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Re-examination of monetary policy using a shift-share regressor and instrumental variables

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Abstract

This study re-examines the effects of monetary policy using Japanese data and a new approach, the shift-share regressor and instrumental variables, which has not been used in previous vector autoregression analyses. We find that consumption and investment respond negatively to interest rates, while output and employment do not respond much. Moreover, a price puzzle is observed, although this difference is not statistically significant. These results imply that the effects of monetary policy are negligible and unstable.

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1. Introduction

Monetary policy, in which the central bank controls short-term interest rates, is believed to influence the rate of inflation and output. This mechanism has been incorporated into the new Keynesian model (Clarida et al., 1999), the workhorse of recent macroeconomics, and is part of the new consensus in macroeconomics (Arestis 2009).

However, Šustek (2011) finds that in their monetary business cycle accounting model, the monetary policy wedge, defined by the Taylor rule residual, is largely uncorrelated with the business cycle. The monetary policy wedge embeds monetary policy shocks, implying the limits of monetary policy.

Moreover, vector autoregression (VAR), an established method for estimating the effects of monetary policy, has several problems, as pointed out by Rudebusch (1998) and Nakamura and Steinsson (2018). First, the VAR interest rate equation comprises very few variables and their lags, whereas actual monetary policy decisions involve a large amount of information. Second, the difference between the future and actual policy rate and the interest rate shock in the VAR rarely coincide. Third, assuming parameter constraints for identification has become the process for determining causality. Fourth, the impulse response function used in the VAR analysis is very sensitive, as it depends upon the correct identification of the entire system. Therefore, the VAR analysis of monetary policy needs a major overhaul.

This study re-examines monetary policy from the perspective of causal inference, using a panel data estimation method. We consider two variables. The first is the Bartik shift-share regressor (Adão et al. 2019), which takes the interaction of the capital share at a given point in time for each prefecture (share factor) and the change in the unsecured overnight call rate (shift factor) as its operating variables. The second is the cross term between the Bank of Japan's (BOJ) policy rate and prefectural dummies (e.g., Nakamura and Steinsson 2014). These variables facilitate the estimation of the effects of a monetary policy with minimum endogeneity problems.

We conducted our panel estimation for the following reasons. First, instead of using time-series information, such as VAR, we used the regional differences captured in the panel data to eliminate endogeneity issues. Second, the transmission mechanism of monetary policy is expected to vary significantly across regions.

These reasons are largely based on Japanese data. First, Japan has a wealth of macro-regional data, and corporate data clearly indicates corporate locations. This allows for the construction of panel data. Second, interest rates in Japan differ significantly across regions (Kano and Tsutsui 2003). Therefore, using Japanese data facilitates the identification of monetary policy effects.

The study contributes to the literature estimating the effects of monetary policy through causal inference instead of using VAR. Our two methods are superior in that they are strongly correlated with the policy rate.

2. Empirical Strategy

2.1 Model

The following equation is estimated:

$$\frac{Y_{it} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha_i + \gamma_t + \beta \cdot \Delta R_{it} + \delta X_{it} + \varepsilon_{it}, \quad (1)$$

where $(Y_{it} - Y_{i,t-1})/Y_{i,t-1}$ is the outcome variable of prefecture $i = 1, \dots, N$ at time $t = 1, \dots, T$, R_{it} is the interest rate; X_{it} is a vector of covariates; α_i is an individual fixed effect; γ_t is a time fixed effect; and ε_{it} is the error term.

For the interest rate, ΔR_{it}, we use two indicators: First, we use the interaction between a share factor and shift factor. The shift factor is the funding rate of each prefecture. The share factor is the share of the firms' external funds, per prefecture and per industry. This is called the Bartik shift-share regressor (Adão et al. 2019). We define the Bartik regressor as

$$\Delta R_{it} = \sum_{k=1}^{K} z_{ik0} \cdot \Delta r_{kt}, \quad (2)$$

where $k = 1, \dots, K$ is an index of industries, z_{ikt} is the share of liability, and r_{kt} is the average borrowing rate of r_{ikt}.

Second, we perform a two-stage least squares (TSLS) procedure with the central bank's policy rate as the operating variable and each prefecture's interest rate as the endogenous variable. This method is the same as that of Nakamura and Steinsson (2014), who estimate the TSLS with government spending per region as the endogenous variable and government spending for the country as the instrumental variable (IV). Specifically, we use the first-stage equation of TSLS:

$$\Delta\bar{R}_{it} = \zeta_i + \xi_t + \sum_{j=1}^{N} \psi_j \Delta R_t^p \cdot I(i = j) + v_{it}, \tag{3}$$

where $\bar{R}_{it}$ is the average borrowing rate,

$$\Delta\bar{R}_{it} = \sum_{k=1}^{K} z_{ikt} \cdot \Delta r_{ikt}, \tag{4}$$

R_t^p is the BOJ's policy rate, and $I(\cdot)$ is the indicator function.

To our best knowledge, the present study is the first to use these two variables to investigate the effects of monetary policy.

2.2 Data

Annual panel data for each prefecture are used. As outcome variables, we use the growth of real GDP, consumption, and investment per capita (i–iii), the growth of employment (iv), and the inflation rate (v). The data are obtained from the Prefectural Accounts of the Cabinet Office and the System of Social and Demographic Statistics of the Ministry of Internal Affairs and Communications of Japan. The starting point for the data is 1980, the year from which the data are available. The end point is 1998, which is the year before the BOJ started the zero-interest-rate policy.

To calculate the Bartik regressor, we first average the share of borrowing and cost of borrowing for all individual firms, by industry and prefecture. We then multiply these two averages to obtain the sum for each prefecture. We obtain the borrowing rate by dividing the total interest expenses by the total debt at firm level and averaging it by prefecture and industry. Unlike the aggregate data in the paragraph above, the data are obtained from Nikkei NEEDS FinancialQUEST. The number of observations obtained is 71,414. The total number of prefectures is $N = 47$. The number of industries is $K = 32$, excluding banks, securities, insurance, and other financials, based on the Nikkei Industrial Classification. We also obtain the share of external financing from FinancialQuest by dividing the total debt of each prefecture in each industry by the total debt of each prefecture.

The proxy variable for policy rate is the average borrowing rate of firms in each prefecture. In practice, the BOJ uses the overnight unsecured call rate as the policy rate; however, it has a relatively high correlation with the borrowing rate for each prefecture (Kitamura et al., 2015). The BOJ published the basic discount rates as its policy rate until 1994 and started publishing the unsecured overnight call rate in 1995. As the BOJ implemented its zero-interest-rate policy in 1999, we use the basic discount rates for 1980–1994 and the unsecured overnight call rates for 1995–1998. We extract these rates as annual averages from the BOJ time series data search.

For the covariates, we use the log of real GDP per capita, the population aged 15–64, investment/GDP, and government consumption/GDP to control for the business cycle, size of the labor force, size of private investment, and size of government, respectively.

3. Results

3.1 Benchmark results

Table I presents the estimation results obtained using Batik's regressor. The effect of the interest rate on GDP and consumption is positive, but not significant. Regarding studies analyzing the impact of monetary policy on GDP, Christiano et al. (1999) stated that monetary policy affects GDP. However, Uhlig (2005) argued that the effect of monetary policy on GDP is unclear. Our analysis supports this view. A tightening policy has a negative effect on investment. The effects of the interest rate on employment and inflation are not statistically significant and are marginally positive. These results present a price puzzle. The price puzzle has been a phenomenon observed in VAR since Sims (1992).

Table II shows the TSLS with the difference in policy rates as an IV. The effect of the interest rate on GDP is not statistically significant, and the sign is positive. The effect of the interest rate on consumption is statistically significantly negative, unlike in Table I. The effect of the interest rate on investment is not statistically significant but is negative, as shown in Table I. The effect of the interest rate on employment and inflation is not statistically significant.

3.2 Robustness

As a robustness check, we estimate the two-year growth rate as the outcome variable. Correspondingly, the differences and lags of the covariates are also set to two periods. This allows us to estimate the effects of the long-term monetary policy. The impact of the interest rate on the outcome variables is not statistically different from zero when using the Bartik regressor and Nakamura–Steinsson IV.

We further regress outcomes with a one-period lag of the interest rate as a treatment variable. Again, the impact of the interest rate on the outcome variables is not statistically significant. Thus, the statistically insignificant impact in Section 3.1 is robust. We also observe a price puzzle in all cases.

4. Conclusions

We test the effects of interest rate policies using two methods that differ from VAR: a regression analysis with a Bartik regressor and one with a Nakamura–Steinsson IV. The results lead to the following conclusions: First, consumption and investment respond negatively—or not very well—to interest rates. Second, the responses of GDP and employment to interest rates are unstable. Third, the effect of interest rates on inflation is stable and positive, but not statistically significant. These results indicate the need for a monetary policy debate.

However, this study has several limitations. First, although VAR can use monthly or quarterly data, our analysis used annual data. More frequent data collection would allow for a more systematic analysis. Second, the interest rates in each region are lending rates, which serve only as proxy variables for the policy rate. Of course, lending rates are determined with reference to the policy rate, but using a better interest rate indicator would improve estimation efficiency.

Table Ⅰ: Estimation using Bartik regressor

Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. In many cases, heteroskedasticity was detected in the residuals. Therefore, the values in parentheses indicate heteroskedasticity-robust standard errors.

Variable	Growth of real GDP per capita		Growth of real consumption per capita		Growth of real investment per capita		Growth of employment		Rate of inflation	
Differenced interest rate	0.2143		0.0373		-0.8659	*	0.1415		0.0047	
	(0.2379)		(0.2131)		(0.4993)		(0.1127)		(0.0901)	
Log of real GDP per capita (*t*-1)	-0.1593	***	-0.0402	*	-0.0774		-0.0054		0.0312	**
	(0.0327)		(0.0221)		(0.0535)		(0.0163)		(0.0153)	
Log of working-age population (*t*-1)	-0.0825	***	-0.0583	***	-0.2769	***	-0.0817	***	0.0103	
	(0.0169)		(0.0198)		(0.0333)		(0.0092)		(0.0123)	
Investment/GDP (*t*-1)	0.0228		-0.0054		-0.8461	***	0.0489	*	-0.0063	
	(0.0283)		(0.0425)		(0.1331)		(0.0271)		(0.0220)	
Government consumption/GDP (*t*-1)	0.4187	*	-0.2254		1.1479	*	-0.1527		0.2721	*
	(0.2468)		(0.2300)		(0.5770)		(0.1497)		(0.1374)	

Table Ⅱ: Estimation using a Nakamura–Steinsson IV

Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. In many cases, heteroskedasticity was detected in the residuals. Therefore, the values in parentheses indicate heteroskedasticity-robust standard errors.

Variable	Growth of real GDP per capita		Growth of real consumption per capita		Growth of real investment per capita		Growth of employment		Rate of inflation
Differenced interest rate	0.4343		-1.6740	***	-0.1908		-0.0820		0.5801
	(0.7041)		(0.4860)		(0.9824)		(0.2175)		(0.5003)
Log of real GDP per capita (*t*-1)	-0.1638	***	-0.0265		-0.0721		-0.0053		0.0264
	(0.0341)		(0.0243)		(0.0563)		(0.0162)		(0.0164)
Log of working-age population (*t*-1)	-0.0835	***	-0.0530	***	-0.2776	***	-0.0813	***	0.0085
	(0.0171)		(0.0188)		(0.0340)		(0.0094)		(0.0125)
Investment/GDP (*t*-1)	0.0169		0.0007		-0.8287	***	0.0465	*	-0.0087
	(0.0310)		(0.0443)		(0.1302)		(0.0259)		(0.0225)
Government consumption/GDP (*t*-1)	0.3974	*	-0.1207		1.1371	*	-0.1439		0.2363
	(0.2394)		(0.2422)		(0.5893)		(0.1475)		(0.1492)

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