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EXPLORING THE ROLE OF EXCHANGE RATE IN INFLATION TARGETING: EVIDENCE FROM THAILAND

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Presentation outline

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- Introduction and Motivation
- The SOE Model
- The Bayesian estimation
  - Prior selection and the posterior
  - Posterior odds
- Results
  - Impulse responses
  - Welfare analysis
  - Openness and the monetary policy
- Conclusions

Introduction: Some theoretical background

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- One of the important issues for small open economies is whether the central bank should response to the exchange rate fluctuations when setting policy interest rate.
- Micro-founded models often show that there is little to be gained by adding exchange rate to the policy rule (Clarida et al., 2001).
- However,…
  - When allowing for the incomplete exchange rate pass-through in the import price, such claim is no longer true (Monacelli, 2005).
  - When central banks have imperfect knowledge about the states of the economy and exchange rate changes can signal future developments of the economy, it would be optimal for central banks to use policy rate in response to changes in the exchange rates (Pavasuthipaisit, 2010).
  - Monacelli (2013) shows that openness can fundamentally change the nature of optimal policy to be different from the closed economy setting.

Introduction: Some theoretical background

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- The role of exchange rate plays an even more important for developing economies that have adopted inflation targeting (IT) framework.
- Stone et al. (2009) provide a model-based analysis to support an explicit but limited role of exchange rate in the IT framework. Specifically, it is argued that the benefits of a more explicit role of exchange rate depends on
  1. The nature of economic structure
  2. The shocks to which it is exposed
  3. How the exchange rate is explicitly taken into account in policy rate setting.

Introduction: Some evidence

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- Based on the DSGE model, the Bank of Canada and the Bank of England do include the nominal exchange rate in its policy rule, but the central banks of Australia and New Zealand do not (Lubik and Schorfheide, 2007).
- However, Dong (2013) finds that all three central banks in Canada, New Zealand and the United Kingdom did not adjust their policy rates in response to exchange rate movements and the results are less clear for Australia.
- Garcia et al. (2011) employ a DSGE model to argue that financially-vulnerable emerging markets are likely to benefit more from exchange rate smoothing.
- While such a debate may remain unsettled, there is clearly a need for further research, particularly for the case of emerging market economies.

Introduction: Some evidence

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- Based on panel regressions using data from 16 countries during 1989-2006, Aizenman et al. (2011) find that inflation-targeting emerging markets follow a mixed strategy whereby interest rate setting is based on both inflation and real exchange rates.

- Cabral et al. (2020), covering 24 countries during 2000-2015, found that the role of exchange rate in the policy reaction function still remains significant but quantitatively less across IT emerging market countries, compared with non-IT countries.

Our motivation

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- The Bank of Thailand has adopted inflation targeting framework for more than two decades since May 2000.
- When facing with large movements in the exchange rate, however, public debates often arise on the appropriate response and sometimes cast doubts about the applicability of the broad IT framework. (Saicheau et al. 2012).
- This paper aims to revisit the role of exchange rate under the IT regime in the Thai economy.
- Our research investigation is whether exchange rate movements have been taken into account in the Thai monetary policy formulation.

Our research

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- We employ a small open economy DSGE model based on Gali and Monacelli (2005) and Lubik and Schorfheide (2007) and estimate structural parameters for the Thai economy and monetary policy reaction function using the Bayesian techniques.
- We then use the model to conduct welfare evaluation of Thai monetary policy rule with and without exchange rate response.
- Furthermore, given that Thai economy is highly open in terms of international trade, we look at the impacts of how varying the degree of openness on
  - The Phillips curve
  - Policy coefficient in the central bank reaction function;
  - Monetary transmission mechanism
  - Welfare evaluation

The Small Open Economy Model

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- The model is specified along the lines of Gali and Monacelli (2005) and Lubik and Schorfheide (2007).
- Households

$$Max \sum_{t=0}^{\infty} E_t \beta^t \left(\frac{C_t / Z_t^{\,1-\sigma} - 1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right)$$

Subject to

$$P_t C_t + \frac{1}{R_t} D_{t+1} + \frac{1}{R_t^*} \varepsilon_t D_{t+1}^* \leq W_t N_t + D_t + \varepsilon_t D_t^* + \int \Phi_t(i) di$$

Focs

$$N_t^{\varphi} = c_t^{-\sigma} w_t$$

$$c_t^{-\sigma} = \beta E_t [R_t c_{t+1}^{-\sigma} (z_{t+1} \pi_{t+1})^{-1}]$$

$$0 = E_t [R_t - R_t^* e_{t+1} \frac{c_{t+1}^{-\sigma}}{c_t^{-\sigma}} (z_{t+1} \pi_{t+1})^{-1}$$

The Small Open Economy Model

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- Firms
- Firms type I. These firms maximize profits in a perfectly competitive environment.

$$Max\ P_t C_t - P_{H,t} C_{H,t} - P_{F,t} C_{F,t}$$

Subject to $C_t = [(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}$

Focs $C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t$

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

$$P_t = \left[(1-\alpha)\, {P_{H,t}}^{\eta-1} + \alpha P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

The Small Open Economy Model

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- Firms type II. These firms are perfectly competitive. They buy the domestic intermediate goods, package them and resell the composite good to the first type firms.

$$Max\ P_{H,t}Y_t - \int_0^1 P_{H,t}(i)\,Y_t(i)di$$

Subject to

$$Y_t = \left[\int_0^1 Y_t(i)^{\frac{\epsilon-1}{\epsilon}} di\right]^{\frac{1}{1-\epsilon}}$$

$$Y_t(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} Y_t$$

$$P_{H,t} = \left[\int_0^1 P_{H,t}(i)^{1-\epsilon}\, di\right]^{\frac{1}{1-\epsilon}}$$

The Small Open Economy Model

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- Firms type III. These firms behave monopolistic competitive. There are firms producing the domestic intermediate goods.

The firms' production function $Y_t(i) = Z_t N_t(i)$

$$Max E_t[\sum_{\tau=0}^{\infty} \theta^{\tau} Q_{t+\tau|t} Y_{t+\tau}(i)\left(\tilde{P}_{H,t}(i)\pi_{H,ss}^{\tau}\right) - MC_{t+\tau}^{n}]$$

Subject to $$Y_{t+\tau}(i) \leq \left(\frac{\tilde{P}_{H,t}(i)\pi_{H,ss}^{\tau}}{P_{H,t+\tau}}\right)^{-\epsilon} Y_{t+\tau}$$

Focs $$E_t[\sum_{\tau=0}^{\infty} \theta^{\tau} Q_{t+\tau|t} \left(\frac{\tilde{P}_{H,t}\pi_{H,ss}^{\tau}}{P_{H,t+\tau}}\right)^{-\epsilon} Y_{t+\tau}\left[(\epsilon-1)\tilde{P}_{H,t}\pi_{H,ss}^{\tau} - MC_{t+\tau}^{n}\right] = 0$$

$$P_{H,t} = [\theta \tilde{P}_{H,t}^{1-\epsilon} + (1-\theta)(\pi_{H,ss} P_{H,t-1})^{1-\epsilon}]^{\frac{1}{1-\epsilon}}$$

The Small Open Economy Model

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Term of trade and real exchange rate

The law of one price for foreign goods hold

$$P_{F,t} = \mathcal{E}_t P^*_{F,t}$$

The term of trade can be expressed as

$$Q_t = \frac{P_{H,t}}{\mathcal{E}_t P^*_{F,t}}$$

The real exchange rate is defined as

$$S_t = \frac{\mathcal{E}_t P^*_t}{P_t}$$

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Domestic market

The market for domestically produced goods clears $y_t = c_{H,t} + c^*_{H,t}$

We can rewrite it as $y_t = (1-\alpha)(S_t Q_t)^{-\eta} c_t + \alpha \vartheta Q_t^{-\eta} c_t^*$

Rest of the world

The relationship between domestic and foreign consumption is derived from the perfect risk sharing assumption.

$$c_t = \vartheta c_t^* S_t^{\frac{1}{\sigma}}$$

The global resource constraint

$$c_t + S_t c_t^* = Q_t S_t y_t + S_t y_t^*$$

The Small Open Economy Model

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The policy rule

$$R_t = \rho_R R_{t-1} + (1-\rho_R)[\psi_1 \pi_t + \psi_2 y_t + \psi_3 \Delta e_t] + \varepsilon_t^R$$

If $\psi_3 > 0$, the central bank responds to exchange rate in conducting the monetary policy whereas If $\psi_3 = 0$, the policy rule does not include the exchange rate.

Shocks

$$\Delta q_t = \rho_q \Delta q_{t-1} + \varepsilon_{q,t}$$ TOT

$$y_t^* = \rho_{y^*} y_{t-1}^* + \varepsilon_{y^*,t}$$ World output

$$\pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + \varepsilon_{\pi^*,t}$$ World inflation

$$z_t = \rho_z z_{t-1} + \varepsilon_{z,t}$$ Technology

The Bayesian Estimation

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- Finding the posterior distribution of the parameters is the objective of the Bayesian influence process.
- The posterior is the density of parameters knowing the data. Using the Bayesian rule, the posterior distribution can be computed as:

$$p(\theta|\Upsilon^T, M) = \frac{p(\Upsilon^T|\theta, M)p(\theta|M)}{p(\Upsilon^T|M)}$$

  - where $\mathrm{p}(\,.\,)$ stands for a probability density function
  - M stands for the model
  - $\mathrm{p}(\theta|\Upsilon^T, \mathrm{M})$ is the posterior distribution of the parameters conditional on the model
  - The term $\mathrm{p}(\Upsilon^T|\theta, \mathrm{M})$ is the likelihood density of the model parameter.

The Bayesian Estimation

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- The variables are in quarterly basis and from 2000Q1 to 2019Q4. All series are seasonally adjusted.
  - Real GDP growth
  - CPI inflation
  - The Bank of Thailand policy rate
  - Changes in Nominal effective exchange rate
  - Changes in TOT

  The vector of observations is related to the model variables according to

$$Y_t = [4R_t, 4\pi_t, \Delta y_t + z_t, \Delta e_t, \Delta q_t]$$

The Bayesian Estimation: Prior selection

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PARAMETERS		PRIOR	
	Density	Mean	Stan.dev
Non-policy rule parameters			
Import share α	beta	0.11	0.03
Interest rate at the steady state r_{ss}	gamma	2.225	0.985
Slope coef. of the Phillips curve κ	gamma	0.50	0.25
Intertemporal substitution elasticity τ	beta	0.50	0.20
Persistence in the technology growth rate ρ_z	beta	0.5238	0.05
Persistence in TOT growth rate ρ_q	beta	0.2913	0.20
Persistence in world inflation shock ρ_{π^*}	beta	0.8697	0.10
Persistence in world output ρ_{y^*}	beta	0.846	0.05
Policy parameters			
Persistence in nom. int. rate; smoothing term ρ_R	beta	0.50	0.20
Policy coefficient w.r.t. inflation ψ_1	gamma	1.50	0.50
Policy coefficient w.r.t. output ψ_2	gamma	0.25	0.13
Policy coefficient w.r.t. nom. exch. rate diff ψ_3	gamma	0.25	0.13
Shock parameters			
Stan.dev in the technology growth rate $\varepsilon_{z,t}$	Inv gamma	1.00	4
Stan.dev in TOT growth rate $\varepsilon_{q,t}$	Inv gamma	1.50	4
Stan.dev in world inflation shock $\varepsilon_{\pi^*,t}$	Inv gamma	0.55	4
Stan.dev in world output $\varepsilon_{y^*,t}$	Inv gamma	1.50	4
Stan.dev in nom. int. rate $\varepsilon_{R,t}$	Inv gamma	0.50	4
Trend z	Normal	0.2012	0.95

Pre-sample analysis using data from 2000Q1-2019Q4

Persistence parameters
Fitting AR(1) process to
-Thai output growth rate
-TOT
-World inflation
-The ratio of World GDP to Thai GDP
-The policy rate

Import share
Average import consumption goods to consumption expenditure

Interest rate at the steady state
Average the policy rates

Trend
Average the growth rates

The Bayesian Estimation: Posterior

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PARAMETERS		PRIOR		POSTERIOR		
	Density	Mean	Stan.dev	Mean	90% Interval	
Non-policy rule parameters						
Import share α	beta	0.11	0.03	0.2115	0.1686	0.2584
Interest rate at the steady state r_{ss}	gamma	2.225	0.985	2.1901	0.8304	3.7449
Slope coef. of the Phillips curve κ	gamma	0.50	0.25	0.5780	0.3902	0.7415
Intertemporal substitution elasticity τ	beta	0.50	0.20	0.2790	0.2331	0.3344
Persistence in the technology growth rate ρ_z	beta	0.5238	0.05	0.4443	0.3972	0.5024
Persistence in TOT growth rate ρ_q	beta	0.2913	0.20	0.3156	0.0903	0.5606
Persistence in world inflation shock ρ_{π^*}	beta	0.8697	0.10	0.4946	0.3450	0.6581
Persistence in world output ρ_{y^*}	beta	0.846	0.05	0.9343	0.8956	0.9750
Policy parameters						
Persistence in nom. int. rate; smoothing term ρ_R	beta	0.50	0.20	0.6388	0.5466	0.7369
Policy coefficient w.r.t. inflation ψ_1	gamma	1.50	0.50	3.2701	2.5202	4.2547
Policy coefficient w.r.t. output ψ_2	gamma	0.25	0.13	0.1976	0.1010	0.2870
Policy coefficient w.r.t. nom. exch. rate diff ψ_3	gamma	0.25	0.13	0.4787	0.2636	0.7708
Shock parameters						
Stan.dev in the technology growth rate $\varepsilon_{z,t}$	Inv gamma	1.00	4	0.7338	0.2934	1.2391
Stan.dev in TOT growth rate $\varepsilon_{q,t}$	Inv gamma	1.50	4	1.6297	0.4437	2.8600
Stan.dev in world inflation shock $\varepsilon_{\pi^*,t}$	Inv gamma	0.55	4	0.4005	0.1442	0.7316
Stan.dev in world output $\varepsilon_{y^*,t}$	Inv gamma	1.50	4	1.0206	0.4234	1.6172
Stan.dev in nom. int. rate $\varepsilon_{R,t}$	Inv gamma	0.50	4	0.3776	0.1438	0.6486
Trend z	Normal	0.2012	0.95	0.2424	0.1981	0.2874

The Bayesian Estimation: Posterior odds

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- Two models
- M_1 : The model with the BOT monetary policy function excluding the exchange rate.

Policy rule: $R_t = \rho_R R_{t-1} + (1-\rho_R)[\psi_1 \pi_t + \psi_2 y_t + \psi_3 \Delta e_t] + \varepsilon_{R,t}$ $\psi_3 = 0$

$$R_t = 0.6687 R_{t-1} + (1-0.6687)[3.29141\pi_t + 0.1992 y_t] + \varepsilon_{R,t}$$

- M_2 : the model with the BOT monetary policy function including the exchange rate.

Policy rule: $R_t = \rho_R R_{t-1} + (1-\rho_R)[\psi_1 \pi_t + \psi_2 y_t + \psi_3 \Delta e_t] + \varepsilon_{R,t}$ $\psi_3 = 0.4787$

$$R_t = 0.6388 R_{t-1} + (1-0.6388)[3.2701\pi_t + 0.1976 y_t + 0.4787\Delta e_t] + \varepsilon_{R,t}$$

The Bayesian Estimation: Posterior odds

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- To compare the two models, we use the ratio of their posterior model probability

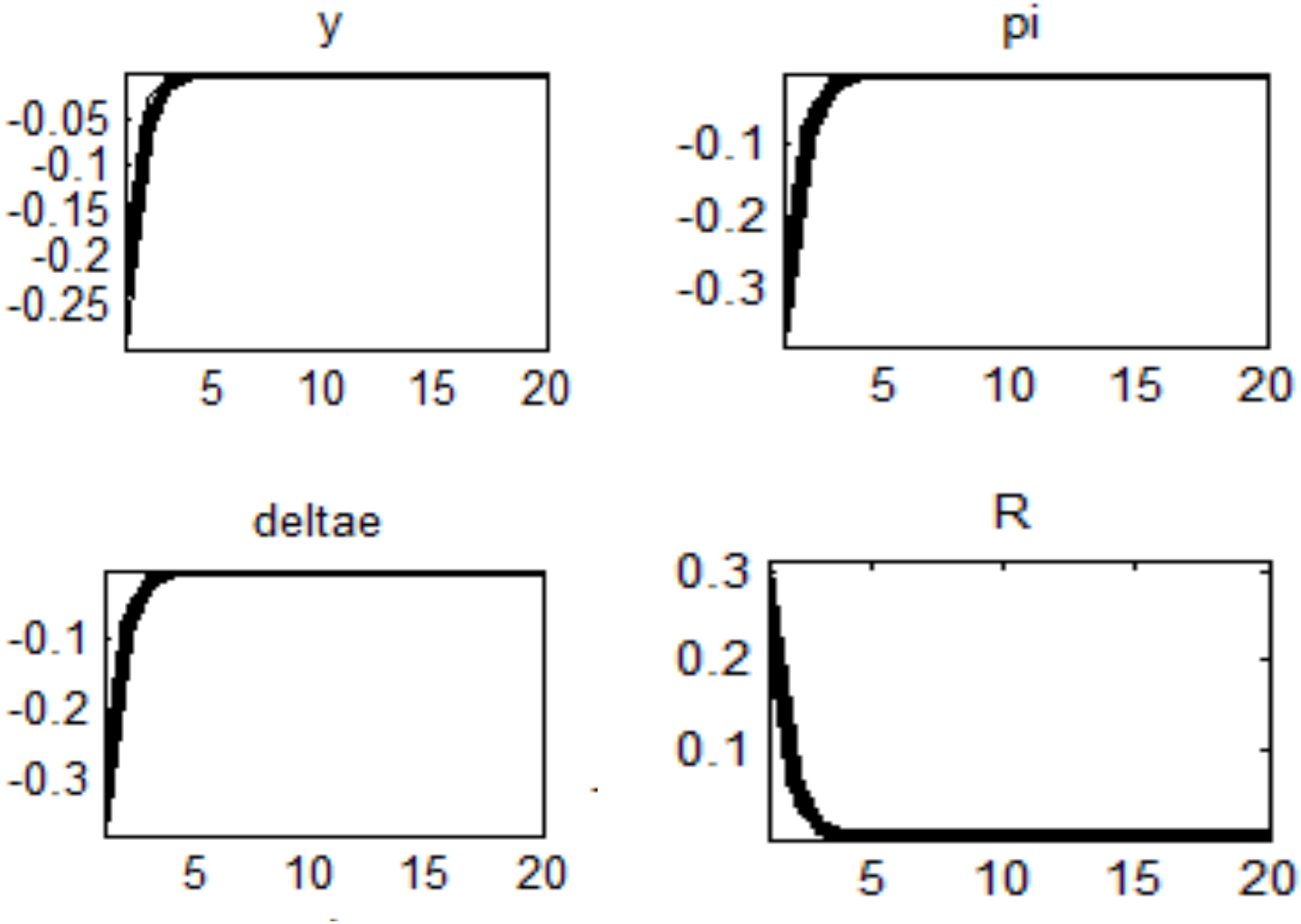
$$po_{12} = \frac{p(M_1|\Upsilon^T)}{p(M_2|\Upsilon^T)} = \frac{p(\Upsilon^T|M_1)p(M_1)}{p(\Upsilon^T|M_2)p(M_2)}$$

	Model	
	M1	M2
Priors	0.5000	0.5000
Log marginal density	-649.1510	-642.3198
Bayes ratio	0.001080	1.000000
Posterior model probability	0.001078	0.998922

The Bayes factor is in favor of M2. The Thai data during the observation period gives very weak evidence in favor of the simpler model M1.

This indicates that the Bank of Thailand sets its policy rate in response to exchange rate movement.

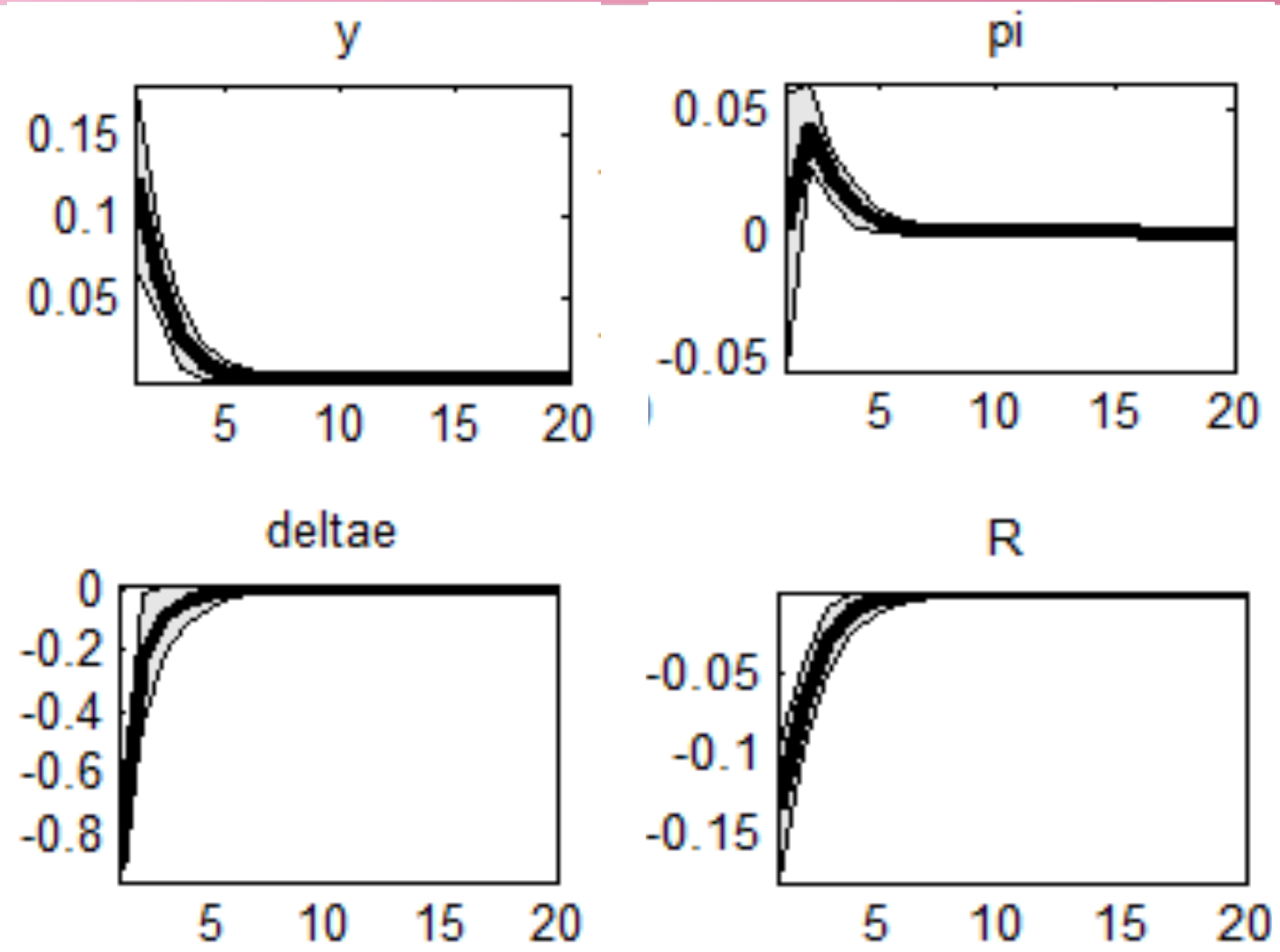
Impulse responses: The interest rate shock



Contraction monetary policy
-appreciates the currency
-lowers inflation
-lowers output.

Reponses to one standard deviation shock
Posterior means (solid line), 90% posterior probability intervals (dashed lines)

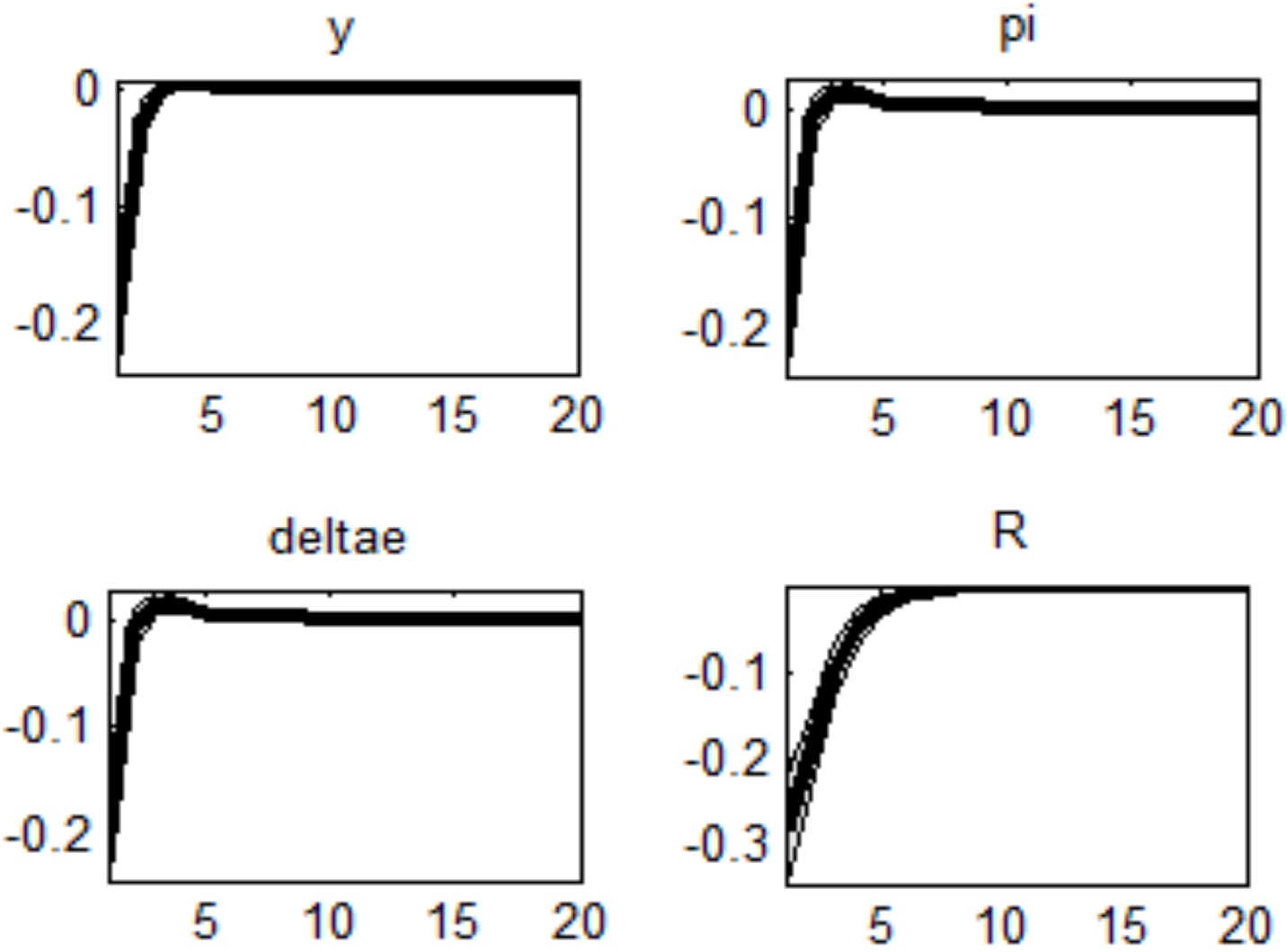
Impulse responses: TOT shock



Reponses to one standard deviation shock
Posterior means (solid line), 90% posterior probability intervals (dashed lines)

An improvement in TOT
-appreciates the currency
-lowers inflation on impact
-lowers interest rate
-raises output.

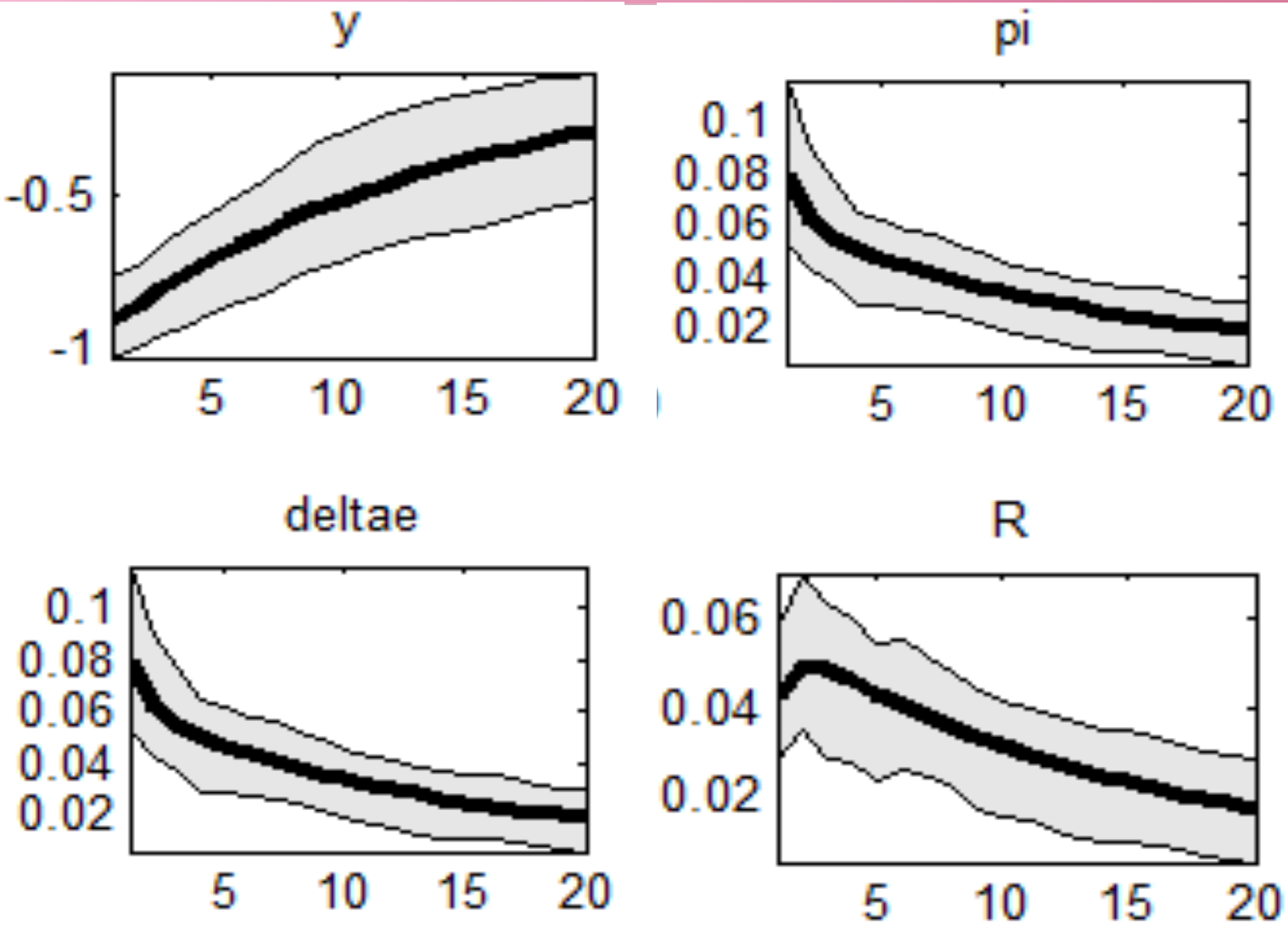
Impulse responses: Technology shock



A positive technology shock
-appreciates the currency
-lowers inflation
-lowers interest rate
-lowers output in the SR

Reponses to one standard deviation shock
Posterior means (solid line), 90% posterior probability intervals (dashed lines)

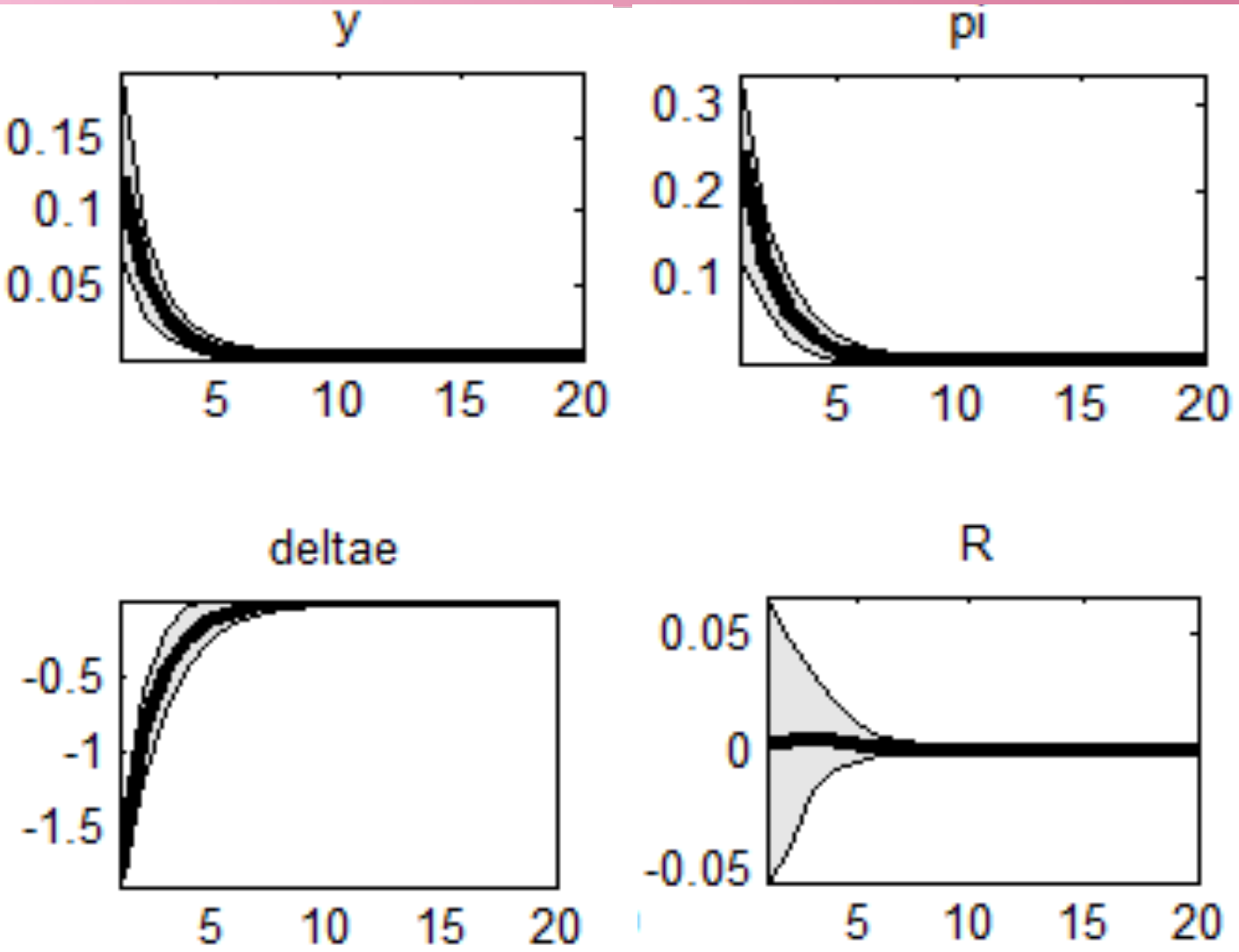
Impulse responses: World output shock



Reponses to one standard deviation shock
Posterior means (solid line), 90% posterior probability intervals (dashed lines)

An increase in the demand shock from the rest of the world
-decreases the domestic output
-raises inflation
-increases interest rate
-increase the exchange rate

Impulse responses: World inflation shock



Reponses to one standard deviation shock
Posterior means (solid line), 90% posterior probability intervals (dashed lines)

An increase in the import price inflation
-appreciates the currency
-raises inflation
-lowers interest rate
-increases the domestic output

Welfare analysis

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- Recall
- The inflation targeting policy (OIT):

Policy rule: $R_t = 0.6687R_{t-1} + (1 - 0.6687)[3.29141\pi_t + 0.1992y_t] + \varepsilon_{R,t}$

- The exchange rate augmented inflation targeting policy (EIT):

Policy rule: $R_t = 0.6388R_{t-1} + (1 - 0.6388)[3.2701\pi_t + 0.1976y_t + 0.4787\Delta e_t] + \varepsilon_{R,t}$

- Following Gali and Monacelli (2005), using the second order approximation to the utility losses of domestic consumer resulting from deviation from the optimal policy.
- The losses are

$$W = -\frac{(1-\alpha)}{2}\sum_{t=0}^{\infty}\beta^t\left[\frac{\varepsilon}{\lambda}\pi_{H,t}^2 + (1+\varphi)y_t^2\right]$$

$$V = -\frac{(1-\alpha)}{2}\left[\frac{\varepsilon}{\lambda}var(\pi_t) + (1+\varphi)var(y_t)\right]$$

Welfare analysis

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Variables/Shock	TOT	World inf.	Technology	World output	Interest rate
OIT Policy					
Output	0.007	0.000	0.039	8.156	0.082
Inflation	0.009	0.000	0.047	0.050	0.179
Welfare loss	0.13	0.000	0.700	13.44	2.590
EIT Policy					
Output	0.019	0.020	0.038	7.441	0.071
Inflation	0.002	0.081	0.040	0.043	0.128
Welfare loss	0.045	1.140	0.5905	12.34	1.89

The elasticity of goods, ε = 6 and the elasticity of labor,φ = 3 from Gali and Monacelli (2005). Entries of output and inflation are variances and expressed in percent. Entries of the welfare loss are percent units of steady state consumption.

The EIT policy performs better in terms of the welfare loss in all shocks except the world inflation shock.

Openness and Monetary Policy

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- How varying degree of openness could potentially impact the conduct of Thai monetary policy
  - The slope of the Phillips curve
  - The reaction function of the BOT monetary policy
  - Transmission mechanism of monetary policy shocks
  - Welfare losses

Openness: The slope of the PC

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- How changes in the degree of trade openness could impact the slope of the Phillips curve

The degree of openness	0.21	0.30	0.40
The slope of the PC	0.76	0.63	0.53

- The slope of the Phillips curve becomes flatter as the Thai economy becomes more open and the amount of import share increases.
- To achieve a given change in inflation, the current output gap has to vary much more.

Openness: The reaction function of BOT

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- How changes in the degree of openness could impact the reaction function of Thai monetary policy

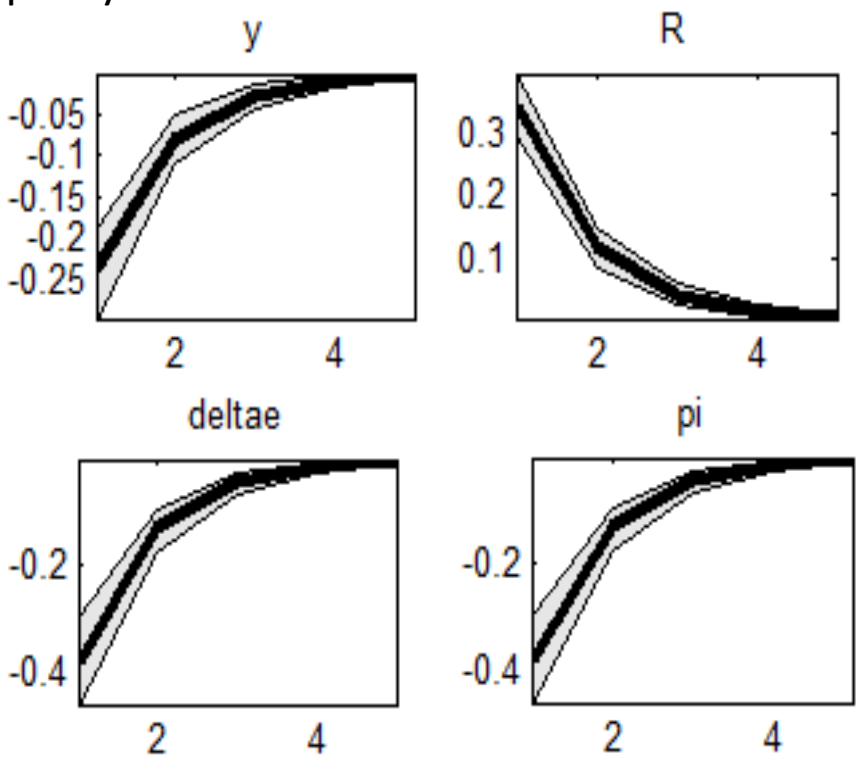
Policy	Policy parameters	Degree of openness			
		0.1	0.2	0.3	0.4
OIT	Persistency in nom. Int. rate	0.7037	0.6748	0.6667	0.6549
	Coeff. w.r.t. inf	3.1769	3.3717	3.4256	3.5107
	Coeff. wr.t output	0.208	0.1918	0.1943	0.2036
EIT	Persistency in nom. Int. rate	0.6814	0.6461	0.6277	0.6274
	Coeff. w.r.t. inf	2.9538	3.1788	3.2041	3.2712
	Coeff. wr.t output	0.2271	0.201	0.2005	0.2068
	Coeff. w.r.t exchage rate	0.4683	0.4503	0.4334	0.4064

- As the degree of openness increases,
  - The policy response to inflation is stronger
  - The policy becomes less persistent.
  - The policy become less sensitive to exchange rate movement.
  - The policy response to output does not significantly change.

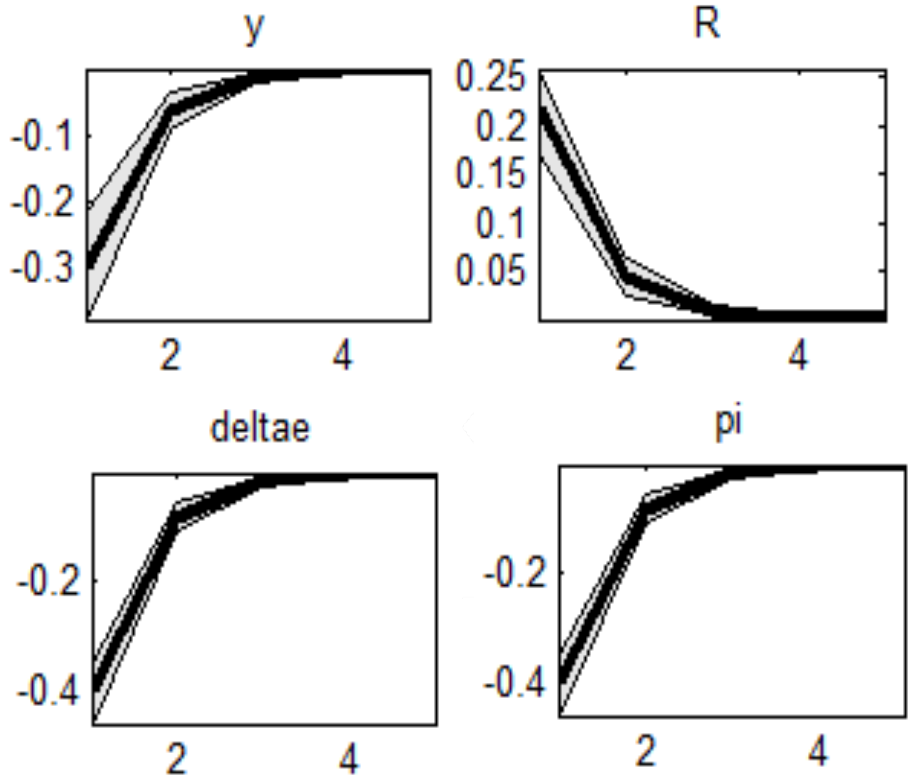
Openness: The transmission mechanism

- We find that monetary policy under the policy rule with exchange rate influences more to the macroeconomy with the higher degree of openness.

OIT policy



Degree of openness 0.1

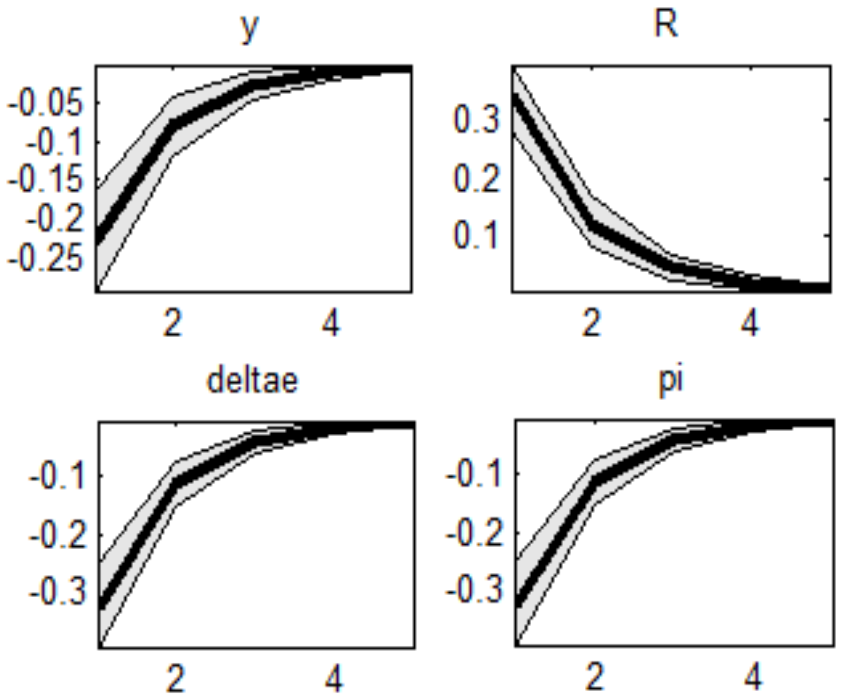


Degree of openness 0.4

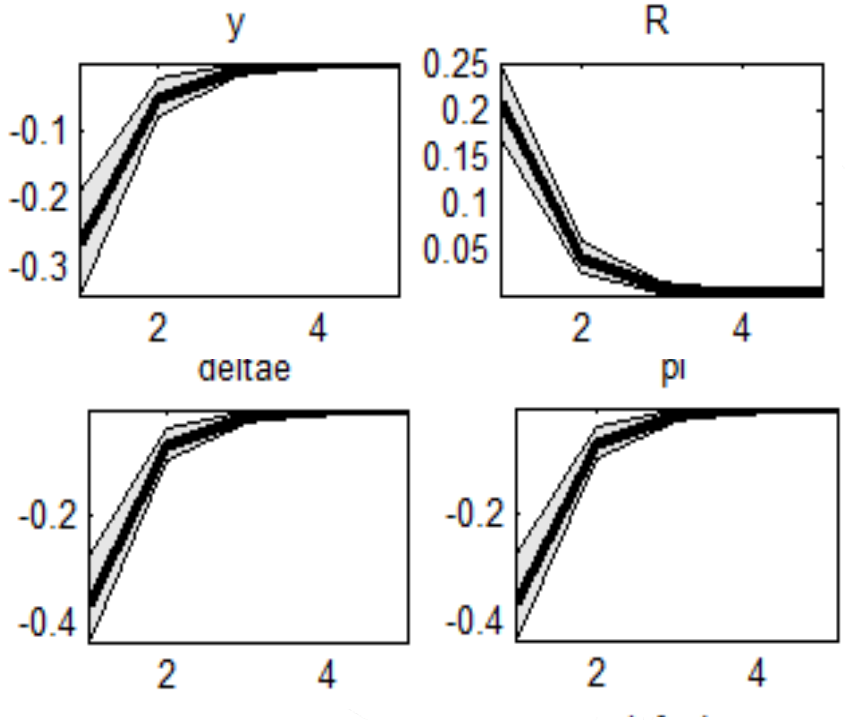
Openness: The transmission mechanism

- We find that monetary policy under the policy rule with exchange rate influences more to the macroeconomy with the higher degree of openness.

EIT policy



Degree of openness 0.1



Degree of openness 0.4

Openness: Welfare loss

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- How changes in the degree of trade openness could impact the welfare

	Variables/Shock	TOT	World inf.	Technology	World output	Interest rate
Openness=0.3	**OIT policy**					
	Output	0.016	0.000	0.034	8.528	0.090
	Inflation	0.016	0.000	0.041	0.049	0.180
	Welfare loss	0.215	0.000	0.549	12.549	2.350
	EIT policy					
	Output	0.032	0.019	0.032	7.754	0.077
	Inflation	0.004	0.067	0.035	0.043	0.131
	Welfare loss	0.094	0.852	0.478	11.382	1.723
Openness=0.4	**OIT policy**					
	Output	0.034	0.000	0.030	8.715	0.092
	Inflation	0.024	0.000	0.037	0.049	0.182
	Welfare loss	0.298	0.000	0.432	10.978	2.037
	EIT policy					
	Output	0.049	0.016	0.027	7.804	0.077
	Inflation	0.010	0.056	0.033	0.042	0.134
	Welfare loss	0.166	0.613	0.384	9.811	1.515

Openness: Welfare loss

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- When the degree of openness increases to 0.3 and 0.4,
  - the EIT policy provides lower welfare loss than the OIT policy under all shocks except for only the world inflation shock.
- Nevertheless, the policy with exchange rate generally performs better in term of welfare loss regardless of the level of openness.

Conclusions

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- We develop a general equilibrium model of small-open economy based on Lubik and Schorfheide (2007) and estimate structural parameters for Thai economy.
  - Estimating the monetary policy rule
    - During the past 20 years, the BOT incorporated exchange rate movements into interest rate setting.
  - Conducting a welfare analysis
    - Overall welfare improvements over the closed-economy policy rule.
  - Exploring the degree of openness with Thai monetary policy
    - The higher degree of openness,
      - The flatter the slope of the Phillips curve
      - The stronger policy response to inflation
      - The less persistent and smaller reaction to exchange rate fluctuations.

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THANK YOU