The Neo-Fisher Effect
Econometric Evidence from Empirical and Optimizing Models

Martín Uribe

Columbia University and NBER

July 10, 2019

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

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 (i) on Inflation (π)

	Long Run Effect on π	**Short** Run Effect on π
Transitory increase in i	0	$\downarrow$
Permanent increase in i	$\uparrow$	$\boxed{\uparrow}$

Entry (2,1) is the Fisher effect.
Entry (2,2) is the Neo-Fisher effect.

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

- **Two Frameworks:**

◇ An empirical model
◇ A New-Keynesian model

- Both models estimated on (the same) postwar data.

Contribution

- The main result of this paper is that a permanent increase in the nominal interest rate causes inflation to increase to a permanently higher level in the short run (within a year) and entails no output loss.

- A temporary increase in the nominal interest rate causes a fall in inflation and output in the short run.

Preliminaries: Evidence on the Fisher Effect

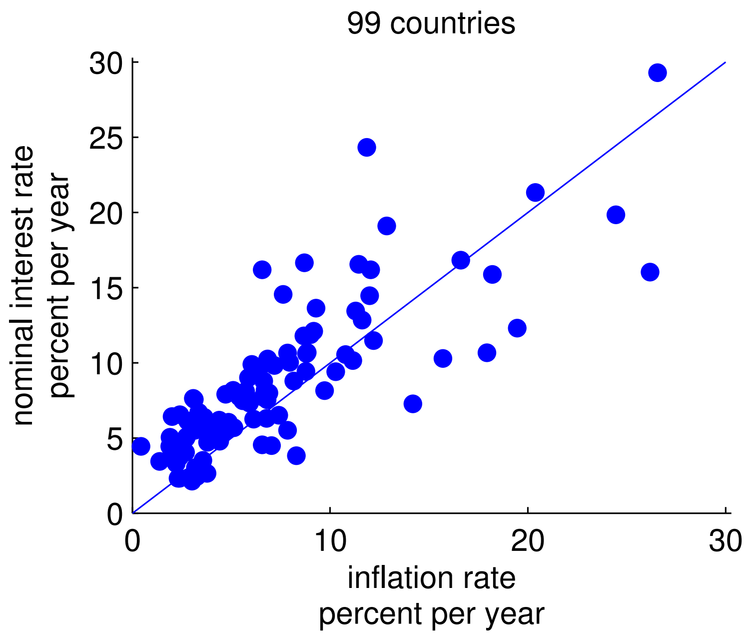
• Let i, r, and π denote average values of the nominal interest rate, the real interest rate, and the inflation rate. Then, assuming that on average expected inflation equals actual inflation, the Fisher equation says that

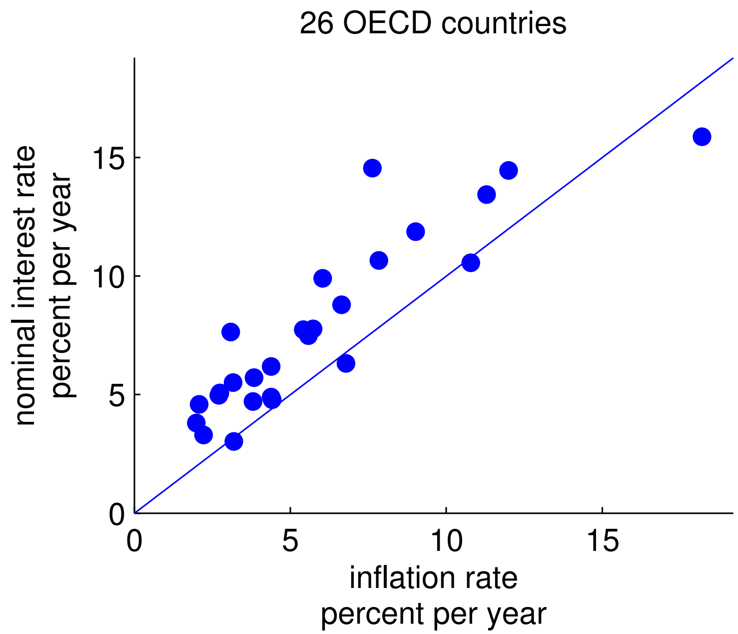
$$i = r + \pi.$$

• Further assuming that the average real interest rate is primarily determined by real factors (demographics, technology, etc.) and that these factors are more stable than monetary factors across time and space, the Fisher equation implies a positive relationship between the nominal interest rate and the rate of inflation.

• The following two figures provide cross-sectional and time series evidence consistent with the validity of the Fisher hypothesis in the long run.

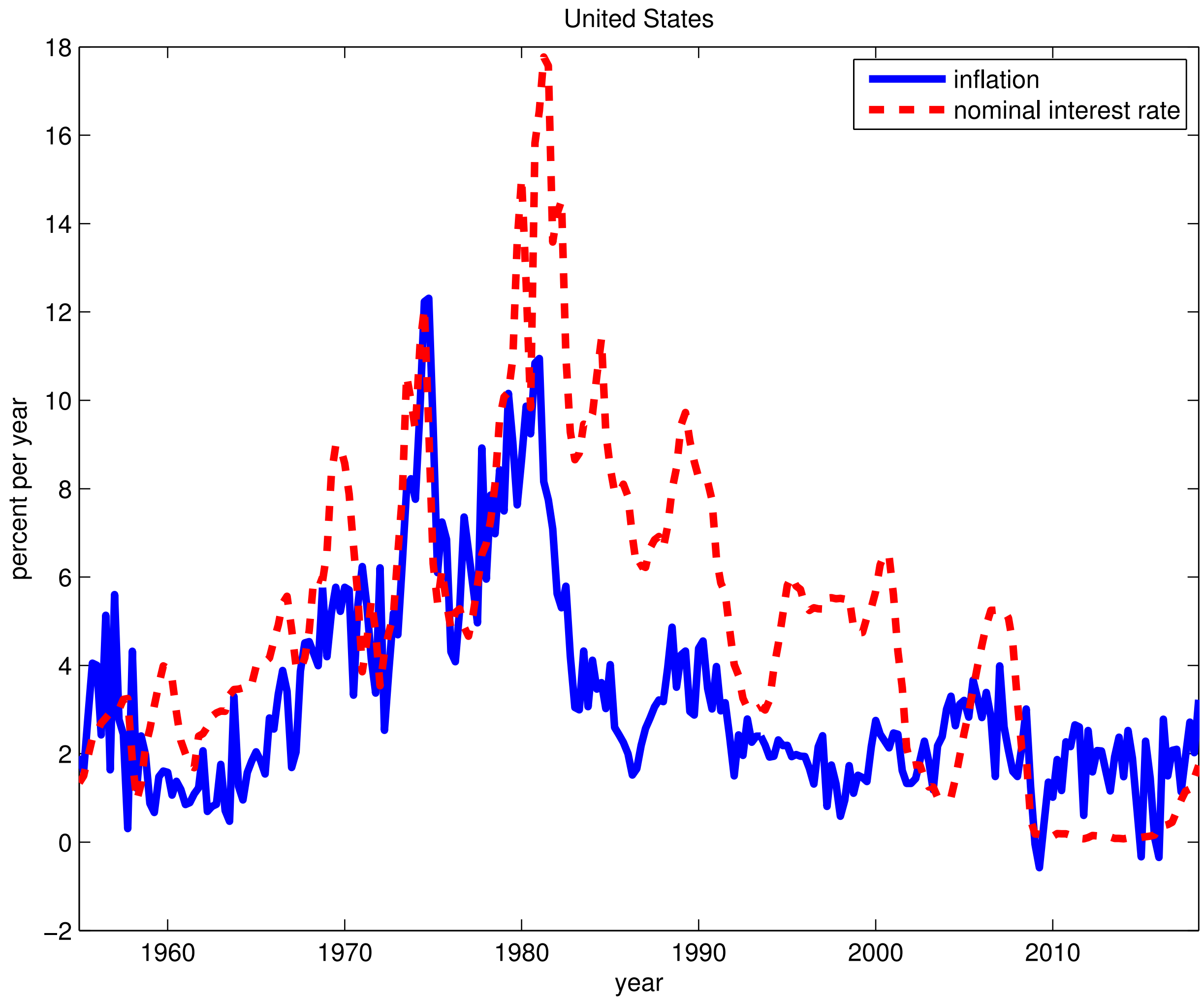
Average Inflation and Nominal Interest Rates: Cross-Country Evidence





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



Notes. Quarterly frequency, annualized rates.

The Empirical Model

$$\begin{bmatrix} y_t \\ \pi_t \\ i_t \end{bmatrix} \equiv \begin{bmatrix} \text{log of real output} \\ \text{inflation} \\ \text{policy rate} \end{bmatrix}; \qquad \begin{bmatrix} \widehat{y}_t \\ \widehat{\pi}_t \\ \widehat{i}_t \end{bmatrix} \equiv \begin{bmatrix} y_t - X_t^n \\ \pi_t - X_t^m \\ i_t - X_t^m \end{bmatrix}.$$

$$\begin{bmatrix} \widehat{y}_t \\ \widehat{\pi}_t \\ \widehat{i}_t \end{bmatrix} = B(L) \begin{bmatrix} \widehat{y}_{t-1} \\ \widehat{\pi}_{t-1} \\ \widehat{i}_{t-1} \end{bmatrix} + C \begin{bmatrix} \Delta X_t^m \\ z_t^m \\ \Delta X_t^n \\ z_t^n \end{bmatrix}$$

$$\begin{bmatrix} \Delta X_t^m \\ z_t^m \\ \Delta X_t^n \\ z_t^n \end{bmatrix} = \rho \begin{bmatrix} \Delta X_{t-1}^m \\ z_{t-1}^m \\ \Delta X_{t-1}^n \\ z_{t-1}^n \end{bmatrix} + \psi \begin{bmatrix} \epsilon_t^1 \\ \epsilon_t^2 \\ \epsilon_t^3 \\ \epsilon_t^4 \end{bmatrix}$$

where X_t^m =permanent monetary shock; X_t^n =permanent nonmonetary shock; z_t^m =transitory monetary shock; and z_t^n =transitory nonmonetary shock. Innovations $\epsilon_t^i \sim$ iid$N(0,1)$, for $i = 1, 2, 3, 4$, and ρ, ψ diagonal.

Observables and Observation Equations

- Δy_t, growth rate of real output per capita.
- $r_t \equiv i_t - \pi_t$, interest-rate-inflation differential.
- $\Delta i_t \equiv i_t - i_{t-1}$, time difference of the nominal interest rate.

We then have the following **observation equations**:

$$\begin{aligned} \Delta y_t &= \widehat{y}_t - \widehat{y}_{t-1} + \Delta X_t^n \\ r_t &= \widehat{i}_t - \widehat{\pi}_t \\ \Delta i_t &= \widehat{i}_t - \widehat{i}_{t-1} + \Delta X_t^m \end{aligned} \qquad (1)$$

Identification Assumptions

• Output (y_t) is cointegrated with the permanent nonmonetary shock (X_t^n).

• Inflation (π_t) is cointegrated with the permanent monetary shock (X_t^m).

• The nominal interest rate (i_t) is cointegrated with the permanent monetary shock (X_t^m).

• A transitory increase in the interest rate ($z_t^m \uparrow$) has a nonpositive impact effect on inflation.

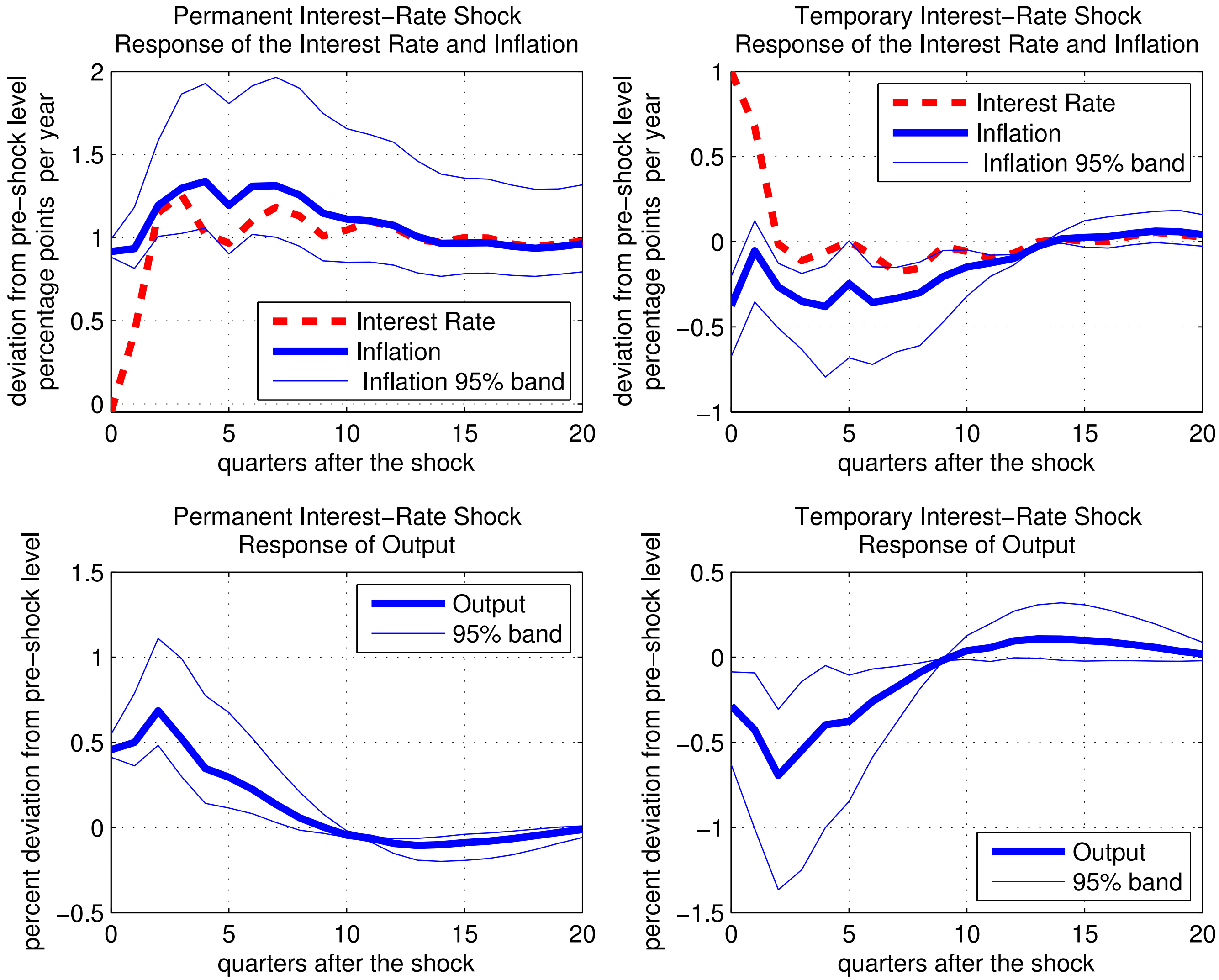
• A transitory increase in the interest rate ($z_t^m \uparrow$) has a nonpositive impact effect on output.

$\diamond$ **Identifiability:** The model passes the Iskrev (2010) test.

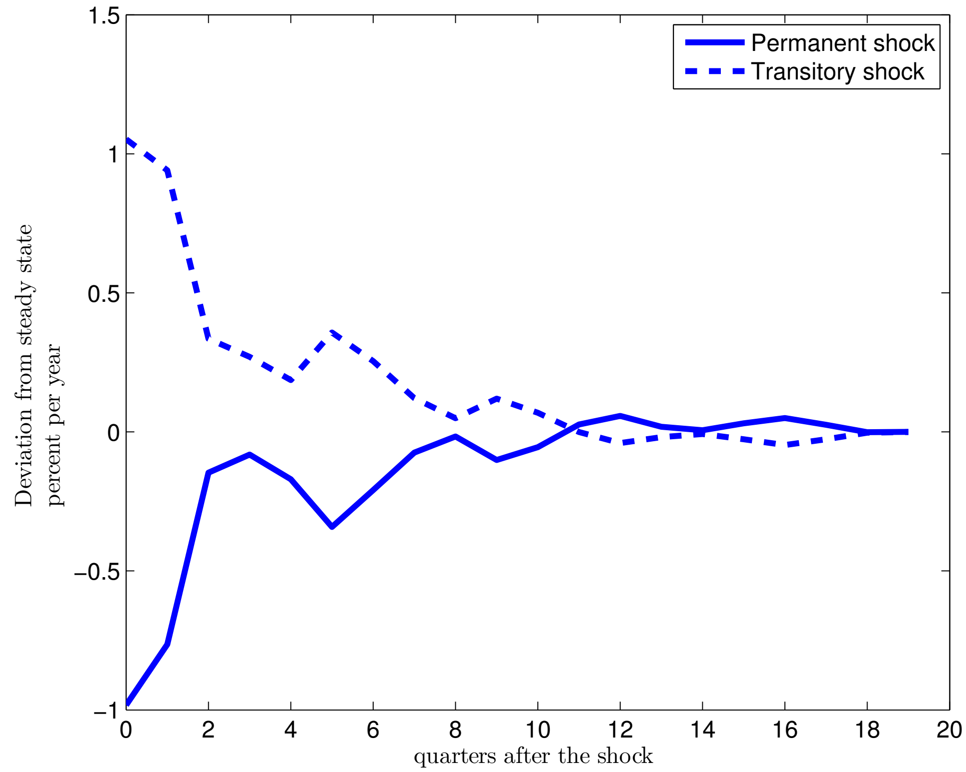
The Neo-Fisher Effect in the Empirical Model

United States, 1954.Q4 to 2018.Q2

Impulse Responses to Interest-Rate Shocks: Empirical Model Estimated on U.S. Data 1954.Q4 to 2018.Q2



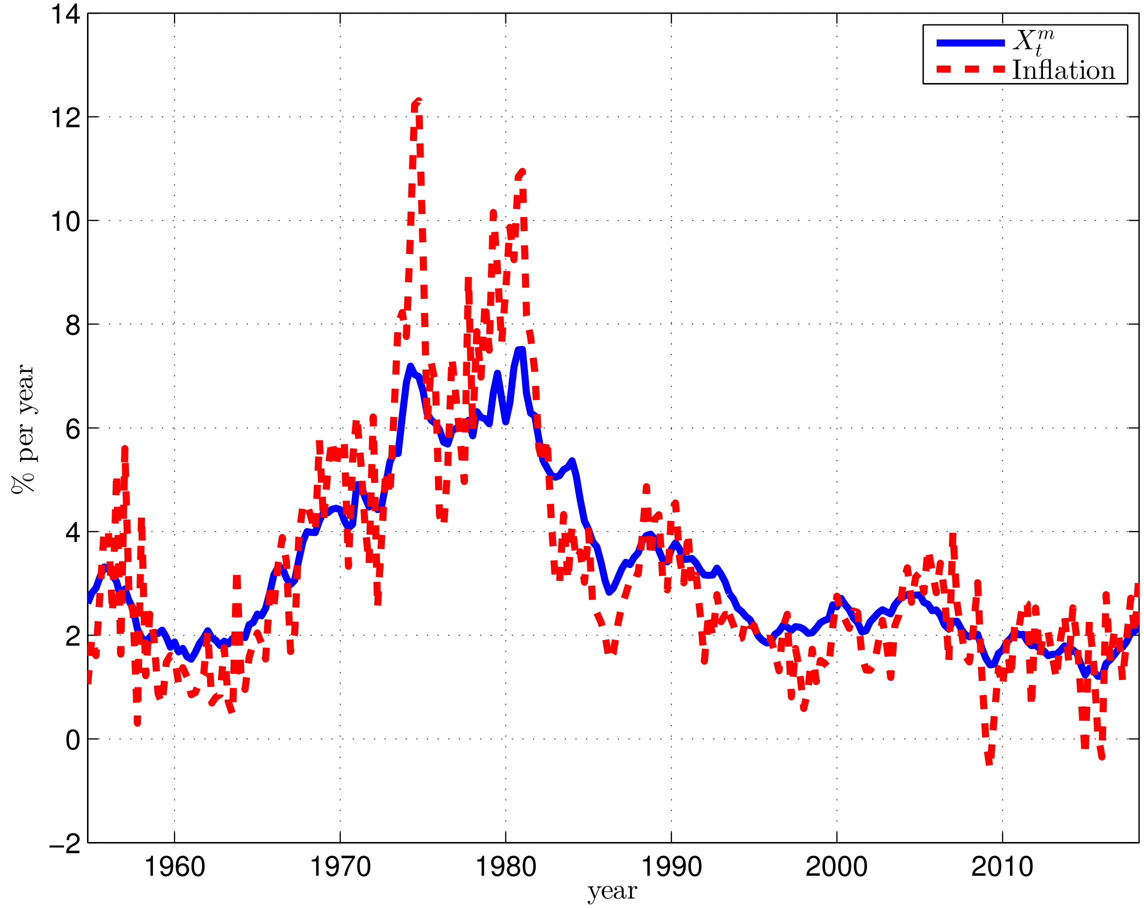
Response of the Real Interest Rate to Permanent and Transitory Interest-Rate Shocks in the Empirical Model



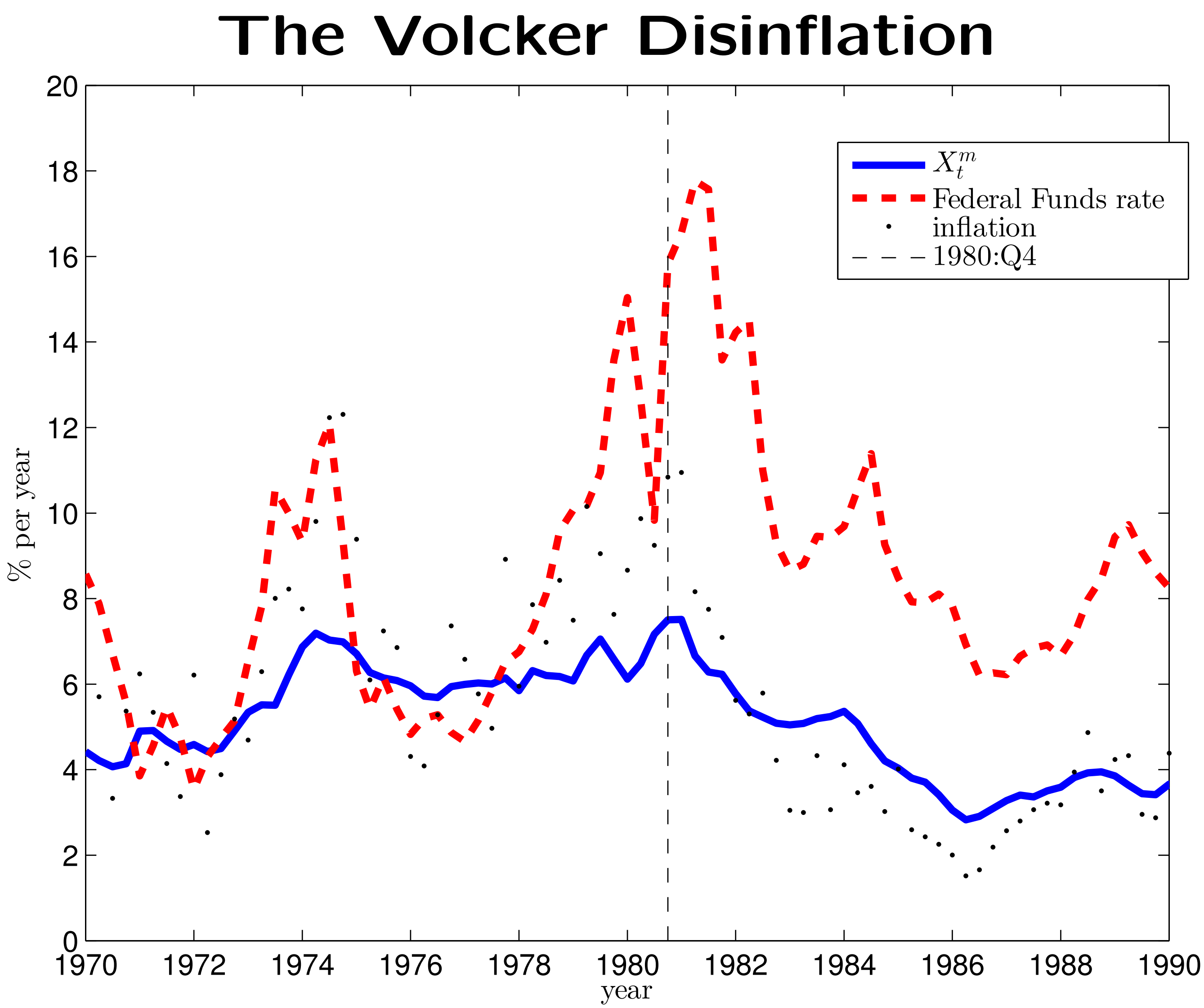
Notes. Posterior mean estimates. The real interest rate is defined as $i_t - E_t\pi_{t+1}$.

U.S. Inflation and Its Permanent Component

π_t and Inferred I Values of X_t^m



Note. Quarterly frequency. Smoothed using the Kalman filter. Initial value of X_t^m normalized to match observed average inflation.


The Volcker Disinflation
X_t^m
Federal Funds rate
inflation
1980:Q4
% per year
year
0
2
4
6
8
10
12
14
16
18
20
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990

Variance Decomposition: Empirical Model

	Δy_t	$\Delta \pi_t$	Δi_t
Permanent Monetary Shock, ΔX_t^m	9.1	44.6	21.9
Transitory Monetary Shock, z_t^m	2.1	6.2	10.9
Permanent Non-Monetary Shock, ΔX_t^n	49.8	27.9	13.5
Transitory Non-Monetary Shock, z_t^n	39.1	21.4	53.7

Note. Posterior means. The variables Δy_t, $\Delta \pi_t$, and Δi_t denote output growth, the change in inflation, and the change in the nominal interest rate, respectively.

Robustness Checks

(1) Truncating the sample at the beginning of the zero-lower-bound period.

(2) Estimating the empirical model on Japanese data.

(3) No cointegration of inflation with the nominal interest rate.

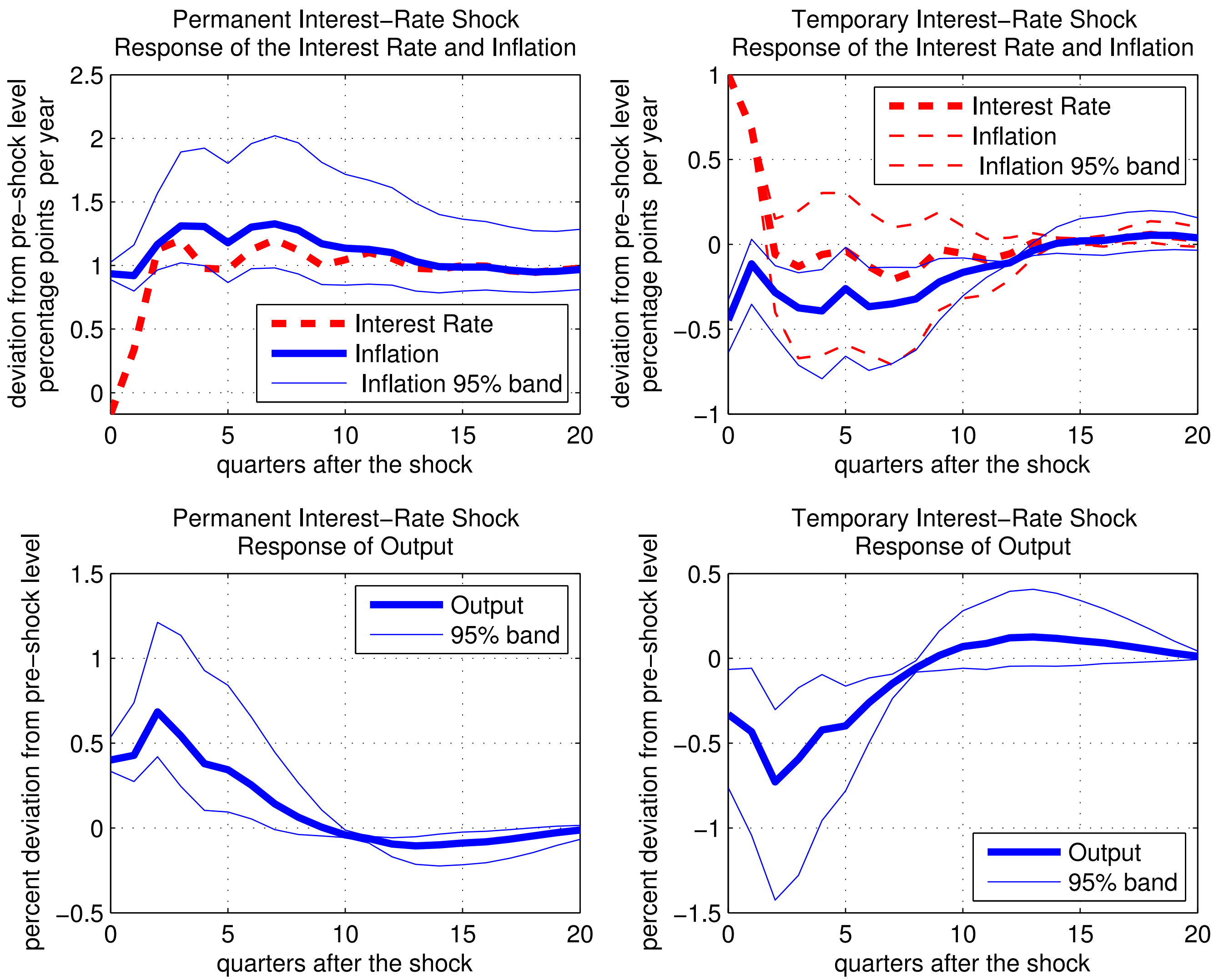
(4) Allowing for correlation between X_t^m and X_t^n.

(5) CEE identification of transitory monetary shock: zero impact effect of z_t^m on π_t and y_t.

Robustness Check 1

Truncating the Sample at the Beginning of the Zero-Lower-Bound Period

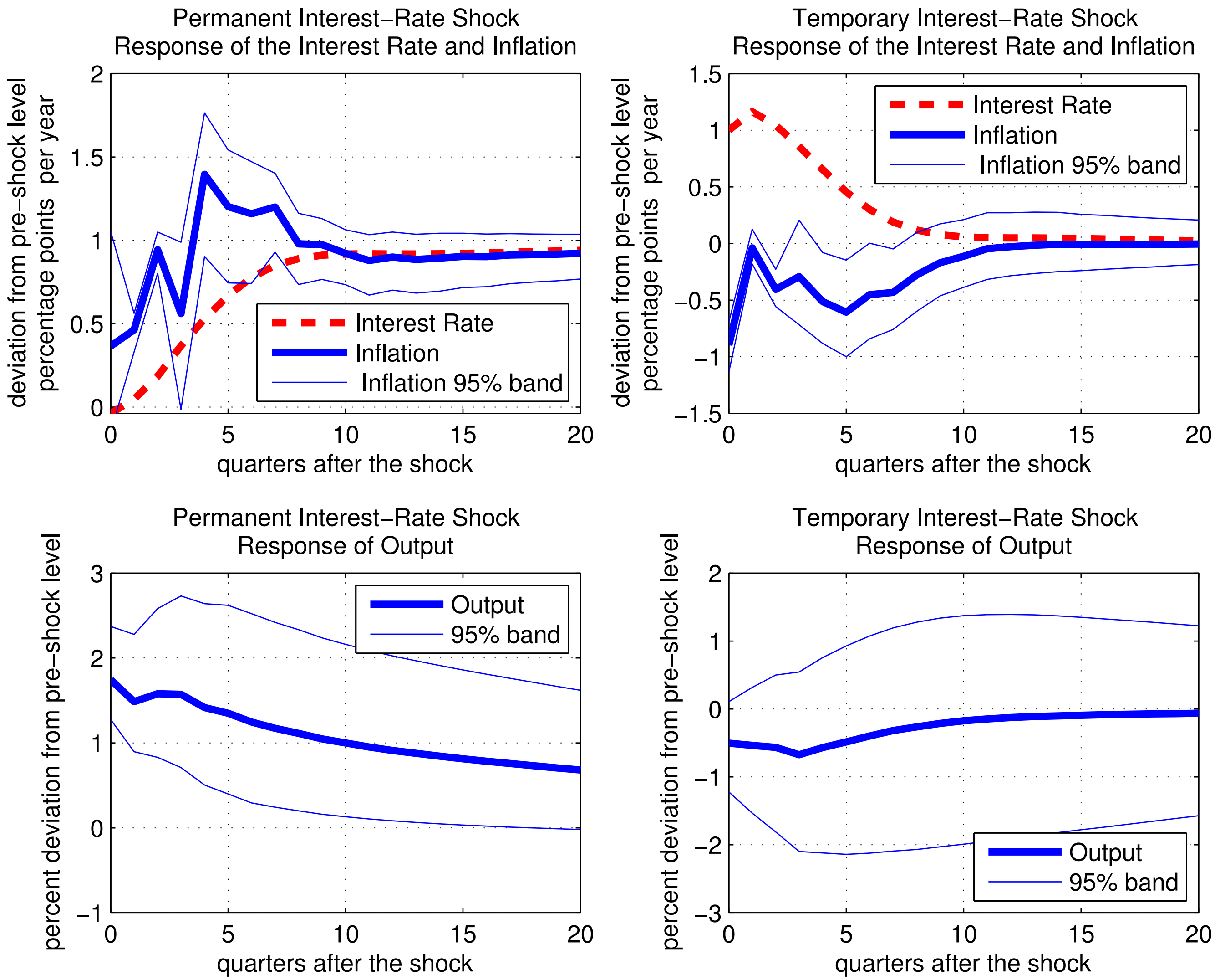
Impulse Responses to Interest-Rate Shocks: Empirical Model, Sample 1954.4 to 2008.4



Robustness Check 2

Estimating the Empirical Model on Japanese Data

Impulse Responses to Interest-Rate Shocks: Empirical Model Estimated on Japanese Data 1955.Q3 to 2016.Q4



Robustness Check 3

No Cointegration of Inflation with the Nominal Interest Rate

A simple regression of the nominal interest rate onto inflation yields:

$$i_t = 1.42 + 1.053\pi_t + \epsilon_t$$

This result suggests some positive correlation between inflation and the real interest rate. To explore this issue more rigorously, consider modifying the empirical model by introducing the parameter γ such that

$$i_t - \gamma X_t^m \text{ and } \pi_t - X_t^m$$

are stationary. The baseline value assumes that $\gamma = 1$ (inflation cointegrated with the nominal inteest rate).

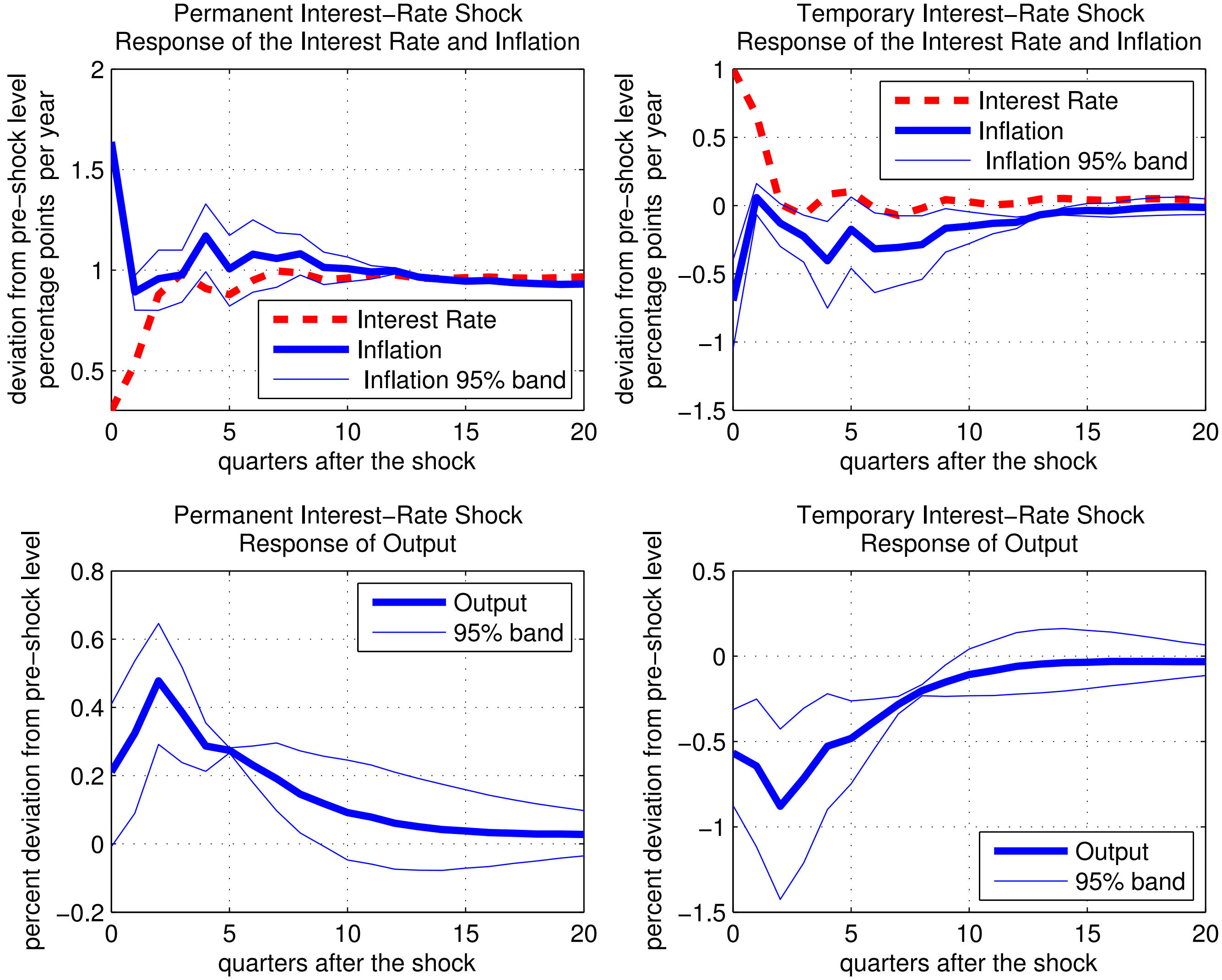
Prior: Assume that $(\gamma - 0.7)/0.6$ has a beta distribution with mean 1/2 and standard deviation 1/4. Thus, γ has support $[0.7, 1.3]$, a mean of 1, and a standard deviaiton of 0.15.

Observables: We can no longer use $r_t \equiv i_t - \pi_t$ as it is nonstationary when $\gamma \neq 1$. Instead, we use $\Delta\pi_t \equiv \pi_t - \pi_{t-1}$.

Posterior: $E(\gamma) = 1.088$; std$(\gamma) = 0.117$, $[5\%, 95\%]$ posteior interval $[0.876, 1.257]$.

Impulse Responses to Interest-Rate Shocks: Empirical Model

Lack of Cointegration of i_t with π_t



A Standard New-Keynesian Model

Households

$$\max\ E_0 \sum_{t=0}^{\infty} \beta^t e^{\xi_t} \left\{ \frac{\left[(C_t - \delta \widetilde{C}_{t-1})(1 - e^{\theta_t} h_t)^{\chi}\right]^{1-\sigma} - 1}{1-\sigma} \right\},$$

subject to

$$\int_0^1 P_{it} C_{it} di + \frac{B_{t+1}}{1+I_t} + T_t = B_t + W_t^n h_t + \Phi_t,$$

$$C_t = \left[\int_0^1 C_{it}^{1-1/\eta} di \right]^{\frac{1}{1-1/\eta}},$$

where C_{it} =consumption of variety i; C_t = consumption of composite good; $\widetilde{C}_t$ = cross-sectional average of C_t; h_t =hours worked; B_t =nominal bond; I_t =nominal interest rate; P_{it} =price of variety i; W_t^n =nominal wage; Φ_t =nominal profit income; T_t =nominal lump-sum taxes; ξ_t =preference shock; θ_t =labor-supply shock.

Firms

$$\max E_0 \sum_{t=0}^{\infty} q_t \left[\frac{P_{it}}{P_t} C_{it} - \frac{W_t^n}{P_t} h_{it} - \frac{\phi}{2} X_t^n \left(\frac{P_{it}}{\widetilde{X}_t^m P_{it-1}} - 1 \right)^2 \right],$$

subject to

$$Y_{it} \geq C_{it}$$

$$C_{it} = C_t \left(\frac{P_{it}}{P_t} \right)^{-\eta},$$

$$Y_{it} = e^{z_t} X_t^n h_{it}^{\alpha},$$

where

$$\widetilde{X}_t^m \equiv (X_t^m)^{\gamma_m} \left(\widetilde{X}_{t-1}^m \right)^{1-\gamma_m} \text{=indexation factor; and}$$

$$X_t^m \text{ =permanent component of inflation, defined later}$$

and P_t = price of composite consumption good; h_{it} =hours employed by firm i; q_t =discount factor; Y_{it} =output of firm i; X_t^n =permanent tech. shock; z_t =transitory tech. shock.

Monetary Policy

$$\frac{1 + I_t}{X_t^m} = \left(\frac{1 + \Pi_t}{X_t^m}\right)^{\alpha_\pi} \left(\frac{Y_t}{X_t^n}\right)^{\alpha_y} e^{z_t^m},$$

where $\Pi_t \equiv P_t/P_{t-1} - 1$ =inflation rate; X_t^m =permanent monetary shock; z_t^m =transitory monetary shock.

Also allow for policy inertia, by including I_{t-1} on the right-hand side.

Fiscal Policy: Passive (or Ricardian); no government consumption.

Estimation

- Same data and sample as in the estimation of the empirical model.

- Estimate a subset of the model's paramters and calibrate the rest.

- Apply likelihood-based Bayesian techniques (same as in the estimation of the empirical model).

Calibrated Parameters in the New Keynesian Model

Parameter	Value	Description
β	0.9982	subjective discount factor
σ	2	inverse of intertemp. elast. subst.
η	6	intratemporal elast. of subst.
α	0.75	labor semielast. of output
g	0.004131	mean output growth rate
θ	0.4055	preference parameter
χ	0.625	preference parameter

Note. The time unit is one quarter.

Prior and Posterior Parameter Distributions: New Keynesian Model

	Prior Distribution			Posterior Distribution			
Param.	Distrib.	Mean	Std	Mean	Std	5%	95%
ϕ	Gamma	50	20	159	31.3	111	214
α_π	Gamma	1.5	0.25	1.83	0.31	1.35	2.37
α_y	Gamma	0.125	0.1	0.687	0.2	0.386	1.03
γ_m	Uniform	0.5	0.289	0.464	0.195	0.201	0.851
γ_I	Uniform	0.5	0.289	0.579	0.108	0.366	0.722
δ	Uniform	0.5	0.289	0.294	0.0508	0.21	0.378
ρ_ξ	Beta	0.7	0.2	0.902	0.0259	0.856	0.941
ρ_θ	Beta	0.7	0.2	0.673	0.201	0.305	0.954
ρ_z	Beta	0.7	0.2	0.667	0.206	0.289	0.954
ρ_g	Beta	0.3	0.2	0.403	0.0915	0.236	0.538
ρ_{gm}	Beta	0.3	0.2	0.331	0.176	0.0553	0.625
ρ_{zm}	Beta	0.3	0.2	0.195	0.126	0.0346	0.432
σ_ξ	Gamma	0.01	0.01	0.0251	0.00393	0.0199	0.0325
σ_θ	Gamma	0.01	0.01	0.00164	0.0013	0.000119	0.00417
σ_z	Gamma	0.01	0.01	0.00124	0.001	9.22e-05	0.00318
σ_g	Gamma	0.01	0.01	0.00626	0.000841	0.00492	0.00769
σ_{gm}	Gamma	0.0025	0.0025	0.00103	0.00032	0.000567	0.0016
σ_{zm}	Gamma	0.0025	0.0025	0.00155	0.000271	0.00107	0.00189

Observatons on Estimation

• Parameters are estimated with significant uncertainty (common feature of estimated small optimizing macro models).

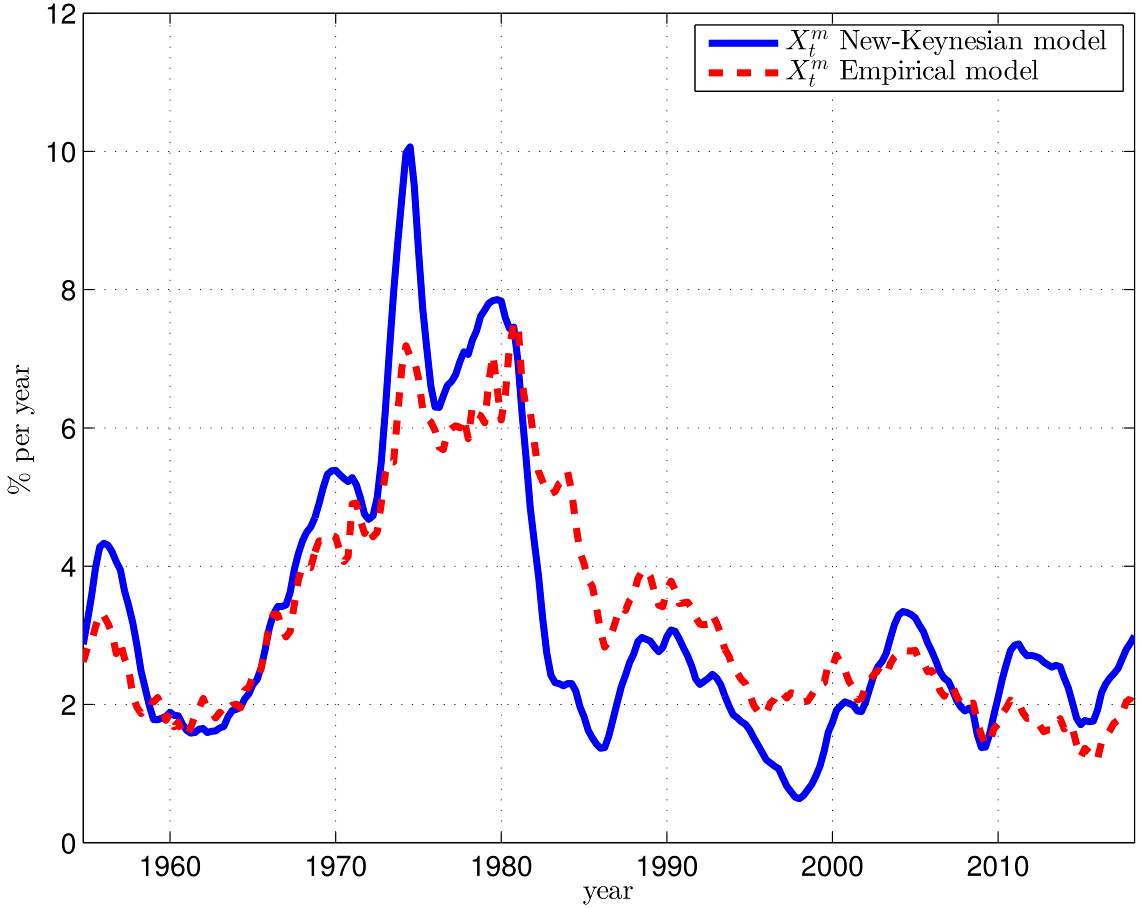
• Nonetheless, the estimation is successful along three dimensions:

⋄ The data speaks with a strong voice with respect to the degrees of price stickiness, ϕ, and habit formation δ, which define the propagation of nominal and real shocks.

• The optimizing model recovers a permanent monetary shock, X_t^m, similar to the one inferred from the empirical model (see next slide).

⋄ The optimizing model predicts a contribution of permanent monetary shocks to inflation changes similar to that predicted by the empirical model (see the slide after the next).

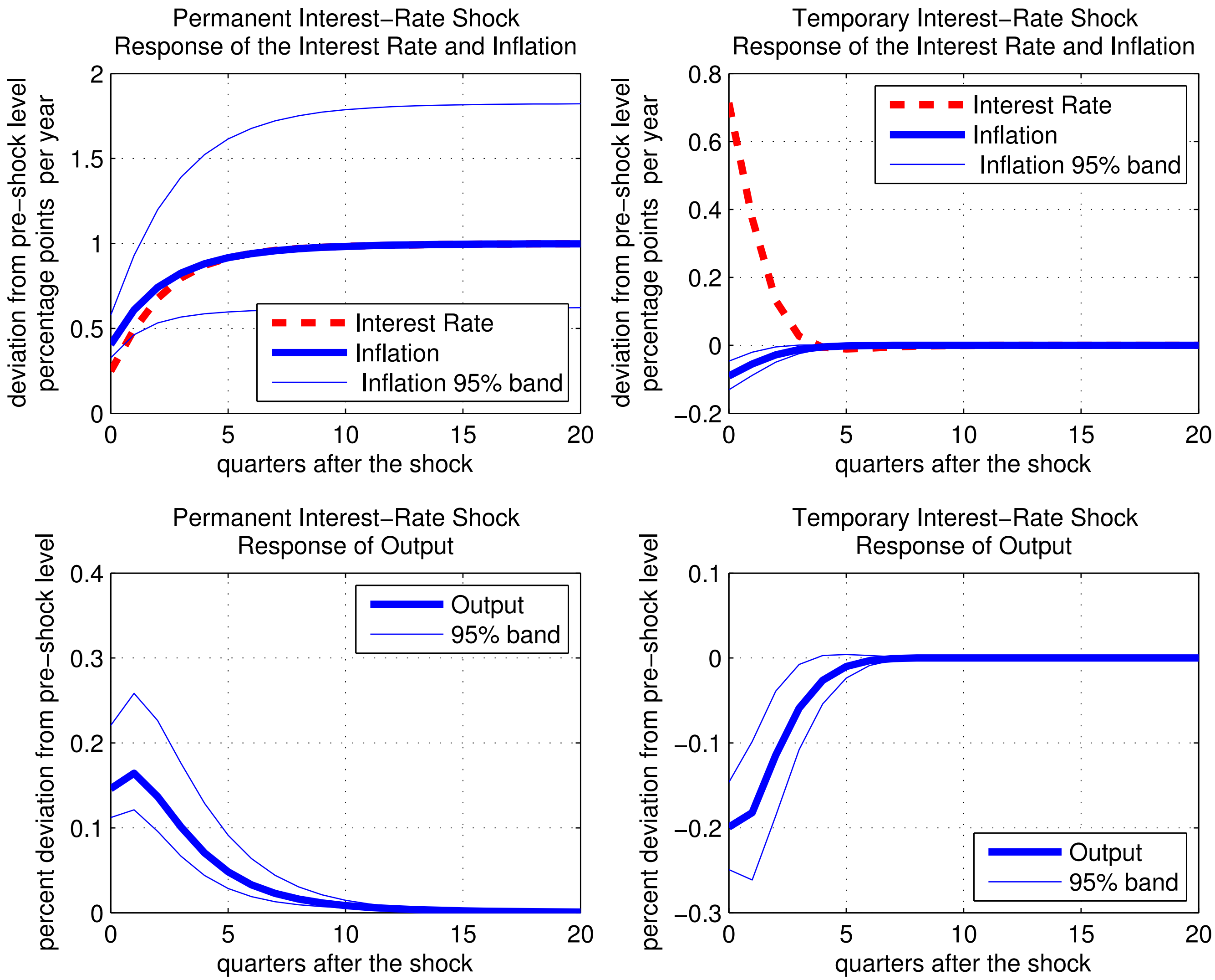
Inflation and Its Permanent Component: New-Keynesian Model



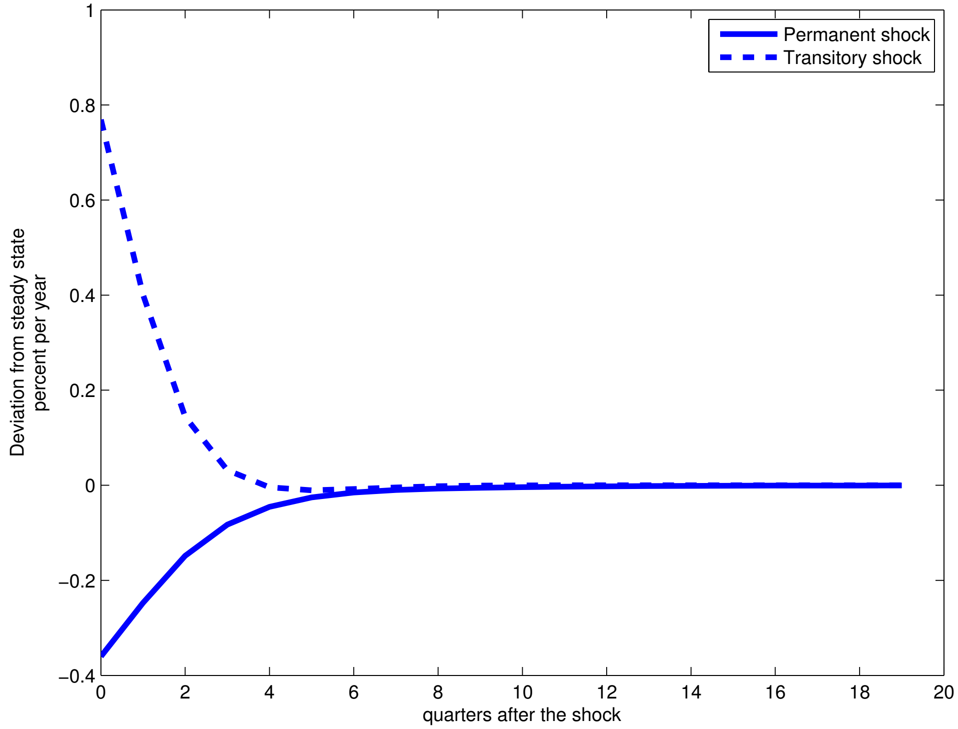
Variance Decomposition: New Keynesian Model

	Δy_t	$\Delta \pi_t$	Δi_t
Permanent Monetary Shock, g_t^m	1.7	42.8	9.3
Transitory Monetary Shock, z_t^m	3.0	2.1	35.7
Permanent Productivity Shock, g_t	84.7	2.2	4.8
Transitory Productivity Shock, z_t	0.4	5.1	2.1
Preference Shock, ξ_t	9.7	42.8	46.0
Labor-Supply Shock, θ_t	0.4	5.1	2.0

Impulse Responses to Interest-Rate Shocks: New Keynesian Model Estimated on U.S. Data 1954.Q4 to 2018.Q2



Response of the Real Interest Rate to Permanent and Transitory Interest-Rate Shocks in the New-Keynesian Model



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

Observations on the Previous Three Figures

The main results from the empirical model carry over to the optimizing model:

- In response to a permanent increase in the interest rate, inflation converges to its higher long-run value in the short run.

- The adjustment takes place in the context of low real rates and does not cause output loss.

- A temporary increase in the nominal interest rate triggers a fall in inflation, an increase in real rates, and a contraction in real activity.

Robustness Checks

(1) Truncating the sample at the beginning of the zero-lower-bound period.

(2) Estimating the empirical model on Japanese data.

(3) Allowing for indexation to past inflation.

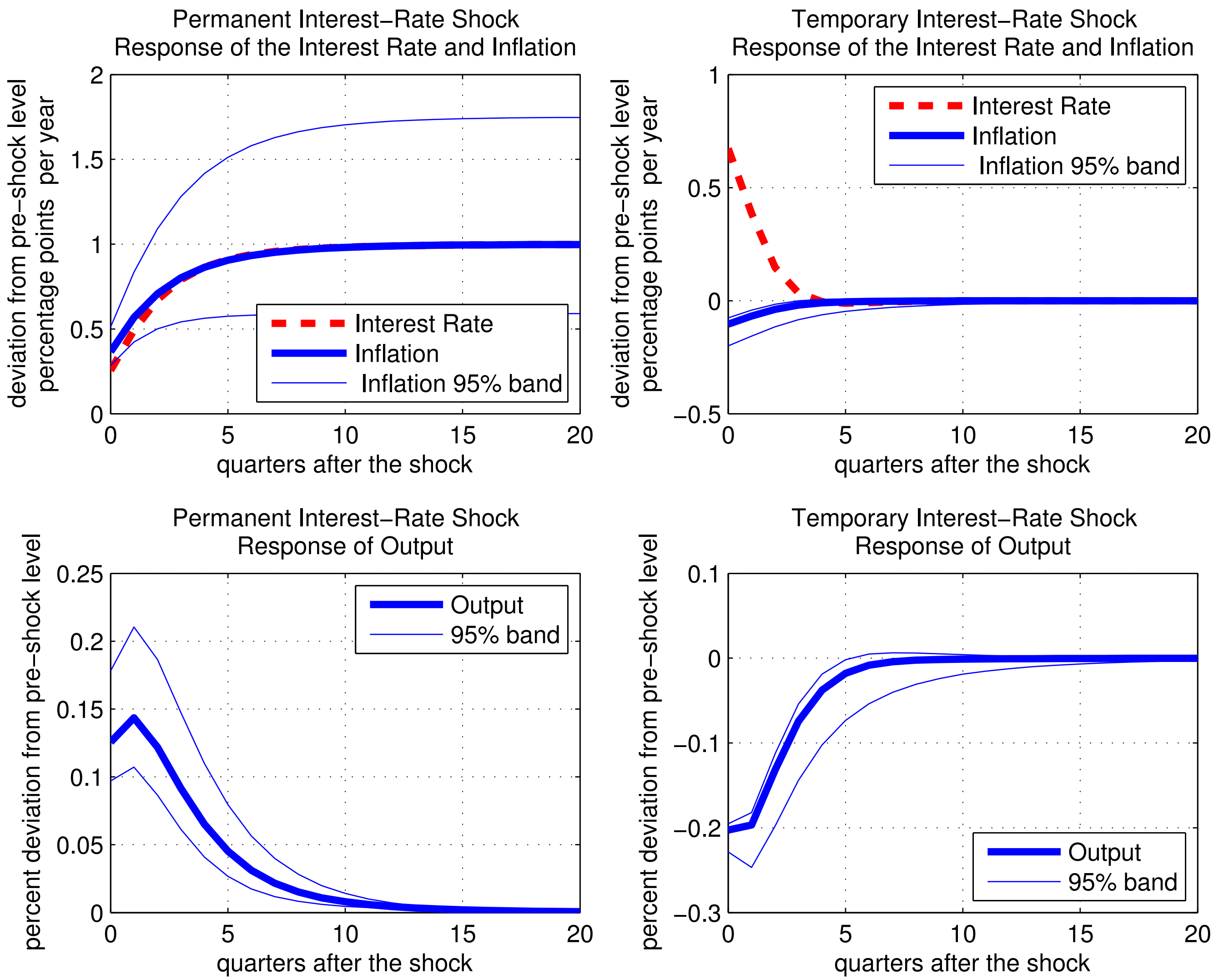
(4) Add a second transitory monetary shock with high persistence to compete for the data with the permanent monetary shock.

(5) Allowing for long memory indexation, by drawing γ_m from the lowest decile of its posterior distribution. (In EXTRAS.)

Robustness Check 1

Truncating the Sample at the Beginning of the Zero-Lower-Bound Period

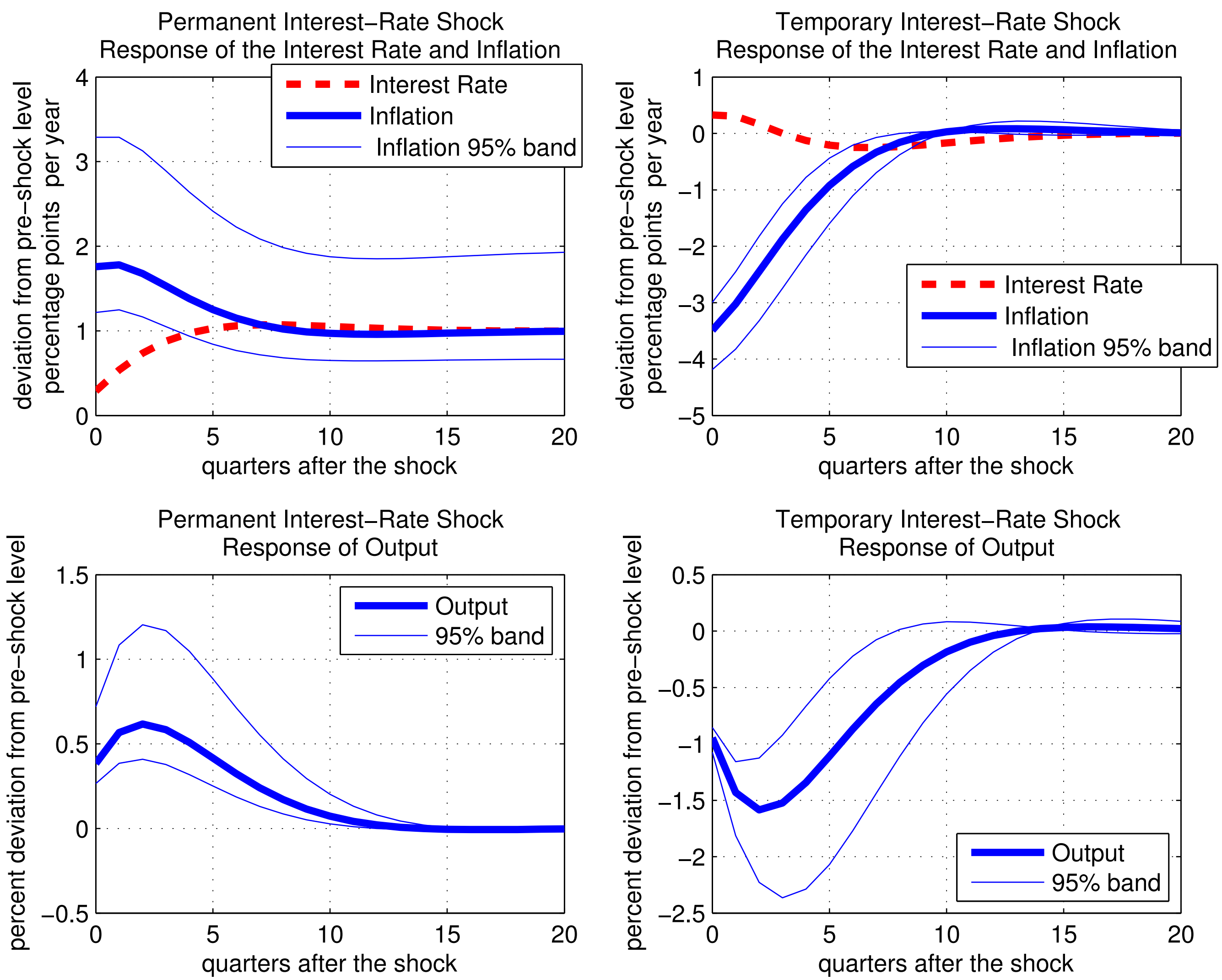
Impulse Responses to Interest-Rate Shocks: New-Keynesian Model Estimated on U.S. Data 1954.4 to 2008.4



Robustness Check 2

Estimating the New-Keynesian Model on Japanese Date

Impulse Responses to Interest-Rate Shocks in the New Keynesian Model Estimated on Japanese Data 1955.Q3 to 2016.Q4



Robustness Check 3

Allowing for Indexation to Past Inflation

Allowing for Indexation to Past Inflation

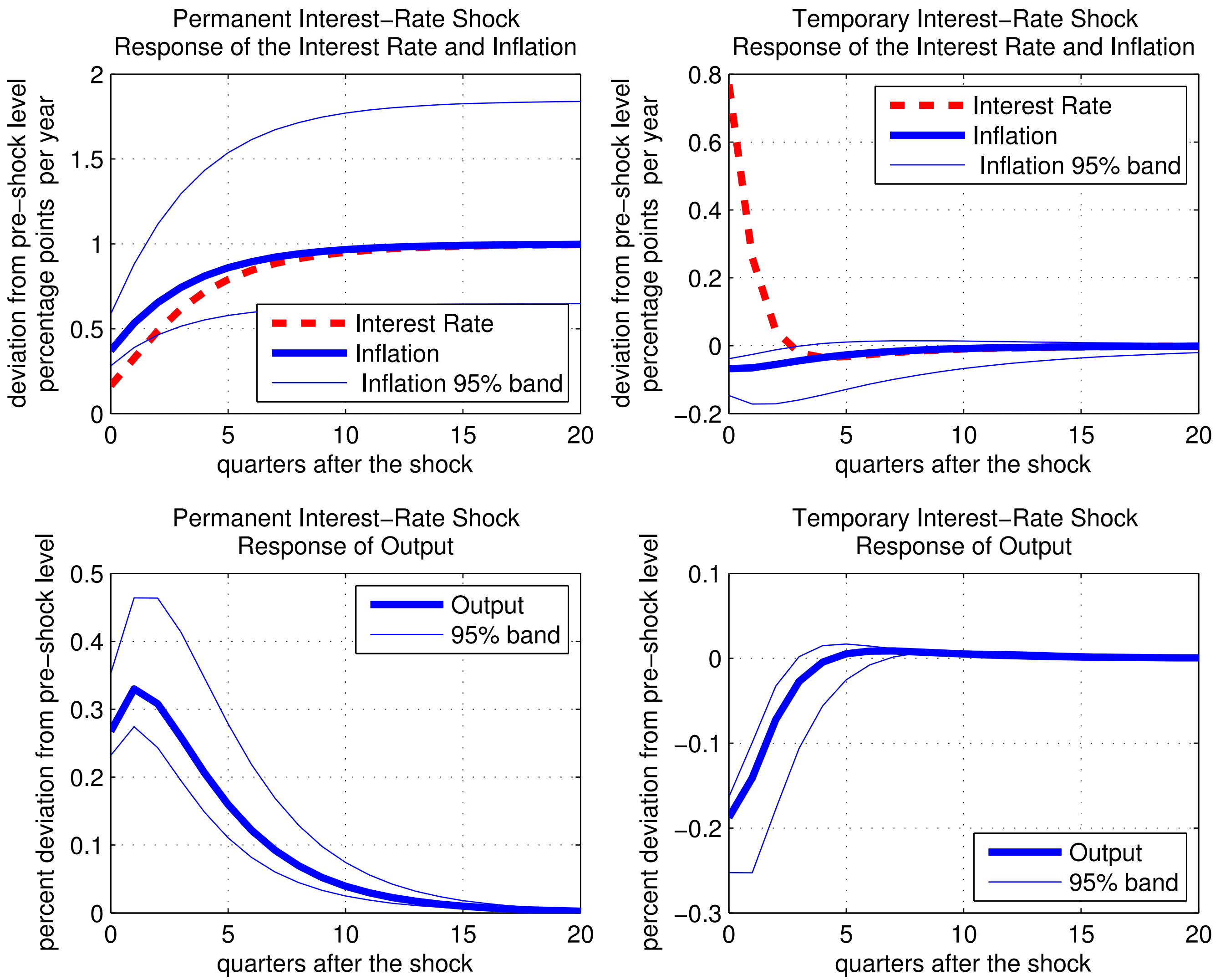
Assume that the indexation factor $\widetilde{X}_t^m$ now takes the form

$$\widetilde{X}_t^m = \left[X_t^{m\gamma_{mm}} (1 + \Pi_{t-1})^{1-\gamma_{mm}} \right]^{\gamma_m} (\widetilde{X}_{t-1}^m)^{1-\gamma_m}$$

with the new parameter $\gamma_{mm} \in [0, 1]$.

Reestimating the model yields a mean posterior value of γ_{mm} of 0.061 and a posterior standard deviation of 0.058, suggesting that indexation to past inflation is relevant. The next slide displays the implied impulse responses to permanent and temporary monetary shocks.

Impulse Responses to Interest-Rate Shocks: Allowing for Indexation to Past Inflation in the New Keynesian Model



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 an empirical model and an optimizing model with temporary and permanent monetary shocks using U.S. and Japanese data. The estimated models 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.

EXTRAS

Extras Empirical Model

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

$$o_t = \begin{bmatrix} \Delta y_t \times 100 \\ r_t \\ \Delta i_t \end{bmatrix} + \mu_t \tag{2}$$

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

$$\widehat{Y}_t \equiv \begin{bmatrix} \widehat{y}_t \\ \widehat{\pi}_t \\ \widehat{i}_t \end{bmatrix}, \quad u_t \equiv \begin{bmatrix} \Delta X_t^m \\ z_t^m \\ \Delta X_t^n \\ z_t^n \end{bmatrix}, \quad \text{and } \xi_t \equiv \begin{bmatrix} \widehat{Y}_t \\ \widehat{Y}_{t-1} \\ \vdots \\ \widehat{Y}_{t-L+1} \\ u_t \end{bmatrix}.$$

Then the system can be written as follows:

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

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

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

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

Data and Estimation Technique

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

• Sample 1954.4 to 2018.2. Ouput is proxied by real GDP per capita. Inflation is measured by the growth rate of the Implicit GDP Deflator. The nominal interest rate is the Effective Federal Funds Rate.

• Robustness: Also estimate the model on Japanese data from 1955.Q3 to 2016.Q4.

• The model is estimated with 4 lags using Bayesian techniques.

Priors

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

• 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	Normal	0	0.25
C_{21}, C_{31}	Normal	-1	1
$-C_{12}, -C_{22}$	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
R_{ii}	Uniform	$\frac{\text{var}(o_t)}{10\times 2}$	$\frac{\text{var}(o_t)}{10\times\sqrt{12}}$

Unit Root Tests

- The Augmented Dickey-Fuller (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 0.60, 0.13, and 0.14, respectively).

- It rejects the hypothesis that $i_t - \pi_t$ has a unit root at standard confidence levels (p value of 0.04.).

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 the posterior-mean long-run increase in the nominal interest rate is 1 percent.

Robustness Check in the Empirical Model

Correlated Monetary and Real Permanent Components

Evolution of the Driving Forces

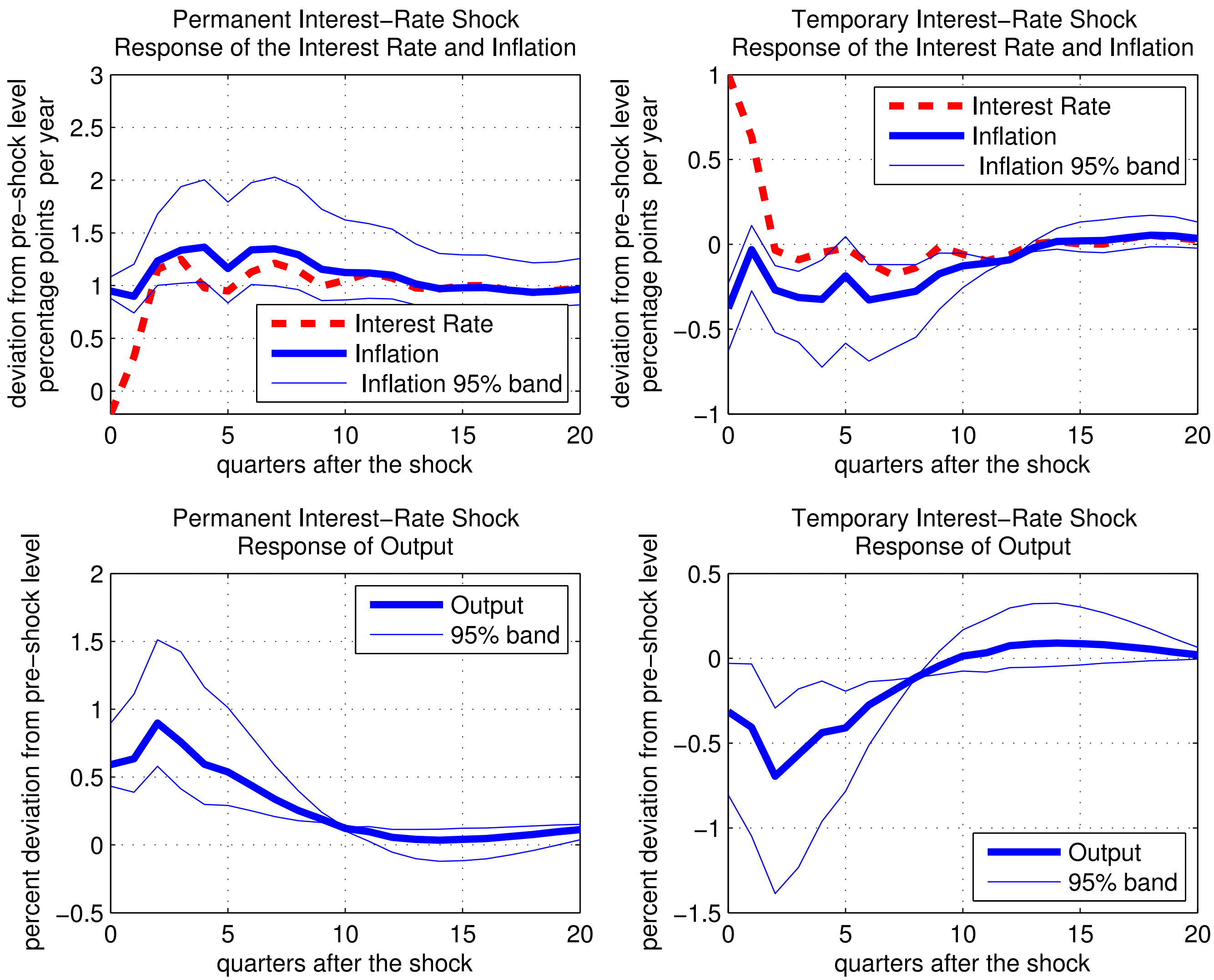
$$\begin{bmatrix} \Delta X_t^m \\ \Delta X_t^n \\ z_t^m \\ z_t^n \end{bmatrix} = \rho \begin{bmatrix} \Delta X_{t-1}^m \\ \Delta X_{t-1}^n \\ z_{t-1}^m \\ z_{t-1}^n \end{bmatrix} + \Gamma \begin{bmatrix} \epsilon_t^1 \\ \epsilon_t^2 \\ \epsilon_t^3 \\ \epsilon_t^4 \end{bmatrix}$$

In the baseline specification, ρ is restricted to be diagonal. Assume now that $\rho_{1,3}$ $\rho_{3,1}$ may be nonzero.

Assume Beta prior distributions for $0.5 + \rho_{1,3}$ and $0.5 + \rho_{3,1}$ with mean 0.5 and standard deviaiton 0.2.

Posterior means: $\rho_{13} = -0.057$ and $\rho_{31} = 0.12$.

Impulse Responses to Interest-Rate Shocks: Empirical Model, Correlated X_t^m and X_t^n



Robustness Check in the New-Keynesian Model

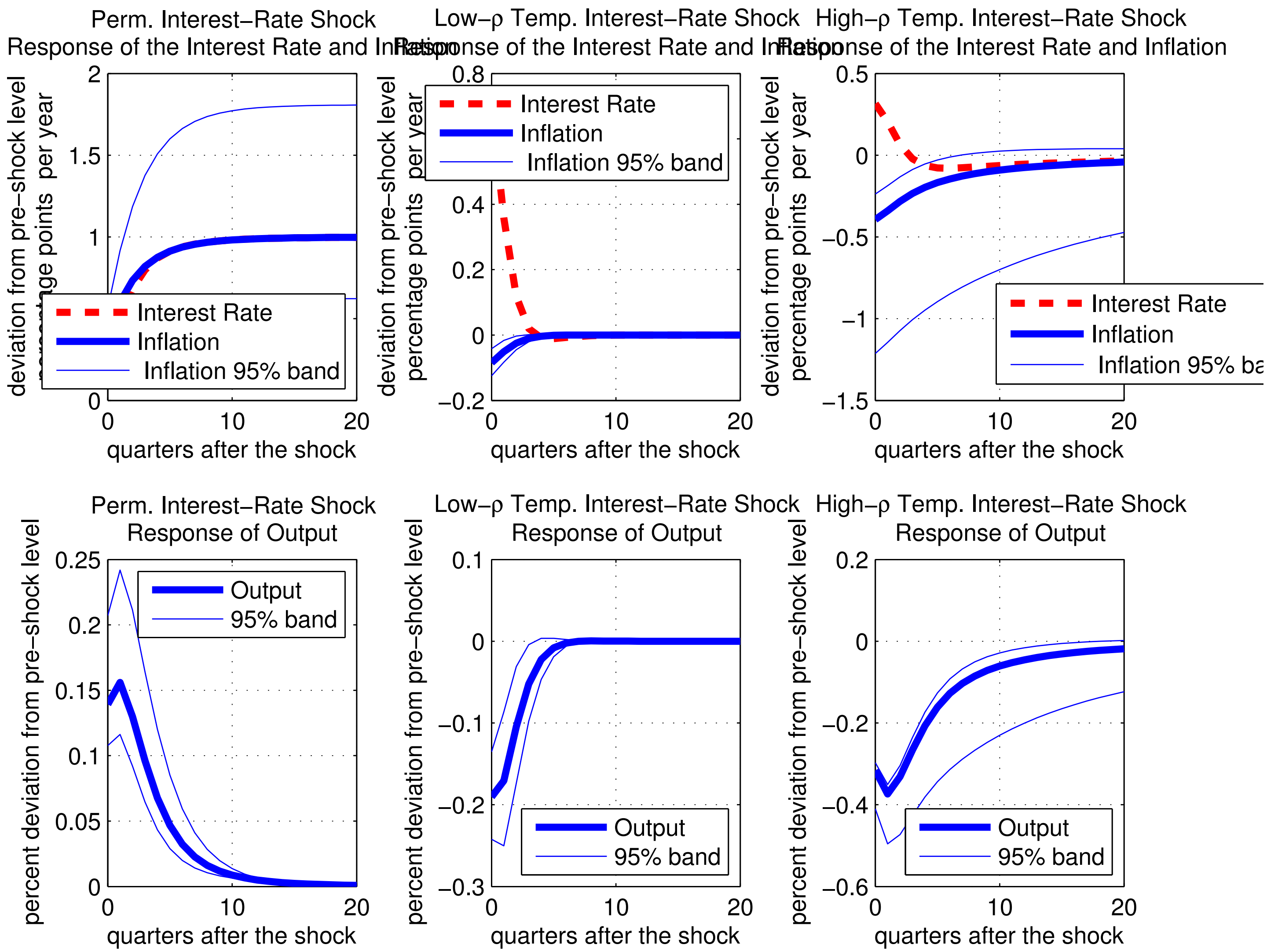
Two Transitory Shocks

Monetary Policy

$$1 + I_t = \left[A \left(\frac{1 + \Pi_t}{X_t^m} \right)^{\alpha_\pi} \left(\frac{Y_t}{X_t^n} \right)^{\alpha_y} X_t^m \right]^{1-\gamma_I} (1 + I_{t-1})^{\gamma_I} e^{z_{1t}^m + z_{2t}^m}$$

Identification by Restrictions on Prior Distributions: Assume that $0.5 z_{m1}$ and $0.5 + 0.5 z_{m2}$ distribute Beta with mean 0.3 and standard deviaiton 0.2.

Impulse Responses to Interest-Rate Shocks: NK Model, Two Transitory Monetary Shocks



Variance Decomposition: New Keynesian Model with Two Transitory Monetary Shocks

	Δy_t	$\Delta \pi_t$	Δi_t
Permanent Monetary Shock, g_t^m	1.5	39.3	9.0
Low-ρ Transitory Monetary Shock, $z_1^m t$	2.4	1.6	30.1
High-ρ Transitory Monetary Shock, $z_2^m t$	1.5	6.1	3.1
Permanent Productivity Shock, g_t	85.1	2.0	4.5
Transitory Productivity Shock, z_t	0.4	5.0	2.3
Preference Shock, ξ_t	8.7	41.3	48.9
Labor-Supply Shock, θ_t	0.4	4.9	2.2

Robustness Check in the New-Keynesian Model

Long-Memory Indexation

$$\gamma_m \in [0.00014, 0.241]$$

The price adjustment cost is

$$\left(\frac{P_{it}}{\widetilde{X}_t^m P_{it-1}} - 1\right)^2$$

and $\widetilde{X}_t^m$ obeys the law of motion

$$\widetilde{X}_t^m \equiv (X_t^m)^{\gamma_m} \left(\widetilde{X}_{t-1}^m\right)^{1-\gamma_m}$$

Posterior mean of γ^m= 0.46

Lowest Decile: $\gamma_m \in [0.00014, 0.241]$

Impulse Responses to Interest-Rate Shocks Conditional on γ_m in Lowest Decile: NK Model,