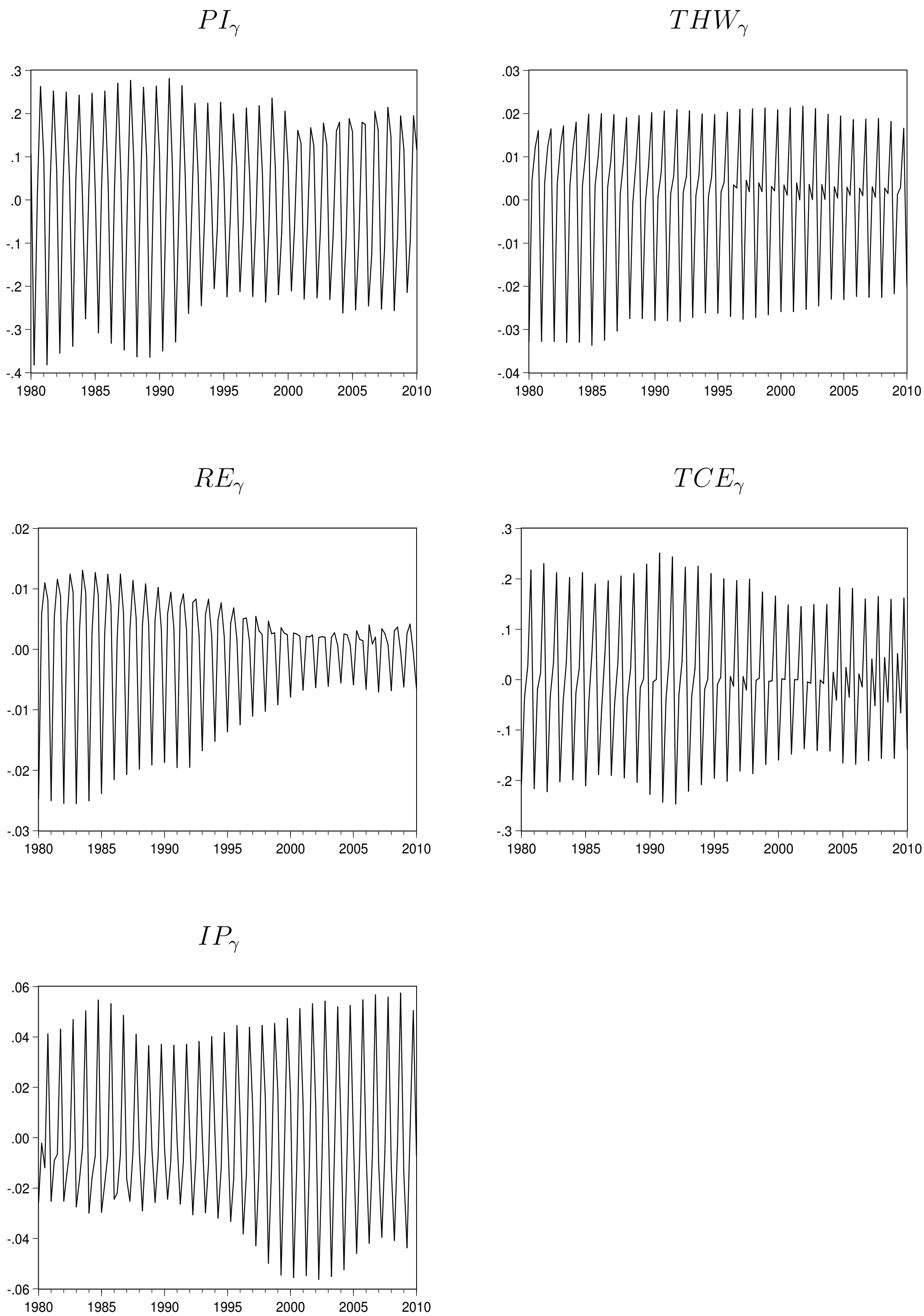

Figure 5: The Estimated Time-varying Seasonal Components

Table 2: Granger Causality Tests

	χ^2-Statistic	P-value
THW_γ to PI_γ	14.496	0.025
RE_γ to PI_γ	10.500	0.105
TCE_γ to PI_γ	10.035	0.123
IP_γ to PI_γ	9.941	0.127
All to PI_γ	53.716	0.001
PI_γ to THW_γ	6.178	0.404
RE_γ to THW_γ	8.912	0.179
TCE_γ to THW_γ	4.123	0.660
IP_γ to THW_γ	7.557	0.272
All to THW_γ	31.638	0.136
PI_γ to RE_γ	17.802	0.007
THW_γ to RE_γ	6.443	0.376
TCE_γ to RE_γ	8.864	0.181
IP_γ to RE_γ	15.432	0.017
All to RE_γ	54.932	0.000
PI_γ to TCE_γ	17.330	0.008
THW_γ to TCE_γ	9.253	0.160
RE_γ to TCE_γ	10.407	0.109
IP_γ to TCE_γ	3.115	0.794
All to TCE_γ	49.462	0.002
PI_γ to IP_γ	7.740	0.258
THW_γ to IP_γ	16.120	0.013
RE_γ to IP_γ	26.368	0.000
TCE_γ to IP_γ	3.539	0.739
All to IP_γ	75.757	0.000

Figure 5 shows the estimated time-varying seasonal components, and the correlation matrix is reported in Table 1. [11] The correlation matrix indicates, albeit quite natural, that there exists a strong positive correlation between PI_γ and IP_γ, suggesting that the public investment creates construction goods demand given the magnitude in any given year.

[11] We can confirm that the amplitude of RE_γ is alleviated from the beginning of the 1980s, although the interpretation is ambiguous compared with the case of PI_γ.

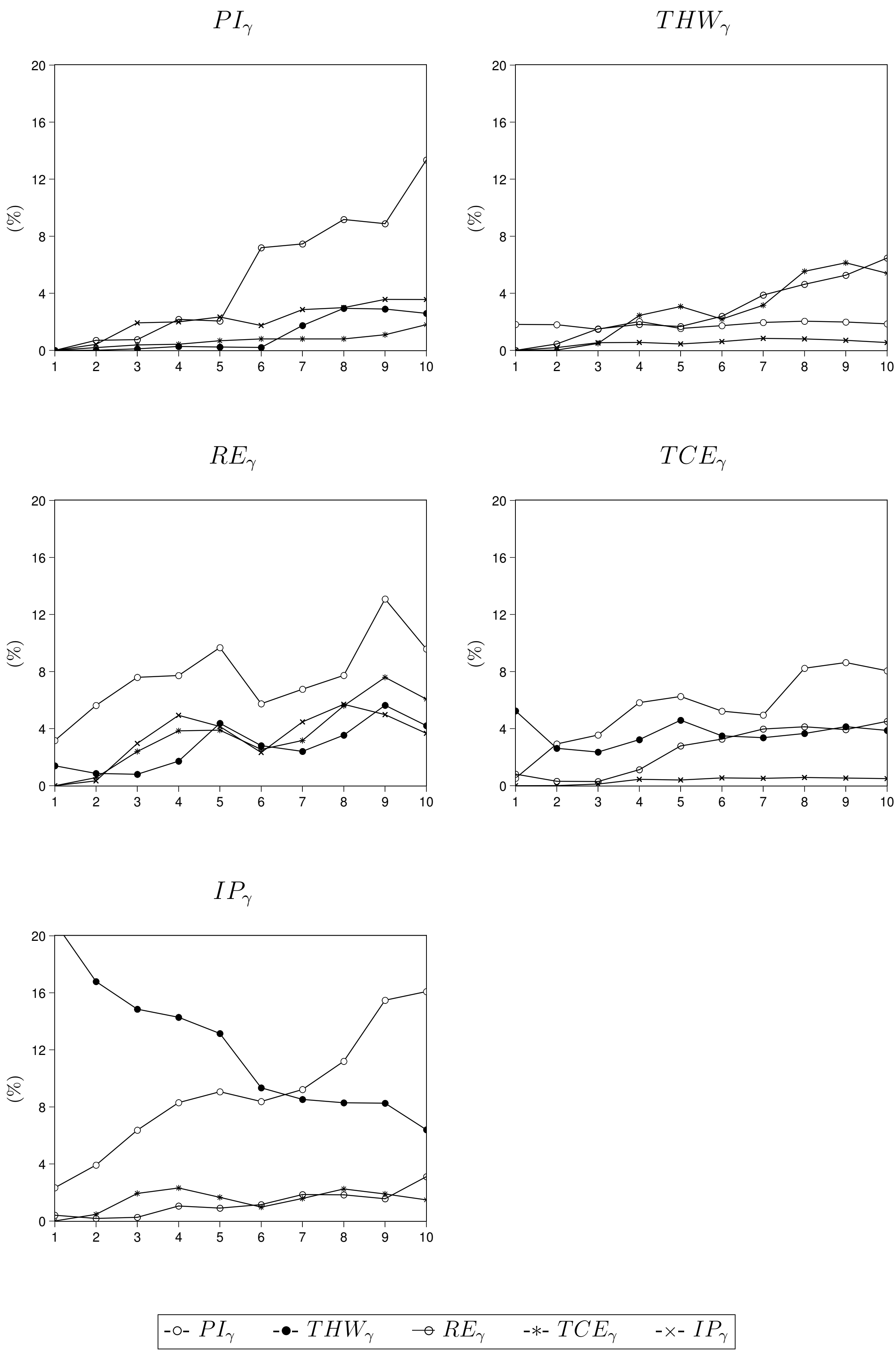

Figure 6: Variance Decomposition

To explore their time series interactions, we next turn to the VAR analysis. [12] The lag length of our VAR model is set to six following to the Schwarz criterion. We first implement the Granger causality tests. The test results are reported in Table 2. From these results, the null hypotheses that PI_γ does not Granger-cause RE_γ, PI_γ does not Granger-cause TCE_γ, and RE_γ does not Granger-cause IP_γ, are rejected at a 1% significance level; and, the null hypotheses that THW_γ does not Granger-cause PI_γ, IP_γ does not Granger-cause RE_γ, and THW_γ does not Granger-cause IP_γ, are rejected at a 5% significance level. As far as PI_γ is concerned, it seems that PI_γ directly affects RE_γ and TCE_γ, and PI_γ indirectly (or laggardly) does IP_γ because RE_γ Granger-causes IP_γ.

We further present variance decomposition in the VAR. Figure 6 shows the results of variance decomposition up to 10 quarters, which is calculated under the ordering of the variables for Cholesky decomposition like (PI_γ, THW_γ, RE_γ, TCE_γ, IP_γ). It is ascertained that the variation in PI_γ has direct repercussions on the variations in both RE_γ and TCE_γ. Moreover, it has an indirect and laggard impact for the variation in IP_γ. When changing the ordering of the variables, similar outcomes are obtained. These are consistent with the results of the Granger causality tests above. In sum, the seasonal fluctuations of public investment affect the seasonal patterns of production in the construction industry through the adjustment of the cash earnings and employees.

6. Conclusion

This paper has offered a first time series analysis of the possible effects of public investment smoothing in Japan. It reaches a conclusion that given the scale over any year the seasonal fluctuations of public investment are influential on those of production in the construction industry. This means that the public investment smoothing can be effective for decreasing the implementation lag of fiscal policy and thereby for fine-tuning. By utilizing supplementary budget, hence, the Japanese fiscal policy authorities should more actively execute the front-loading of public works for buffering the off-season as to business cycle phases, especially in the turndown.

In the present inquiry, we paid special attention to the construction industry to which the public investment is closely related. In this sense, our evidence is only a

[12]The impulse responses are calculated in the almost all VAR analyses where seasonally adjusted series are used. But, as mentioned above, all the present series are seasonal components. Therefore, the estimated impulse responses are not informative and suggestive, because they are highly and frequently volatile and are never persistent.

necessary condition of the phenomenon that the public investment smoothing affects the aggregate industry. So we need to investigate the relation between the seasonal fluctuations of the public investment and those of the aggregate industry.

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