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How much should central banks lean against the wind? (Work in progress)

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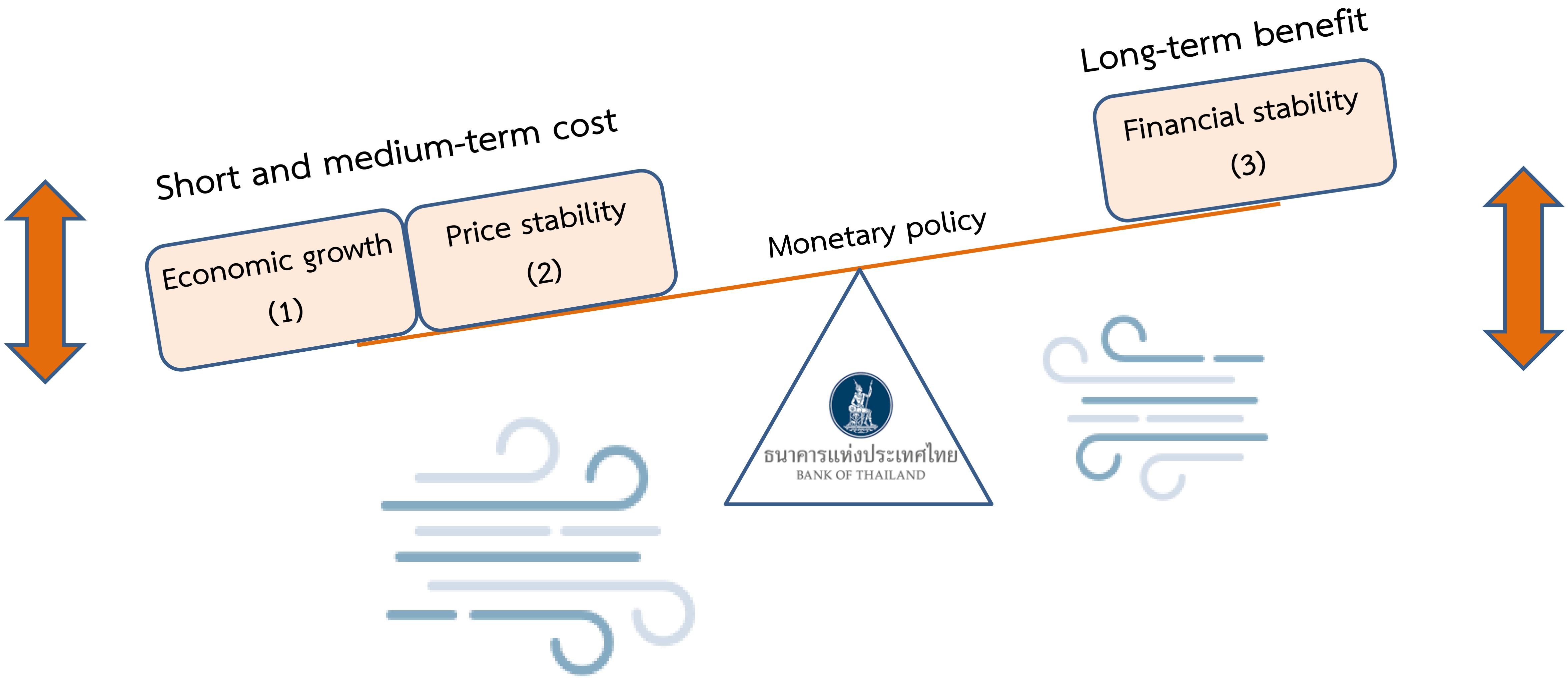
Motivation


Short and medium-term cost
Long-term benefit
Economic growth
(1)
Price stability
(2)
Financial stability
(3)
Monetary policy
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What’ve been done in the past?

Filardo and Rungcharoenkitkul (2016)

A quantitative case for leaning against the wind

Conventional macroeconomic block + Financial cycle block

Govern probability of crisis

Ajello et al. (2019)

Financial stability and optimal interest rate policy

Probability of financial crisis → depends on... → Aggregate financial condition

DSGE model

DSGE model

Model the whole economy

Rationality

Price rigidity

New-Keynesian framework

Monopolistic competition

Non-neutrality of monetary policy

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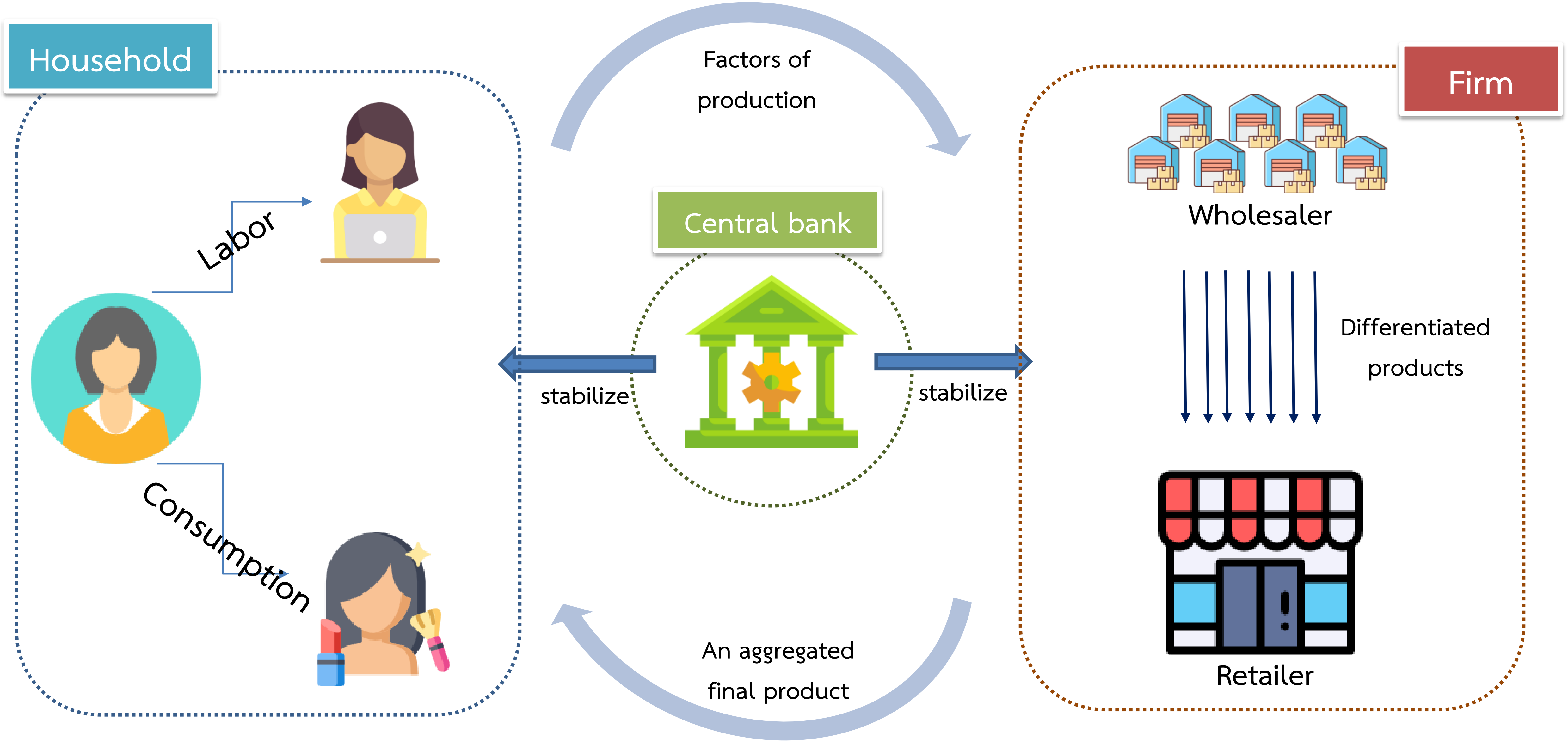
Overall economy in traditional model



Model with probability of crisis

Household is optimistic:

solve optimization problem

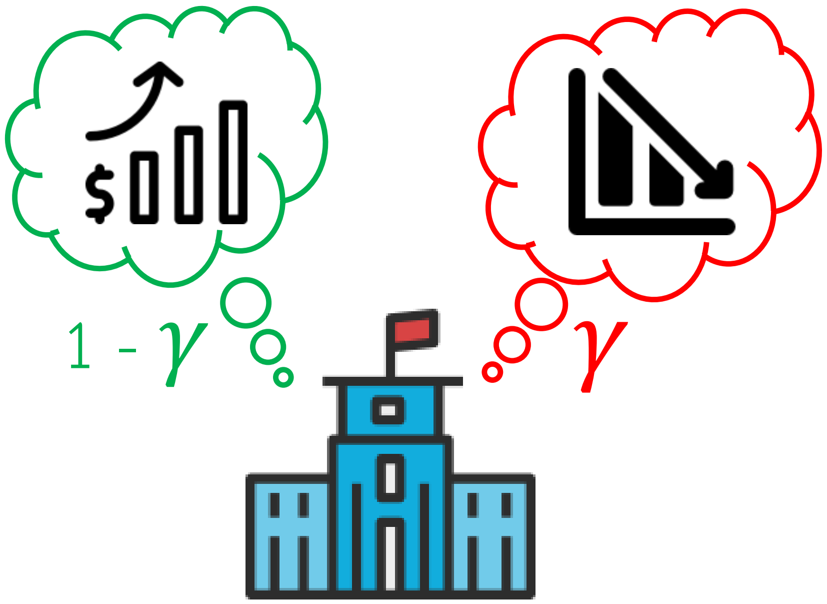
with fixed probability of crisis (ϵ)

ϵ is a small constant number

Central bank is rational:

solve optimization problem

with probability of crisis (γ)



γ is a function of loan growth

Traditional household's problem

Goal: Maximize welfare function subject to budget constraint

$$\max_{C_t, L_t} \sum_{t=1}^{\infty} \beta^{t-1} \underbrace{\left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\psi}}{1+\psi} \right)}_{\text{Welfare function}}$$

Rewrite with recursive relationship

$$\boxed{S_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\psi}}{1+\psi} + \beta S_{t+1}}$$

subject to

$$\underbrace{P_t C_t + \frac{B_{t+1}}{1+i_t}}_{\text{Expenditure}} = \underbrace{W_t L_t + B_t}_{\text{Income}}$$

Notations	Meaning
C	Consumption
L	Labor
P	General price level
B	Saving received
W	Wage
β	Discount factor
σ	Relative risk aversion coef.
ψ	Mar. disutility w.r.t labor supply
S	Value function

HH's problems in the face of crisis

Traditional model

$$S_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\psi}}{1+\psi} + \beta S_{t+1}$$

Teerat's model

$$S_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\psi}}{1+\psi} + \beta(1-\epsilon)S_{t+1} + \beta(\epsilon)S_{t+1}^c$$

subject to

$$P_t C_t + \frac{B_{t+1}}{1+i_t} = W_t L_t + B_t$$

$$C_{t+1}^c = w_1 C_t$$

$$P_{t+1}^c = w_2 P_t$$

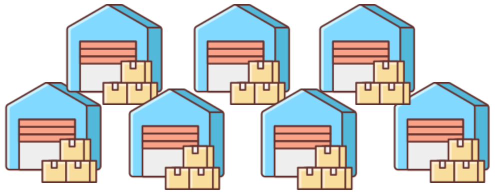
w_1, w_2 are percentages of consumption and price level in crisis state

Euler equation and IS curve

Traditional model	Teerat’s model
$\left(\frac{C_{t+1}}{C_t}\right)^{\sigma} = \frac{\beta(1+i_t)}{(1+\pi_{t+1})}$	$\left(\frac{C_{t+1}}{C_t}\right)^{\sigma}\left(1-\frac{(\epsilon)\beta w_1^{-\sigma}(1+i_t)}{w_2}\right) = \frac{\beta(1-\epsilon)(1+i_t)}{(1+\pi_{t+1})}$
Log linearization	Log linearization
$y_{t+1} = y_t - b_1\pi_{t+1} + b_2 i_t$	$y_{t+1} = y_t - c_1\pi_{t+1} + c_2 i_t + c_3$

b_1, b_2, c_1, c_2, c_3 are constant

Two types of firm & Phillips curve

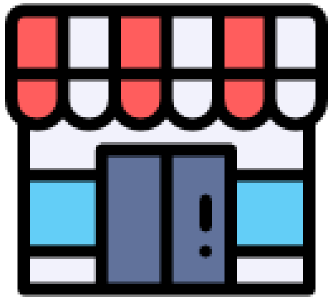


Monopolistic competition

Wholesalers

Price setters

Intermediate goods



Perfect competition

Retailers

Price takers

Final goods

$$\pi_t = \beta \pi_{t+1} + \kappa y_t$$

Traditional Phillips curve

Traditional central bank's problem*

Goal : Minimize a quadratic loss function that depends on output and inflation

$$\min_{y_t,\pi_t} \sum_{t=1}^{\infty} \beta^{t-1} \overbrace{\left(\frac{\lambda y_t^2}{2} + \frac{\pi_t^2}{2} \right)}^{\text{Quadratic loss function}}$$

Rewrite with recursive relationship

$$M_t = \frac{\lambda y_t^2}{2} + \frac{\pi_t^2}{2} + \beta M_{t+1}$$

subject to

$$\pi_t = \beta \pi_{t+1} + \kappa y_t$$

Notations	Meaning
y	Output gap
π	Inflation gap
β	Discount factor
λ	Weight of output gap
κ	Constant
M	Value function

*Central bank follows commitment policy rule

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Central bank's problems with financial stability

Traditional model

$$M_t = \frac{\lambda y_t^2}{2} + \frac{\pi_t^2}{2} + \beta M_{t+1}$$

$$\boxed{\gamma(O) = \frac{e^{h_0 + h_1 O_t}}{1 + e^{h_0 + h_1 O_t}}}$$

$$M_t = \underbrace{-\frac{\lambda y_t^2}{2}}_{\text{Output}} \underbrace{- \frac{\pi_t^2}{2}}_{\text{Inflation}} + \underbrace{\beta(1 - \gamma(O))M_{t+1} + \beta\gamma(O)M_{t+1}^c}_{\text{Financial stability}}$$

subject to

$$\pi_t = \beta\pi_{t+1} + \kappa y_t$$

Market clearing conditions

1

$$C_t^{-\sigma} = \beta(\epsilon)(C_{t+1}^c)^{-\sigma}\left(\frac{P_t}{P_{t+1}^c}\right)(1+i_t^c) + \beta(1-\epsilon)C_{t+1}^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right)(1+i_t)$$

2

$$P_{t+1}^c = w_2 P_t$$

3

$$C_{t+1}^c = w_1 C_t$$

4

$$Y_t = C_t$$

5

$$L_t^{\psi} P_t = W_t C_t^{-\sigma}$$

6

$$Y_t^c = C_t^c$$

7

$$i_t^c = i_t$$

8

$$i_t = X(O_t)y_t + Y(O_t)\pi_t + Z(O_t)$$

9

$$P_t^{1-\omega} = (1-\theta)(P_t^*)^{1-\omega} + (\theta)P_{t-1}^{1-\omega}$$

10

$$\left(\frac{P_t^*}{P_t}\right) = \left(\frac{\omega}{1-\omega}\right)\frac{\sum_{t=0}^{\infty}\theta^t\beta^t C_t^{1-\sigma}\psi_t\left(\frac{P_t}{P_0}\right)^{\omega}}{\sum_{t=0}^{\infty}\theta^t\beta^t C_t^{1-\sigma}\left(\frac{P_t}{P_0}\right)^{\omega-1}}$$

11

$$O_t = \rho_O O_{t-1} + \phi_i i_t + \phi_\pi\left(\frac{P_{t+1}-P_t}{P_t}\right) - \phi_y Y_t + \phi_0$$

Full-blown Taylor's rule

$$\boxed{i_t = X(O)y_t + Y(O)\pi_t + Z(O)}$$

$$X(O) = \left(\frac{\sigma - \sigma c_1}{c_2c_3 + c_1c_3}\right)\left(\frac{c_2c_4k - \sigma + \sigma c_1}{\sigma - \sigma c_1} + \frac{\beta l_1 c_5\gamma(O) - \lambda}{c_7 - c_7\gamma(O)}\right) \rightarrow \frac{dX(O)}{dO} \text{ positive}$$

$$Y(O) = \left(\frac{\sigma - \sigma c_1}{c_2c_3 + c_1c_3}\right)\left(\frac{c_2c_4m}{\sigma - \sigma c_1} + \frac{k}{m(c_7 - c_7\gamma(O))}\right) \rightarrow \frac{dY(O)}{dO} \text{ negative}$$

$$Z(O) = \left(\frac{\sigma - \sigma c_1}{c_2c_3 + c_1c_3}\right)\left(\frac{1 - c_1 - c_2}{\sigma - \sigma c_1} + \frac{\beta\phi(O)c_6 - c_8\gamma(O)}{c_7 - c_7\gamma(O)}\right)$$

$$\rightarrow \frac{dZ(O)}{dO} \text{ positive}$$

Constants	Meaning
c_1	$\frac{\beta\epsilon(1+i_{ss})}{w_1^\sigma w_2}$
c_2	$\frac{\beta(1-\epsilon)(1+i_{ss})}{(1+\pi_{ss})}$
c_3	$\frac{i_{ss}}{1+i_{ss}}$
c_4	$\frac{\pi_{ss}}{1+\pi_{ss}}$
c_5	$\frac{\lambda k w_1}{m}$
c_6	$M_{t+1}^c - M_{t+1}$
c_7	$\beta\lambda k$
c_8	$\beta c_5(1 - w_1)$

Teerat's rule

$$\boxed{i_t = X(O)y_t + Y(O)\pi_t + Z(O)}$$

$X(O), Y(O), Z(O)$ are functions of loan growth

Key takeaways:

1. Coefficient of output and inflation gaps
2. Additional term that is always positive
3. Signs of partial derivatives

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Fine-tune parameters

Calibration – The process of restricting parameters in an economic model so that the model is consistent with long run growth facts and microeconomic observations.

Parameters to calibrate:

$$\beta, \sigma, l_1, l_2, \epsilon, i_{ss}, \pi_{ss}, \kappa, \lambda, \underbrace{\phi_0, \phi_y, \phi_\pi, \phi_i}, h_0, h_1$$

Run regression on Thai data:

$$O_t = \rho_O O_{t-1} + \phi_i(i_t + i_{ss}) + \phi_\pi(\pi_t + \pi_{ss}) + \phi_y y_t + \phi_0$$

Example

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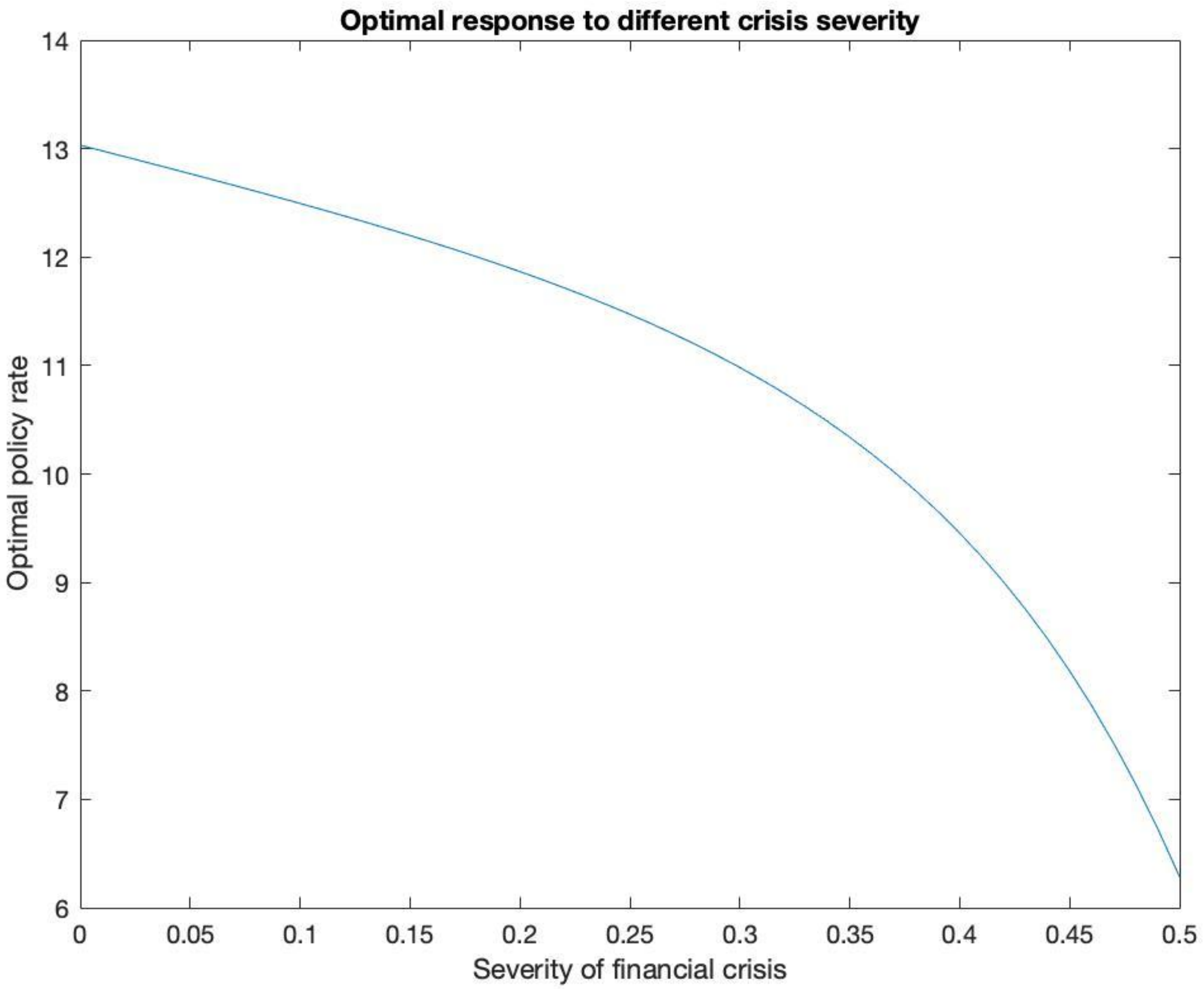
Optimal policy rate in response to severity of crisis



Expand the model

Firms solve optimization problems with probability of crisis

Add financial sector to the model

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