Taylor Rules with Real-Time Data: A Tale of Two Countries and One Exchange Rate

Tanya Molodtsova, Alex Nikolsko-Rzhevskyy
and David H. Papell

Conference on John Taylor's Contributions to
Monetary Theory and Policy
Federal Reserve Bank of Dallas
October 12, 2007

Theme of the Paper

Taylor rules for monetary policy evaluation

- Real-time data available to central banks
- Forward-looking specifications

Taylor rules for out-of-sample exchange rate predictability

- Real-time data (but not the same data)
- Forward-looking specifications

Estimate Taylor rule interest rate reaction functions for the United States and Germany

Exploit the results to investigate exchange rate predictability for the DM/USD exchange rate

Questions We Ask:

Does the use of real-time data affect monetary policy evaluation?

- (Yes, but more for Germany than for the U.S.)

Are U.S. and German monetary policies different with real-time data?

- (Yes, but mostly in response to the output gap and real exchange rate, not to inflation)

Are forward-looking specifications preferable for Taylor rule estimation?

- (Not necessarily)

Questions We Ask:

Do models with Taylor rule fundamentals provide evidence of exchange rate predictability?

- (Yes, but only with real-time data and heterogeneous coefficients)

Are forward-looking specifications preferable for Taylor rule predictability?

- (No, and they're sometimes worse)

Is bad news about inflation good news for the exchange rate?

- (Yes)

Literature: Taylor rules

- Original formulation: Taylor (1993)
- Real-time estimation

  - Orphanides (1999, 2001) for the U.S.,

  - Gerberding, Worms and Seitz (2004) (Germany) and Nelson (2001) (UK)

- Interest rate smoothing with a forward-looking specification

  - Clarida, Gali, Gertler (1998, 2000)

Literature: Exchange Rate Predictability

- Meese and Rogoff (1983):economic models do not perform better out-of-sample than a naïve no change (random walk) model
- Cheung, Chinn, and Pascual (2005): same conclusion two decades later
- Faust, Rogers and Wright (2001): monetary model for Japan, Germany, Canada, and Switzerland performs better using real-time data than using revised data, but not better than a random walk
- Molodtsova and Papell (2007): exchange rate predictability using Taylor-rule fundamentals with quasi-revised data

Taylor Rule

- The Original Taylor Rule

$$i_t^* = \pi_t + \delta(\pi_t - \pi_t^*) + \gamma y_t + r^*$$

- Taylor (1993): $\delta = \gamma = 0.5$ and $r^* = \pi^* = 2\%$

$(1+\delta) > 1$ - Taylor principle

- Other possible goals:

- Germany might target DM/USD exchange rate and/or money growth rate

Extended Taylor Rule

- Introduce interest rate smoothing

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + v_t$$

- After combining two equations and allowing for additional regressors z_t

$$i_t = (1-\rho)(\mu + \lambda\pi_t + \gamma y_t + \delta z_t) + \rho i_{t-1} + v_t$$

- Estimate this equation for US and Germany using
  - revised and
  - real-time data

Forward-looking regressors (US)

We allow for two forward-looking terms

- Inflation forecast $E\pi_{t+h}$ instead of realized inflation
  - Year-over-year GDP deflator growth rate
  - Constructed by averaging four quarter-over-quarter Greenbook forecasts
- Output gap growth forecast $E\Delta y_{t+h}$
  - Available only for 1-year-ahead horizon
  - Constructed as $E\Delta y_{t+h} = Ey_{t+4} - y_t$
  - Both series come from Orphanides (2003)

Real-time Datasets

- US:
  - Philadelphia Fed dataset: Croushore and Stark (2001)
  - Orphanides (2003): output gap data
  - "Greenbook" dataset: inflation forecasts
- Germany:
  - Bundesbank dataset: Gerberding et al. (2004)

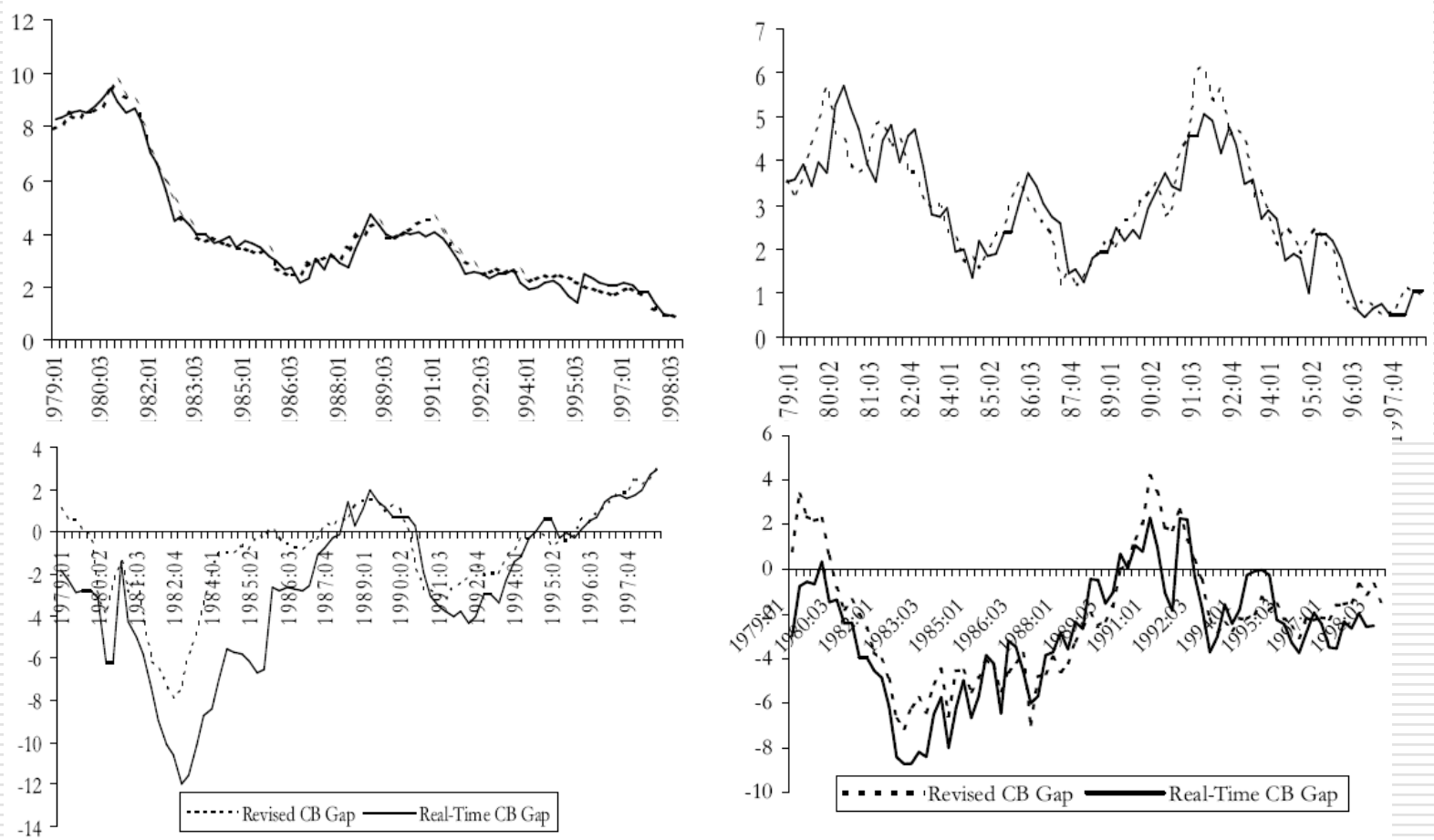
- 1979:1-1998:4 (starting point as in CGG (1998))
- Revised dataset: the 1999:Q1 vintage in both real-time datasets

Real-time vs. Revised: Inflation & GDP Gap

U.S. **Germany**

Inflation

Output gap



U.S. Taylor Rule: Real-time & Revised Data

	Revised Data		*Real-Time Data*	
Inflation Coefficient, λ	1.39	1.50	1.32	1.36
	(0.17)	(0.21)	(0.16)	(0.21)
Output Gap Coefficient, γ	0.11	0.28	-0.01	0.01
	(0.15)	(0.20)	(0.08)	(0.12)
Smoothing Coefficient, ϱ	-	0.55	-	0.54
		(0.18)		(0.18)
R-squared	0.73	0.82	0.73	0.82

- U.S. Monetary policy satisfies the Taylor principle with both revised and real-time data.

German Taylor Rule: Real-time & Revised

	Revised Data					*Real-Time Data*				
Inflation Coefficient, λ	1.36	0.84	0.84	0.88	0.86	1.37	1.19	1.19	1.19	1.20
	(0.15)	(0.51)	(0.36)	(0.43)	(0.34)	(0.14)	(0.48)	(0.27)	(0.48)	(0.27)
Output Gap Coefficient, γ	0.09	1.13	1.27	1.02	1.20	0.23	0.78	0.99	0.78	1.00
	(0.09)	(0.77)	(0.64)	(0.67)	(0.59)	(0.07)	(0.35)	(0.28)	(0.38)	(0.29)
Smoothing Coefficient, ϱ	-	0.89	0.85	0.88	0.85	-	0.87	0.80	0.87	0.80
		(0.07)	(0.07)	(0.08)	(0.07)		(0.06)	(0.06)	(0.06)	(0.06)
Exchange Rate Coefficient, δ_1	-	-	0.09	-	0.08	-	-	0.08	-	0.08
			(0.05)		(0.05)			(0.03)		(0.03)
Money Growth Coefficient, δ_2	-	-	-	-0.23	-0.12	-	-	-	0.01	0.01
				(0.30)	(0.14)				(0.37)	(0.17)
R-squared	0.71	0.95	0.96	0.95	0.96	0.68	0.95	0.95	0.95	0.95

- German monetary policy only satisfies the Taylor principle with real-time data.

Forward-Looking Taylor Rule: Fed's Forecast

	Period t Inflation	*Period t+1 Inflation*	*Period t+2 Inflation*	*Period t+3 Inflation*
Inflation Coefficient, λ	1.33	1.34	1.30	1.34
	(0.21)	(0.23)	(0.26)	(0.27)
Output Gap Coefficient, γ	-0.02	-0.05	-0.08	-0.10
	(0.11)	(0.11)	(0.11)	(0.10)
Smoothing Coefficient, ϱ	0.52	0.54	0.59	0.57
	(0.18)	(0.15)	(0.13)	(0.13)
R-squared	0.82	0.82	0.81	0.82

- "Forward-looking" rule very similar to "backward-looking" rule – Taylor (1999).

Forward-Looking Taylor Rule: Output Gap Growth Forecast

	Period t Inflation	*Period t+1 Inflation*	*Period t+2 Inflation*	*Period t+3 Inflation*
Inflation Coefficient, λ	1.95	2.11	2.16	2.28
	(0.38)	(0.41)	(0.46)	(0.44)
Output Gap Coefficient, γ	0.17	0.17	0.14	0.11
	(0.14)	(0.14)	(0.15)	(0.13)
Output Gap Growth Coefficient	1.07	1.32	1.44	1.54
	(0.51)	(0.56)	(0.65)	(0.60)
Smoothing Coefficient, ϱ	0.54	0.57	0.61	0.59
	(0.16)	(0.13)	(0.12)	(0.12)
R-squared	0.84	0.84	0.83	0.84

- Very different from standard Taylor rules.
- Higher inflation and significant output gap growth coefficient.

Exchange Rate Predictability

- Subtract Taylor rule for Germany from Taylor rule for US:

$$i_t - \tilde{i}_t = \alpha + \alpha_{u\pi}\pi_t - \alpha_{g\pi}\tilde{\pi}_t + \alpha_{uy}y_t - \alpha_{gy}\tilde{y}_t + \alpha_{uz}z_t - \alpha_{gz}\tilde{z}_t + \rho_u i_{t-1} - \rho_g \tilde{i}_{t-1} + \eta_t$$

- If uncovered interest rate parity (UIRP) held:

$$E(\Delta s_{t+1}) = \beta(i_t - \tilde{i}_t)$$

Exchange Rate Predictability

- Combine to produce a forecasting equation:

$$\Delta s_{t+1} = \alpha + \alpha_{u\pi}\pi_t - \alpha_{g\pi}\tilde{\pi}_t + \alpha_{uy}y_t - \alpha_{gy}\tilde{y}_t$$
$$+ \alpha_{uz}z_t - \alpha_{gz}\tilde{z}_t + \rho_u i_{t-1} - \rho_g \tilde{i}_{t-1} + \eta_t$$

- Problems with this specification
  - UIRP does not hold
  - Interest rate adjustments not completed within one quarter
- Use Taylor rule variables but not Taylor rule estimated coefficients

Exchange Rate Predictability

- Two types of Taylor rules:
  - Symmetric - relative inflation and output gap terms only
  - Asymmetric - real DM/USD rate for Germany
- Real-time forecasts require real-time data known to market participants
  - U.S. – Not true for output gap or Greenbook forecast data
  - Germany – Output gap data partially known
- Also use publicly available real-time data
  - Quadratic detrended GDP
  - SPF inflation forecasts

Evaluating Predictability

- We use Clark & West (2006) tests to evaluate our forecasts
- CW Statistics: compare MSPE of the RW model and the Taylor rule model forecasts

$$CW = \frac{\bar{f}}{\sqrt{P^{-1}\hat{V}^{ADJ}}}$$

where

$$\hat{f}_{t+1}^{ADJ} = \hat{e}_{1,t+1}^{2} - \left[\hat{e}_{2,t+1}^{2} - \left(X'_{t+1}\hat{\beta}_t\right)^2\right]$$

- Estimation is done by OLS, rolling regressions, 40 quarter window, 1-step-ahead forecast

CW Statistics: One-Quarter-Ahead DM/USD Forecasts

	w/o Smoothing		*w/ Smoothing*	
	Symmetric	*Asymmetric*	*Symmetric*	*Asymmetric*
Central Bank Output Gaps				
Revised Data	0.358	0.548	0.258	-0.107
	(0.31)	(0.25)	(0.35)	(0.50)
Real-Time Data	-0.936	1.979**	-0.689	1.924**
	(0.77)	(0.02)	(0.70)	(0.03)
Quadratic Detrended Output Gaps				
Revised Data	0.201	0.526	0.210	-0.178
	(0.36)	(0.37)	(0.36)	(0.47)
Real-Time Data	0.009	1.775**	0.314	1.754**
	(0.44)	(0.03)	(0.34)	(0.04)
Mixed Output Gaps: German Central Bank - U.S. Detrended				
Revised Data	0.207	0.352	0.545	0.590
	(0.36)	(0.32)	(0.26)	(0.25)
Real-Time Data	-0.517	1.818**	-0.299	1.794**
	(0.63)	(0.03)	(0.56)	(0.04)

CW Statistics: Forward-Looking, Mixed Output gaps

	w/o Smoothing		*w/ Smoothing*	
	Symmetric	*Asymmetric*	*Symmetric*	*Asymmetric*
Real-Time Data with Greenbook Inflation Forecasts				
Period-t Greenbook Inflation Forecasts	0.032	1.795**	0.677	1.626**
	(0.41)	(0.04)	(0.22)	(0.05)
Period-t+1 Greenbook Inflation Forecasts	0.219	1.783**	0.615	1.683**
	(0.35)	(0.03)	(0.24)	(0.03)
Period-t+2 Greenbook Inflation Forecasts	-0.050	1.600*	0.289	1.689**
	(0.46)	(0.06)	(0.35)	(0.05)
Period-t+3 Greenbook Inflation Forecasts	0.341	1.771**	0.323	1.458*
	(0.31)	(0.04)	(0.33)	(0.07)
Real-Time Data with SPF Inflation Forecasts				
Period-t SPF Inflation Forecasts	-0.047	1.682**	0.611	1.521*
	(0.45)	(0.04)	(0.24)	(0.06)
Period-t+1 SPF Inflation Forecasts	-0.169	1.370*	0.532	1.767**
	(0.49)	(0.08)	(0.26)	(0.04)
Period-t+2 SPF Inflation Forecasts	-0.193	1.264*	0.319	1.611**
	(0.51)	(0.09)	(0.33)	(0.05)
Period-t+3 SPF Inflation Forecasts	0.144	1.526*	0.395	1.416*
	(0.39)	(0.06)	(0.30)	(0.07)

CW Statistics: Forward-Looking, Mixed Output gaps

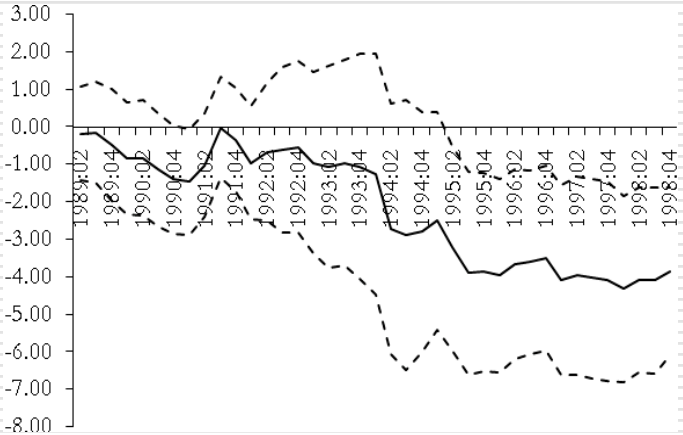
	w/o Smoothing		*w/ Smoothing*	
	Symmetric	*Asymmetric*	*Symmetric*	*Asymmetric*
Real-Time Data with Greenbook Inflation Forecasts and (t+3) Output gap growth				
Period-t Greenbook Inflation Forecasts	-0.456	1.169	0.292	1.264*
	(0.63)	(0.11)	(0.35)	(0.09)
Period-t+1 Greenbook Inflation Forecasts	-0.293	1.223*	0.252	1.290*
	(0.55)	(0.10)	(0.36)	(0.09)
Period-t+2 Greenbook Inflation Forecasts	-0.556	0.938	-0.060	1.445*
	(0.66)	(0.15)	(0.47)	(0.07)
Period-t+3 Greenbook Inflation Forecasts	-0.158	1.253*	-0.156	1.116
	(0.50)	(0.10)	(0.51)	(0.11)
Real-Time Data with SPF Inflation Forecasts and (t+3) Output gap growth				
Period-t SPF Inflation Forecasts	-0.485	1.060	0.185	1.120
	(0.64)	(0.13)	(0.39)	(0.13)
Period-t+1 SPF Inflation Forecasts	-0.603	0.769	0.119	1.350*
	(0.66)	(0.19)	(0.41)	(0.08)
Period-t+2 SPF Inflation Forecasts	-0.651	0.619	-0.064	1.299*
	(0.68)	(0.24)	(0.47)	(0.09)
Period-t+3 SPF Inflation Forecasts	-0.359	0.966	-0.155	0.928
	(0.57)	(0.14)	(0.52)	(0.17)

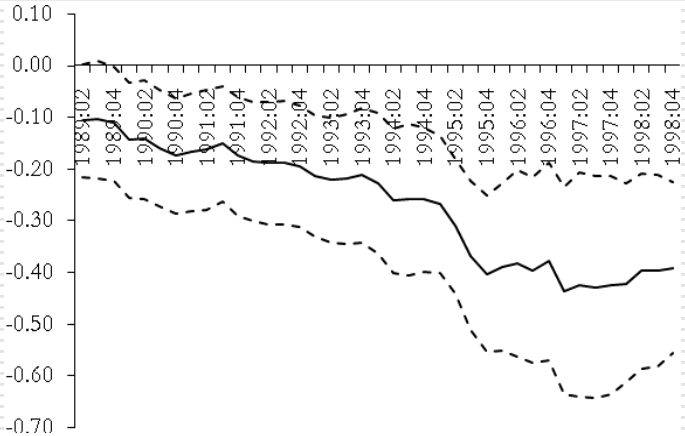
Forecasting Equation Coefficients

Inflation Coefficients

Real DM/USD Rate Coefficient

U.S.





Germany

Extensions

Estimation:

- Greenbook forecasts not available past 2002
- No similar published forecasts for other countries
- Use publicly available data to best replicate Greenbook inflation and output gap forecasts
- Apply to U.S. past 2002 and to other countries

Predictability:

- Need data from 1973 for Meese-Rogoff comparison
- Real-time data not generally available
- Use real-time OECD data from 1999

Both:

- Estimation and predictability for the Euro