The Neo-Fisher Effect in the United States and Japan

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The Fisher Effect

- **The Fisher Equation:**

$$i_t = R_t + E_t \pi_{t+1},$$

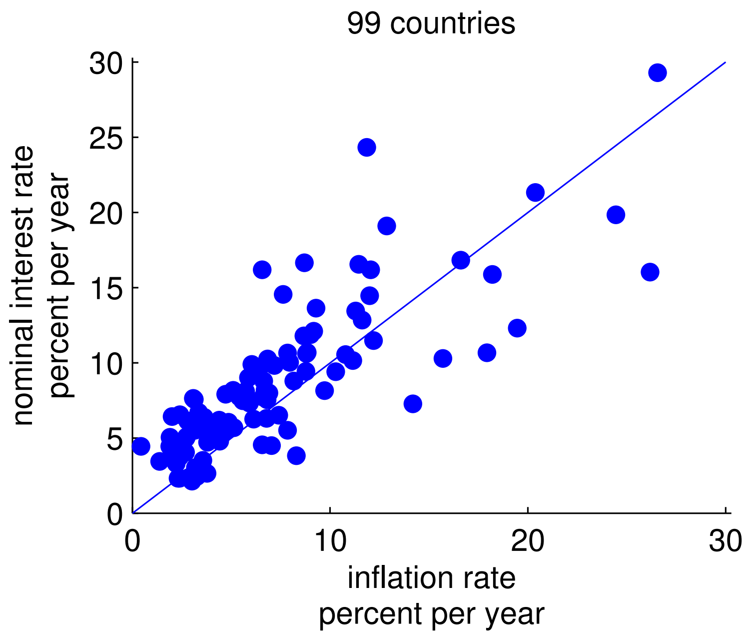
where i_t denotes the nominal interest rate, π_t denotes inflation, and E_t is the expectations operator conditional on information available in period t.

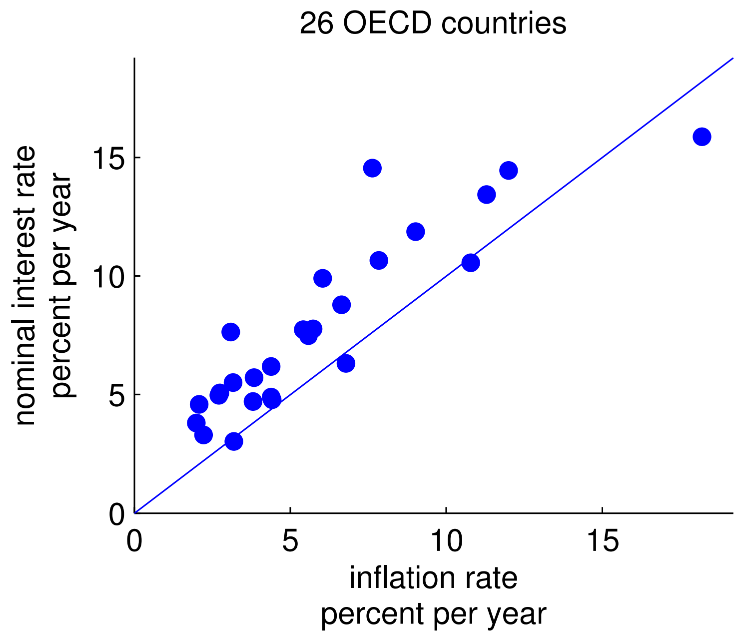
- Assuming that in the long run expected inflation equals actual inflation, we have that

$$i = R + \pi.$$

- Further assuming that in the long run the real interest rate is determined solely by real factors, this expression delivers a one-to-one long-run relationship between the nominal interest rate and the rate of inflation.

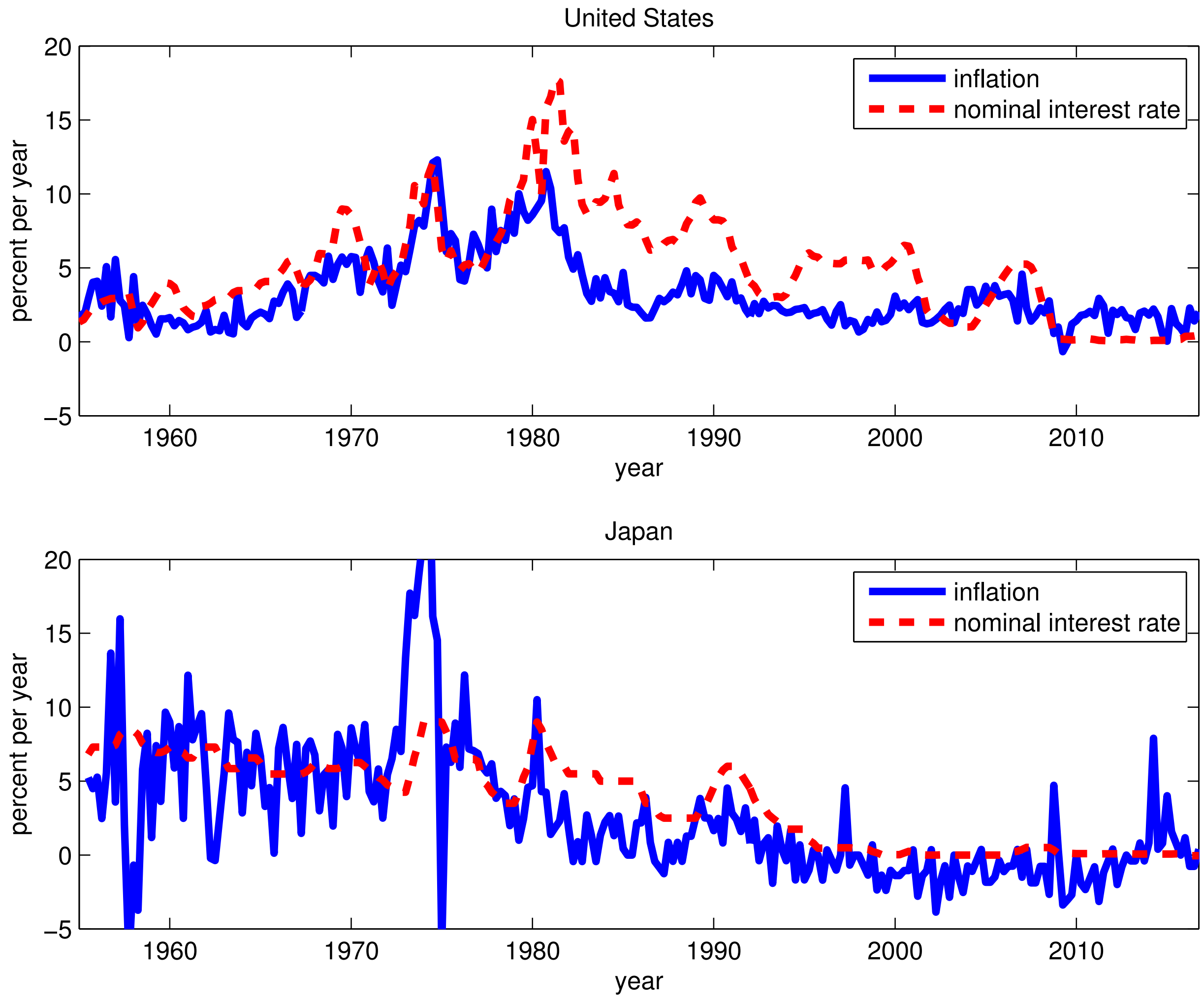
Average Inflation and Nominal Interest Rates: Cross-Country Evidence





Notes. Each dot represents one country. The solid line is the 45-degree line. Average sample 1989 to 2012. Source: WDI.

Inflation and the Nominal Interest Rate in the United States and Japan



Notes. Quarterly frequency, annualized rates.

What is the effect of an interest-rate shock on inflation?

Theory suggests that the answer depends on (a) whether the change in the interest rate is expected to be transitory or permanent; and (b) the time horizon.

Effect of an Increase in the Nominal Interest Rate

	Long Run Effect	**Short** Run Effect
Transitory shock	0	$\downarrow$
Permanent shock	$\uparrow$	$\boxed{\uparrow}$

Entry (2,1): The Fisher effect.
Entry (2,2) : The Neo-Fisher effect.

This Paper presents an empirical investigation of the effects of permanent and temporary movements in the nominal interest rate on inflation, output, and the real interest rate.

- **Framework:** An SVAR model with temporary and permanent nominal and real shocks estimated on U.S. and Japanese data over the postwar period.

The SVAR Model

• The empirical model aims to capture the dynamics of three macroeconomic indicators:

• y_t, denoting the logarithm of real output per capita.

• π_t, denoting the inflation rate, expressed in percent per year.

and

• i_t, denoting the nominal interest rate, expressed in percent per year.

Let the vector Y_t collect these endogenous variables:

$$Y_t \equiv \begin{bmatrix} y_t \\ \pi_t \\ i_t \end{bmatrix}.$$

Four Shocks

X_t^m, denoting a permanent monetary shock.

z_t^m, denoting a transitory monetary shock.

X_t^n, denoting a permanent nonmonetary shock.

z_t^n, denoting a transitory nonmonetary shock.

Long-Run Identification Assumptions

- The nominal interest rate and inflation are cointegrated with the permanent monetary shock.

- Output is cointegrated with the permanent real shock.

These assumptions imply that the following vector is stationary (but unobservable):

$$\widehat{Y}_t \equiv \begin{bmatrix} y_t - X_t^n \\ \pi_t - X_t^m \\ i_t - X_t^m \end{bmatrix}.$$

The Assumed Law of Motion of $\hat{\mathrm{Y}}_\mathrm{t}$

$$\widehat{Y}_t = \sum_{i=1}^{L} B_i \widehat{Y}_{t-i} + C\, u_t \tag{1}$$

$$\text{where } u_t \equiv \begin{bmatrix} x_t^m \\ z_t^m \\ x_t^n \\ z_t^n \end{bmatrix}, \text{ with } \begin{array}{l} x_t^m \equiv \Delta X_t^m \\ x_t^n \equiv \Delta X_t^n \end{array}$$

I assume that u_t distributes AR(1)

$$u_{t+1} = \rho u_t + \psi \epsilon_{t+1}, \tag{2}$$

where ρ and ψ are assumed to be diagonal matrices, and ϵ_t is assumed to distribute i.i.d. $N(\emptyset, I)$.

- **Short-Run Identification Assumptions:**

$C_{12}, C_{22} \leq 0$, which implies that the transitory nominal-interest-rate shock ($z_t^m \uparrow$) has nonpositive impact effects on inflation and output.

Three Observables

- Δy_t, growth rate of real output per capita expressed in percent per quarter.

- $r_t \equiv i_t - \pi_t$, the interest-rate-inflation differential expressed in percent per year.

- $\Delta i_t \equiv i_t - i_{t-1}$, time difference of the nominal interest rate expressed in percent per year.

The following identities link observables to unobservables:

$$\begin{aligned} \Delta y_t &= \widehat{y}_t - \widehat{y}_{t-1} + x_t^n \\ r_t &= \widehat{i}_t - \widehat{\pi}_t \\ \Delta i_t &= \widehat{i}_t - \widehat{i}_{t-1} + x_t^m \end{aligned} \tag{3}$$

Data and Estimation Technique

• The data are quarterly observations of the growth rate of output per capita, the nominal-interest-rate-inflation differential, and the change in the nominal interest rate.

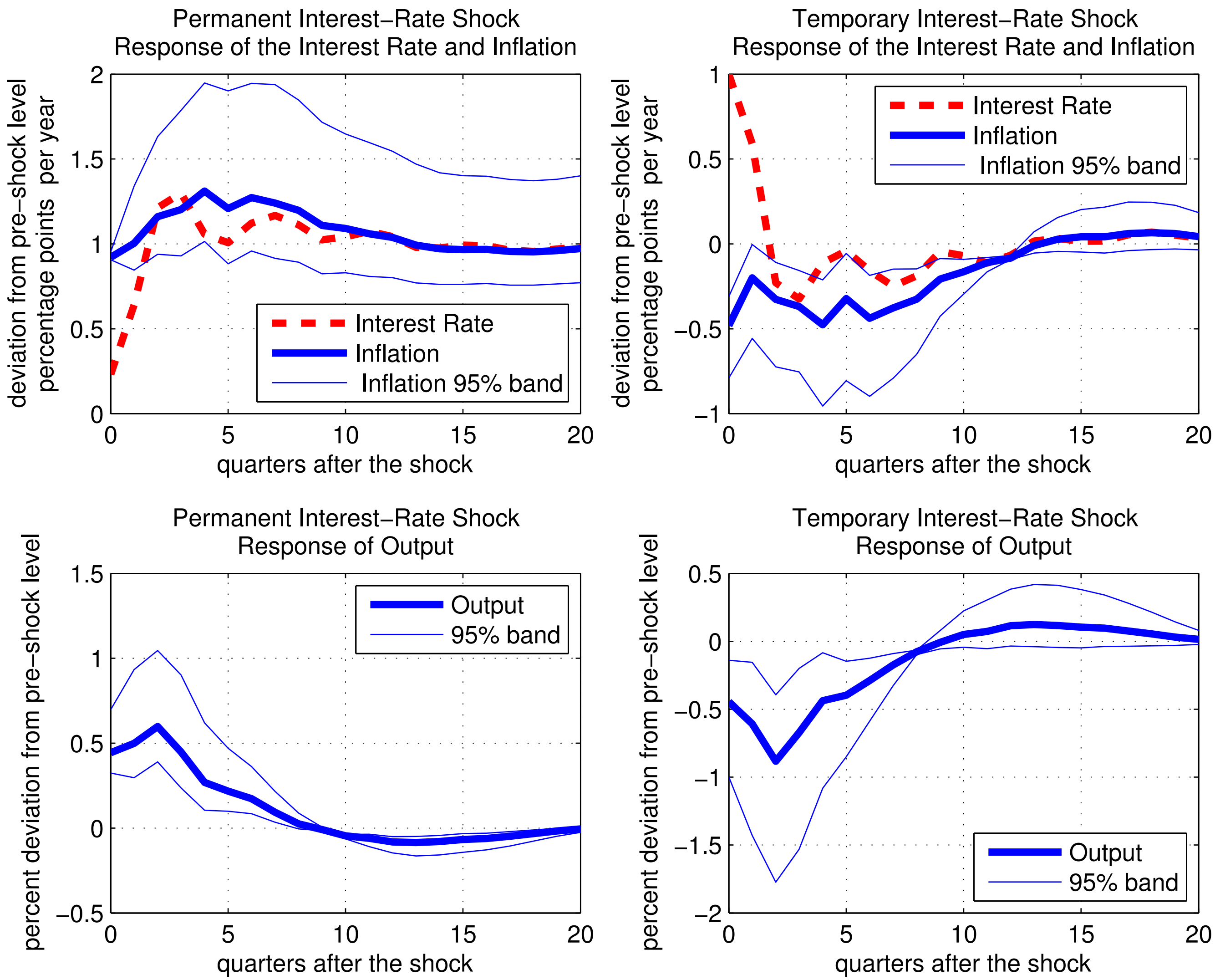
• United States: Sample 1954.4 to 2016.4. Ouput is proxied by real GDP per capita. Inflation is proxied by the Implicit GDP Deflator inflation rate. The nominal interest rate is proxied by the Effective Federal Funds Rate.

• Japan: I consider two samples, 1975.1 to 2016.4 and 1955.3 to 2016.4. Ouput is proxied by real GDP per capita. Inflation is proxied by the Implicit GDP Deflator inflation rate. The interest rate is proxied by the discount rate until 1995:2 and by the call rate thereafter.

• The model is estimated using Bayesian techniques.

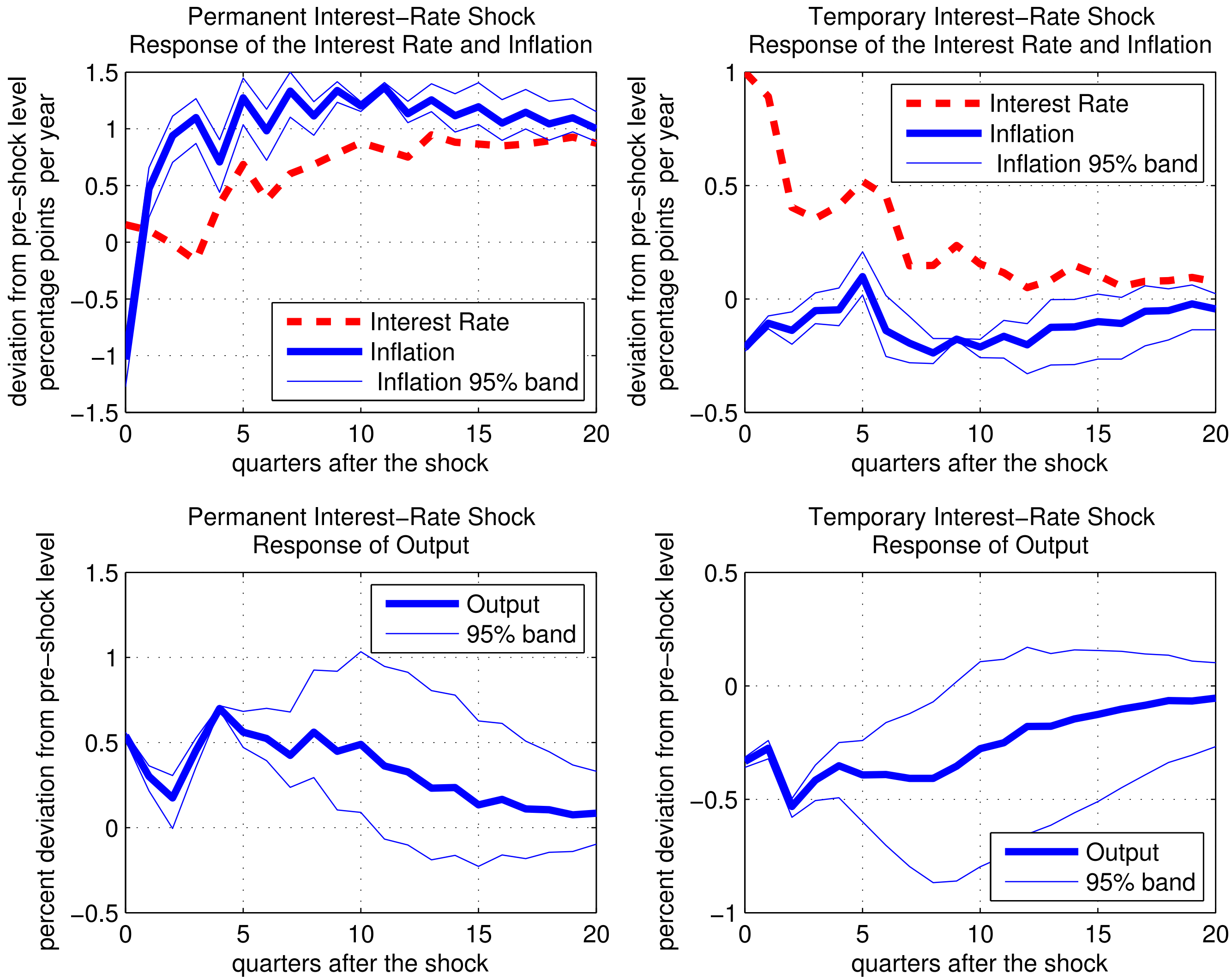
The Neo-Fisher Effect in the United States

Impulse Responses to Interest-Rate Shocks: United States

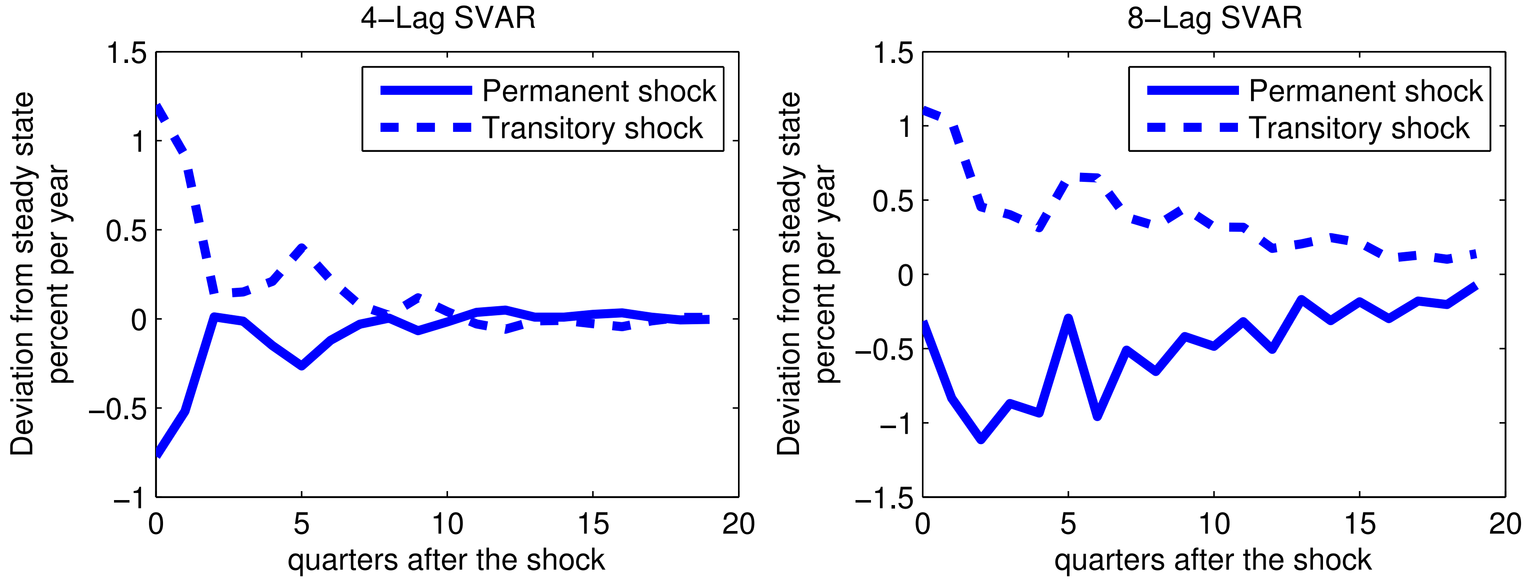


Notes. The SVAR model includes 4 lags.

Impulse Responses to Interest-Rate Shocks: United States, Eight-Lag SVAR Specification



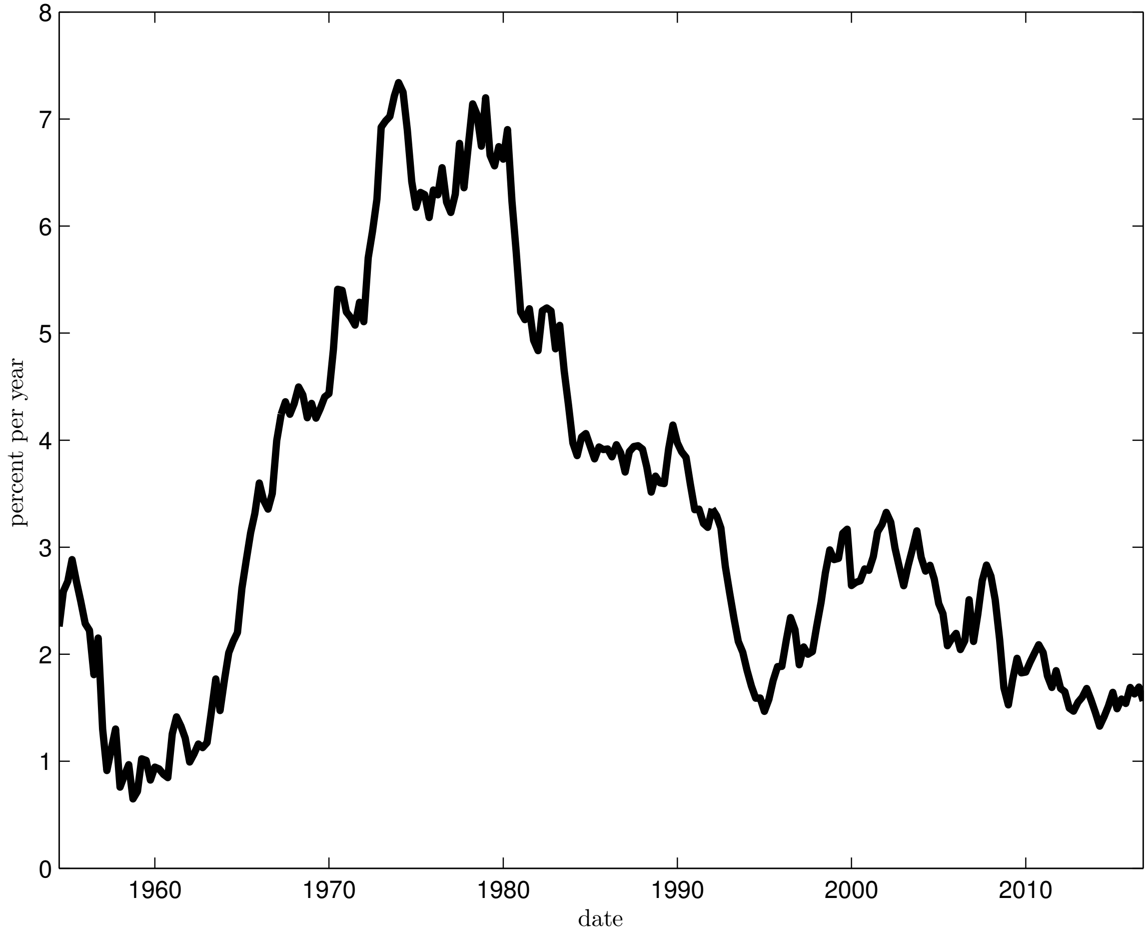
Response of the Real Interest Rate to Permanent and Transitory Interest-Rate Shocks



Notes. Posterior mean estimates. The real interest rate is defined as $i_t - E_t\pi_{t+1}$.

The Time Path of the Permanent Monetary Shock

Inferred Historical Values of X_t^m



Note. Quarterly frequency. Smoothed using the Kalman filter on the eight-lag SVAR model. Initial value of X_t^m normalized to match observed average inflation.

The Neo-Fisher Effect in Japan

Estimation Period

- The baseline estimation is performed on data starting in 1975:Q1.

- Reason: The growth rate of real GDP per capita displays a significant break around this time (see figure on the next slide).

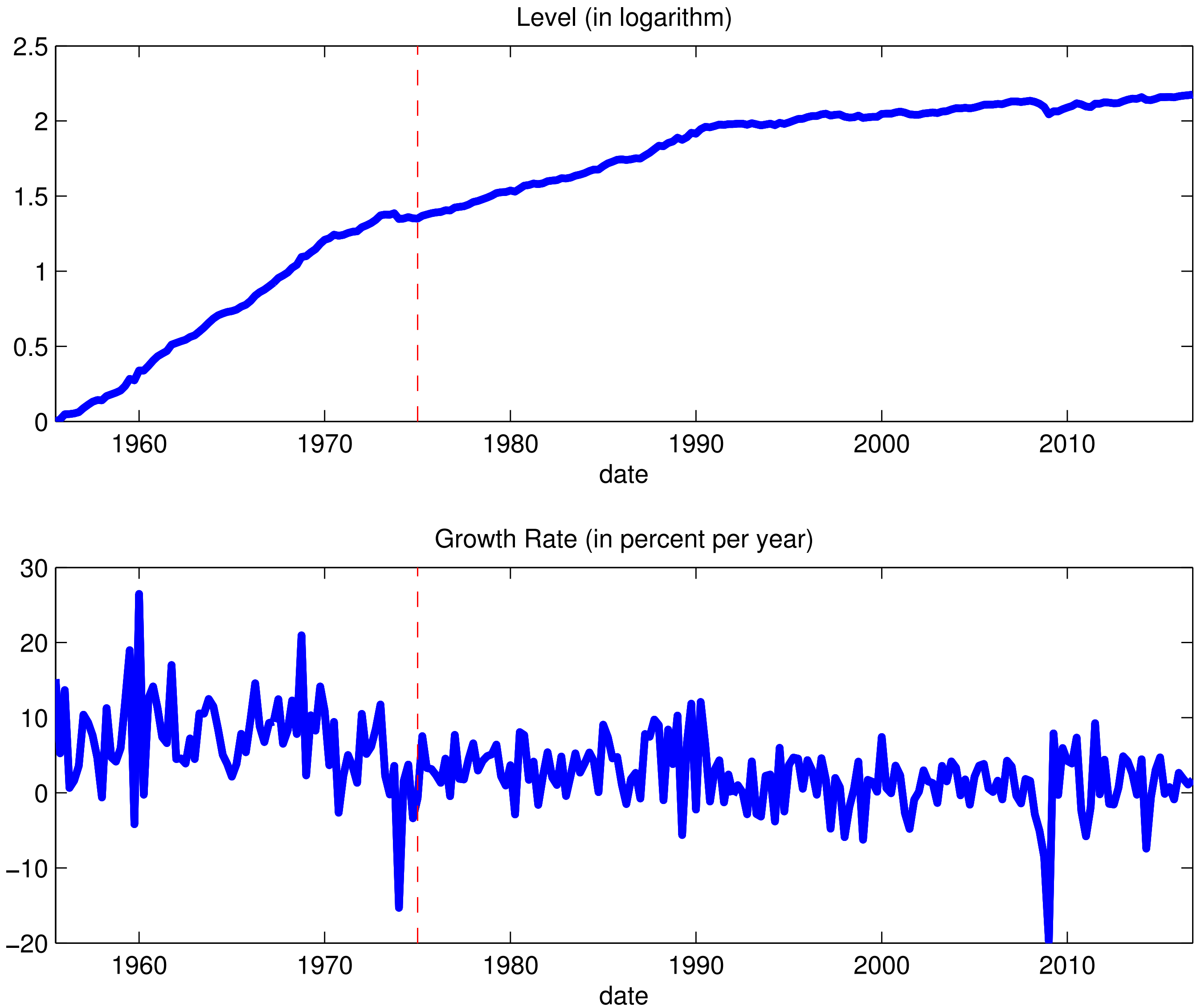
- There is a marked slowdown in the trend of GDP per capita around 1975, possibly marking the end of the postwar reconstruction.

- The average growth rate of GDP per capita from 1955 to 1975 was more than three times as large as over the period 1975 to 2016 (7% versus 2% per year).

- The first subperiod was also more volatile, with a standard deviation of real per capita GDP growth of 6% compared to 4% over the more recent subperiod.

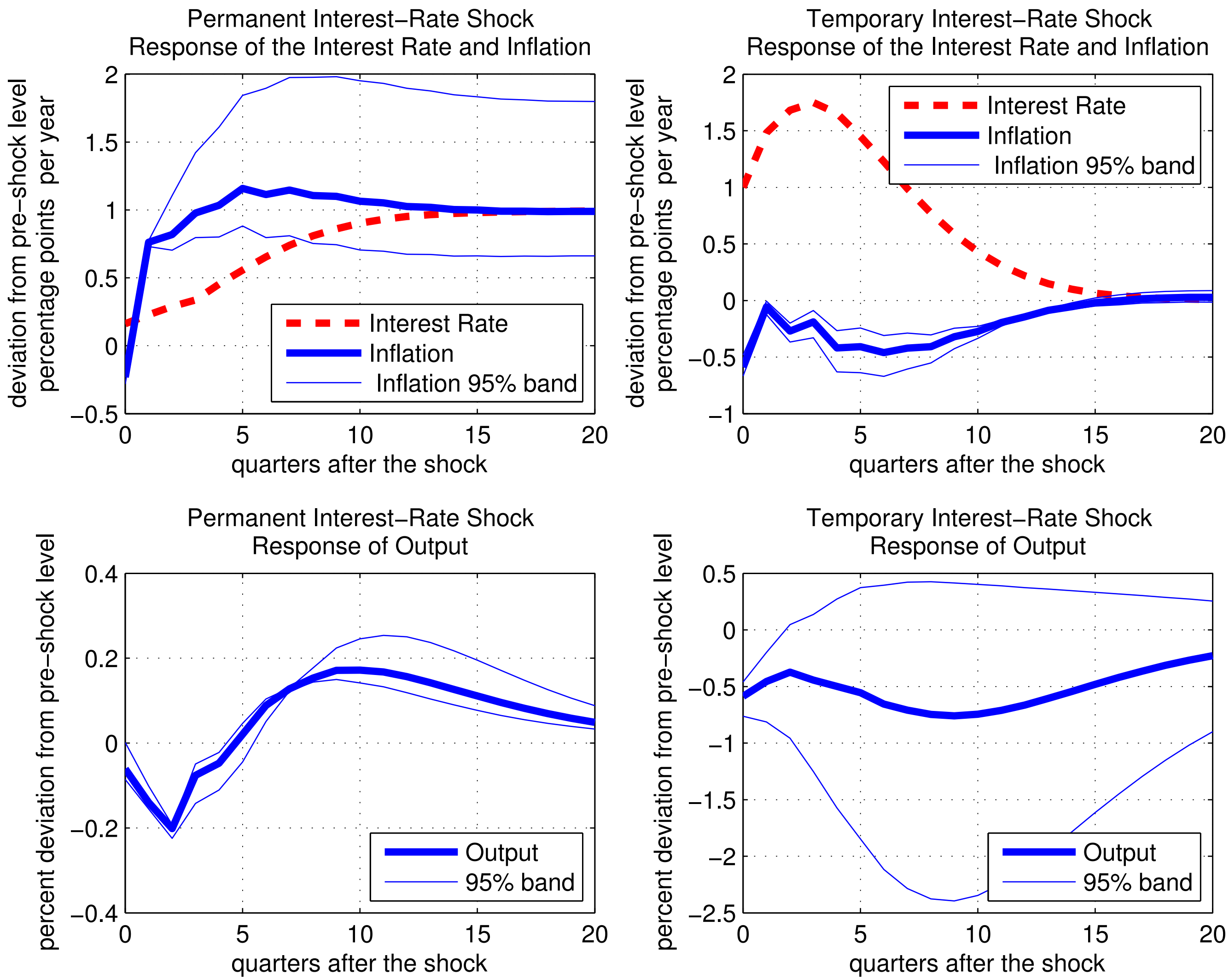
- As a robustness check, I also estimate the model over the whole sample, 1955:Q2 to 2016:Q4.

Real GDP Per Capita: Japan 1955:Q3 to 2016:Q4



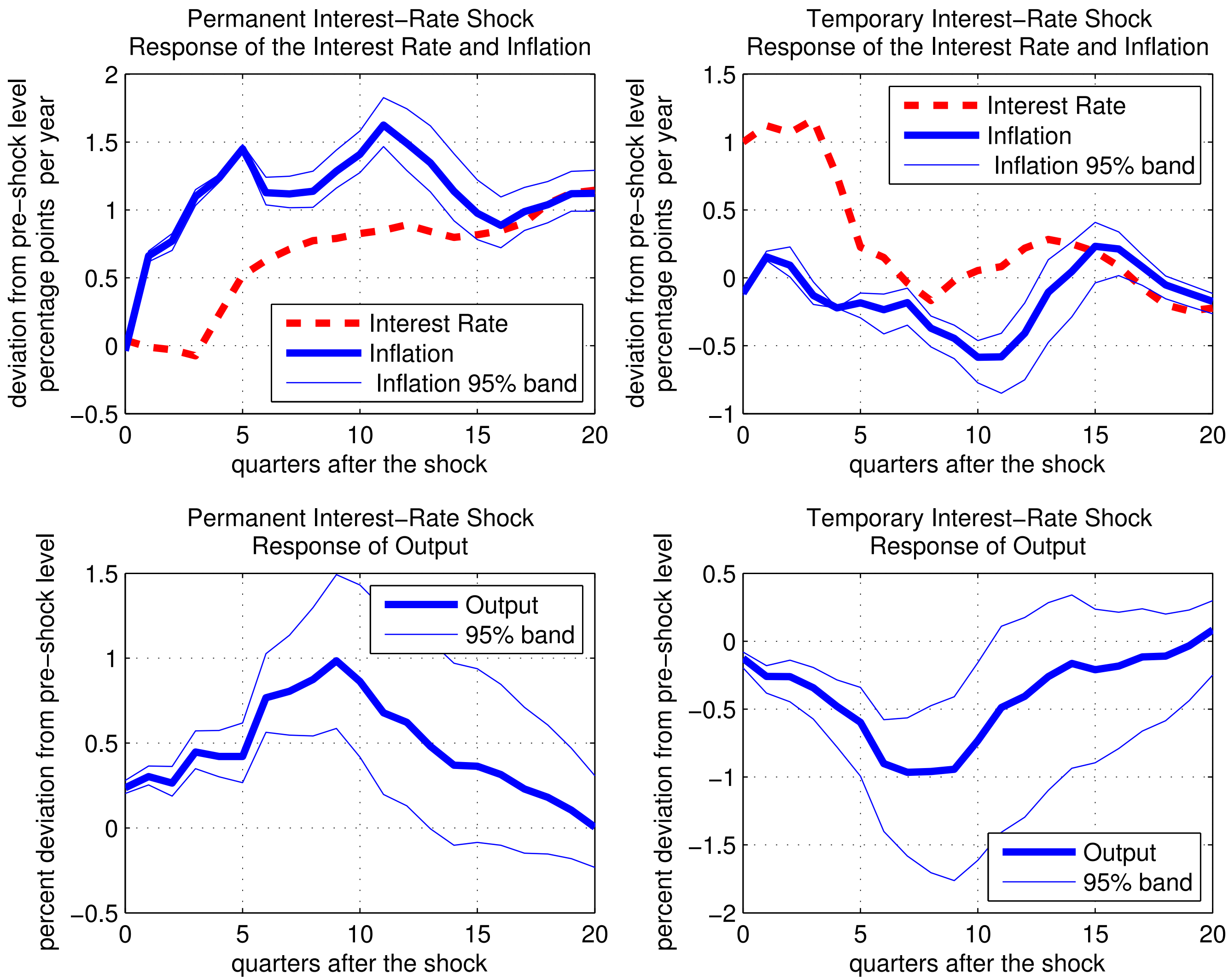
Note. Quarterly frequency.

Impulse Responses to Interest-Rate Shocks: Estimates on Japanese Data



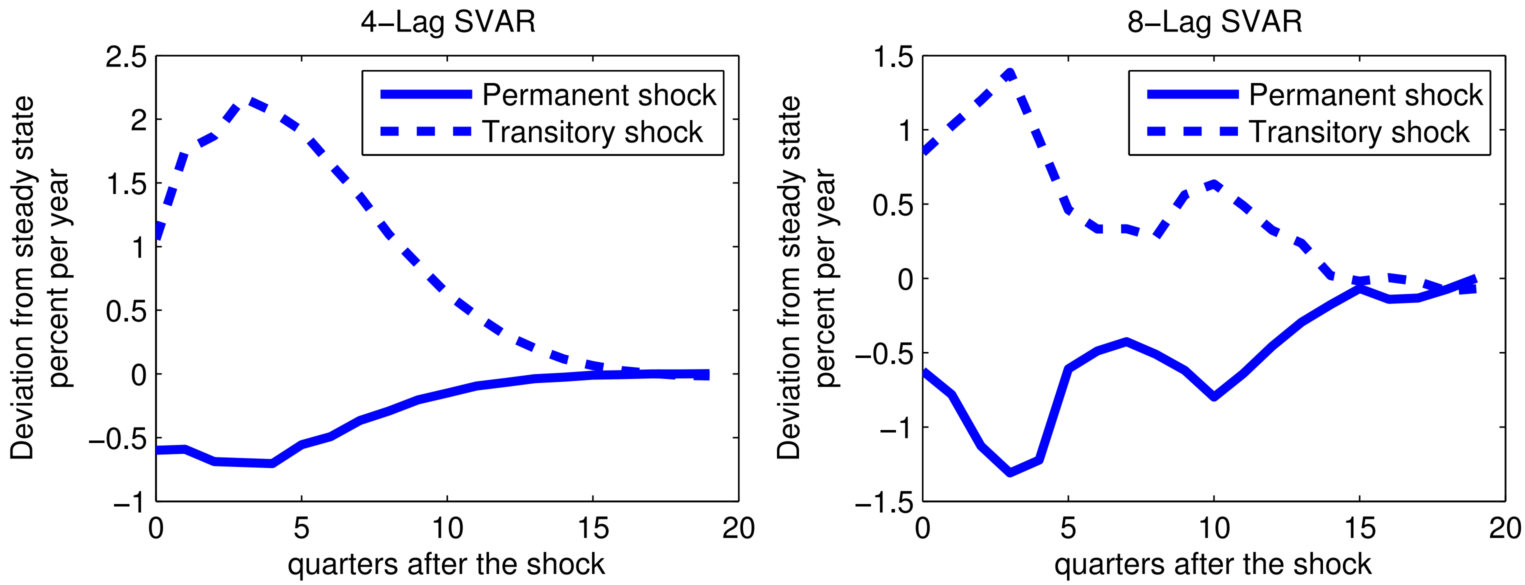
Notes. The SVAR model includes 4 lags. Estimation period 1975:1–2016:4

Impulse Responses to Interest-Rate Shocks Japanese Data, Eight-Lag SVAR Model



Note.Estimation period 1975:1–2016:4.

Response of the Real Interest Rate to Permanent and Transitory Interest-Rate Shocks: Estimates on Japanese Data



Final Remarks

Discussions of how monetary policy can lift an economy out of chronic below-target inflation are almost always based on the logic of how transitory interest-rate shocks affect real and nominal variables.

Within this logic, a central bank trying to reflate a low-inflation economy will tend to set interest rates as low as possible.

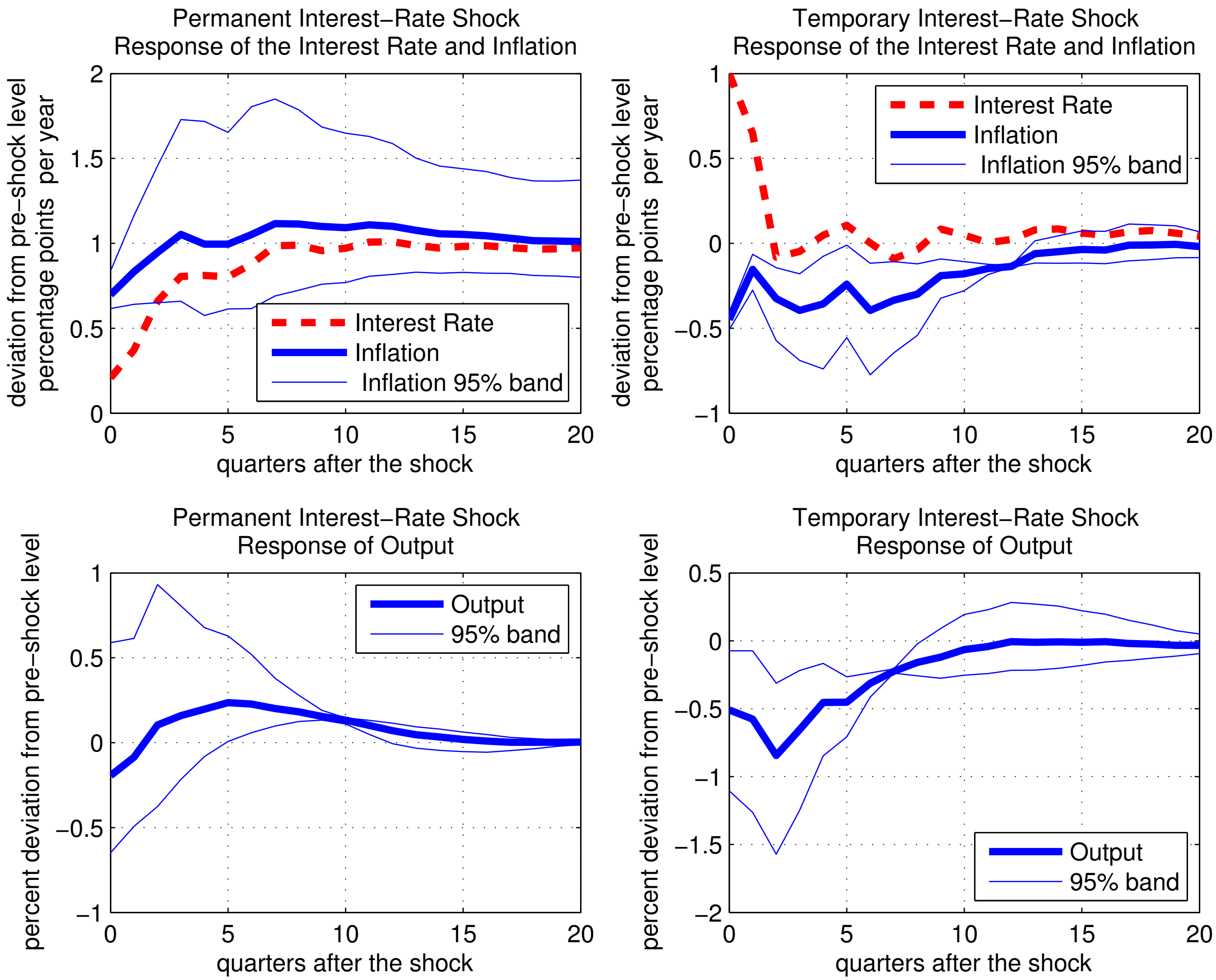
Soon enough these economies find themselves with zero nominal rates and with the low-inflation problem not going away.

At some point, the Fisher effect kicks in, perpetuating the low-interest-rate low-inflation equilibrium.

In this paper I estimate an SVAR model with temporary and permanent monetary shocks using U.S. and Japanese data. The estimated model produces dynamics consistent with the neo-Fisherian prediction that a credible and gradual increase of nominal interest rates to normal levels can generate a quick reflation of the economy with low real interest rates and no output loss.

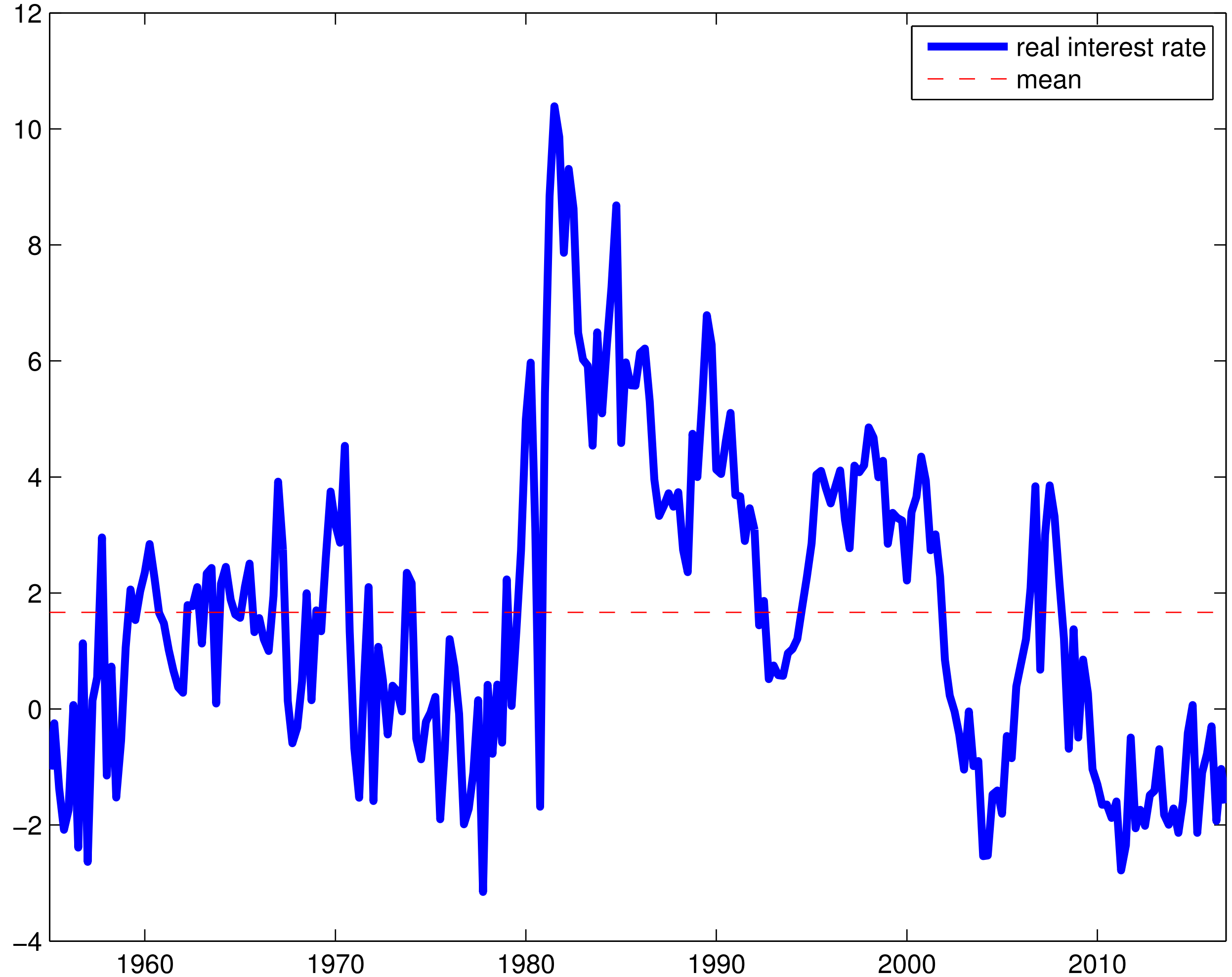
EXTRA

Impulse Responses to Interest-Rate Shocks without Restricting the Impact Effect of Permanent interest-Rate Shocks on the Nominal Interest Rate (C_{31})



Notes. 4 lags estimation on U.S. data.

The Real Interest Rate: United States 1954:4 to 2016:4



Notes. The figure plots the realized real interest rate, defined as $i_t - \pi_{t+1}$ and expressed in percent per year. Quarterly frequency.

Measurement Errors

I assume that Δy_t, r_t, and Δi_t are observed with error. Letting o_t be the vector of variables observed in quarter t, I assume that

$$o_t = \begin{bmatrix} \Delta y_t \times 100 \\ r_t \\ \Delta i_t \end{bmatrix} + \mu_t \tag{4}$$

where μ_t is a 3-by-1 vector of measurement errors distributed i.i.d. $N(\emptyset, R)$, with R diagonal.

State-Space Form

Let

$$\xi_t \equiv \begin{bmatrix} \widehat{Y}_t \\ \widehat{Y}_{t-1} \\ \vdots \\ \widehat{Y}_{t-L+1} \\ u_t \end{bmatrix}.$$

Then the system can be written as follows:

$$\xi_{t+1} = F\xi_t + P\epsilon_{t+1}$$

$$o_t = A' + H'\xi_t + \mu_t,$$

where the matrices F, P, A, and H are known functions of B_i, $i = 1, \ldots L$, C, ρ, ψ, etc.

This representation allows for the use of the Kalman filter to evaluate the likelihood function.

Priors

• In the spirit of the Minnesota Prior (MP), I assume that at the prior mean the elements of $\widehat{Y}_t$ follow univariate autoregressive processes $(B_1(j,k) = 0\ \forall j \neq k,\ B_i(j,k) = 0\ \forall i > 1, j, k)$.

• Also as in the MP, I impose higher prior standard deviations on the diagonal elements of B_1 than on the remaining elements of B_i for $i = 1, \ldots, L$.

• I assume that the prior distribution of C_{21}, governing the impact effect of a permanent interest-rate shock on inflation, is $N(-1, 1)$. The mean of -1 implies a prior belief that the impact effect of a permanent interest rate shock on inflation, given by $1 + C_{21}$, can be positive or negative with equal probability.

• I impose nonnegative serial correlations on exogenous shocks $\rho_{ii} \geq 0$, with beta distributions.

• The table on the next slide provides a full description of the assumed prior distributions.

Prior Distributions

Parameter	Distribution	Mean.	Std. Dev.
Main diagonal elements of B_1	Normal	0.95	0.5
Other elements of B_i	Normal	0	0.25
C_{21}	Normal	-1	1
$-C_{12}, -C_{22}, 1 + C_{31}$	Gamma	1	1
Other elements of C	Normal	0	1
$\psi_{ii},\ i = 1, 2, 3, 4$	Gamma	1	1
$\rho_{ii},\ i = 1, 2, 3$	Beta	0.3	0.2
ρ_{44}	Beta	0.7	0.2
$100 \times \Delta X^n, r, \Delta X^m$	Normal	mean(o_t)	$\sqrt{\frac{\text{var}(o_t)}{T}}$
R_{ii}	Uniform	$\frac{\text{var}(o_t)}{10\times 2}$	$\frac{\text{var}(o_t)}{10\times\sqrt{12}}$

Note. T denotes the sample length.

Augmented Dickey-Fuller Tests

- The ADF test fails to reject the null hypothesis that y_t, i_t, and π_t have a unit root at standard confidence levels (p values of 0.705, 0.154, and 0.143, respectively).

- It rejects the hypothesis that $i_t - \pi_t$ has a unit root at standard confidence levels (p value of 0.036).

Impulse Responses

• Point estimates are means of a random sample of size 100 thousand with replacement from an MCMC chain of length 1 million of draws from the posterior distribution of impulse responses.

• 95-percent asymmetric error bands are computed using the Sims-Zha method.

• **Transitory Interest-Rate Shock:** Initial shock is set so that the impact effect on the nominal interest rate is 1 annual percentage point.

• **Permanent Interest-Rate Shock:** Initial shock is set so that on average (over the aforementioned sample of IRFs) the nominal interest rate increases by 1 annual percentage point in the long run.

Augmented Dickey-Fuller Tests

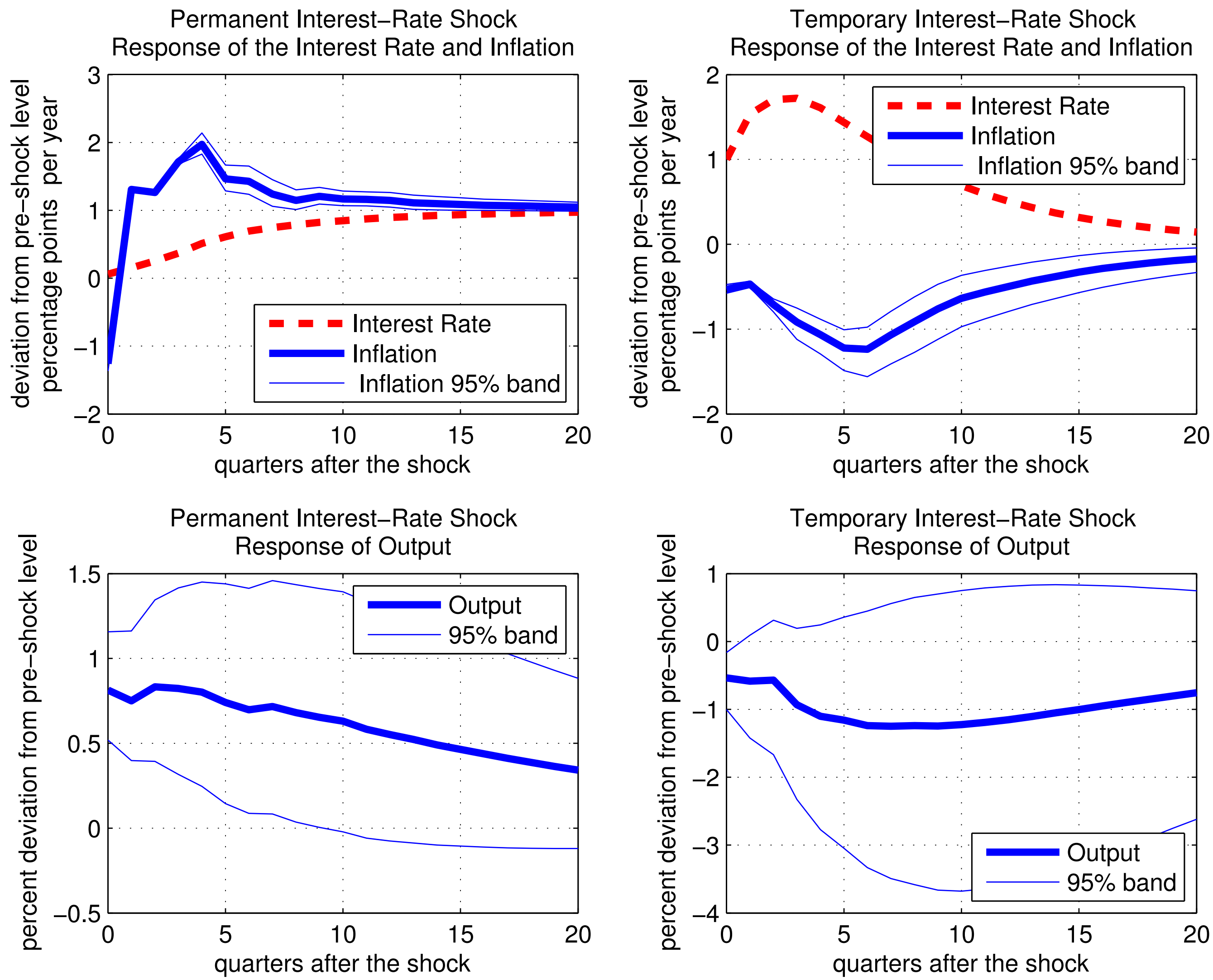
- The ADF test fails to reject the null hypothesis that y_t and i_t have a unit root at conventional confidence levels (p values of 0.414 and 0.549, respectively).

- It rejects the hypothesis that $i_t - \pi_t$ has a unit root (p value of 0.001).

- But it rejects the hypothesis that π_t has a unit root (p value of 0.032).

- This test are robust to starting the sample in 1975:Q1, with associated p values for $y_t, i_t, \pi_t, i_t - \pi_t$ of 0.843, 0.306, 0.027, and 0.021, respectively.

Impulse Responses to Interest-Rate Shocks Estimation: Japanese Data 1955:3–2016:4



Note.4 lags are included.