Goodwill Pricing and the Real Effects of Monetary Policy

NGUYEN, Hiep

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Contents

*Some definitions:

- New Keynesian (NK) economics: microeconomic foundations for Keynesian economics, rational expectations, market failures, imperfect competition
- Industrial organization (IO): add real-world complications to the perfectly competitive model

1. Motivations

- In Tirole (1988), there is a discussion on a goodwill effect (IO theory).
- What is the goodwill effect? ⇒Today's price influences tomorrow's demand negatively.
- In the real life: promotion sale.

⇒ A firm may secure a larger customer base in the future by setting lower price today.

- My paper incorporates a goodwill effect into a simple New Keynesian model.
- Why do I want to include the goodwill effect to macroeconomics?

1. Despite the importance in the real world as well as the field of industrial organization (IO), no study in NK economics that embeds the goodwill effect (to the best of my knowledge).
2. To see what happens when monopoly firms face a dynamic demand function in a dynamic time setting.

2. Setup of the Model

2.1 Firms

*** Firms are introduced first because this is the most important part of the model.

- Final-good firms are perfectly competitive: produce Y_t by choosing combination of $Y_t(j)$.
- New part of the model: the demand function with goodwill that intermediate-good firms face:

$$Y_t(j) = \boldsymbol{\Gamma}(P_t(j), P_{t-1}(j), P_t, P_{t-1})Y_t,$$

where $\boldsymbol{\Gamma}_1 < 0$: the standard law of demand.

$\boldsymbol{\Gamma}_2 \leq 0$: in standard NK models $\boldsymbol{\Gamma}_2 = 0$. A goodwill exists if $\boldsymbol{\Gamma}_2 < 0$.

-Production function: $Y_t(j) = h_t(j)$.

-Nominal cost: $NMC_t = W_t$.

2. Setup of the Model

2.2 Households

- A representative household: purchases consumption goods C_t and one-period bonds B_t in period t as well as supplies labor services h_t.
- Maximizes:

$$E_t \sum_{k=0}^{\infty} \beta^k U(C_{t+k}, h_{t+k}),$$

subject to

$$P_{t+k}C_{t+k} + B_{t+k} = W_{t+k}h_{t+k} + R^n_{t+k-1}B_{t+k-1} + \Pi_{t+k} - T_t.$$

- FOCs:

$$U_{c,t} = E_t\left[U_{c,t+1}(1 + i_t - \pi_{t+1})\right] \text{ : Euler equation}$$

$$-\frac{U_{h,t}}{U_{c,t}} = \frac{W_t}{P_t} \qquad \text{: labor supply condition}$$

2. Setup of the Model

2.3 Monetary Policy

- Log deviation of variable X_t by $\hat{X}_t$:

$$X_t = Xe^{\hat{X}_t} \approx X\left(1 + \hat{X}_t\right).$$

- Central bank follows a Taylor rule

$$i_t = \psi_\pi \pi_t + \psi_y \hat{Y}_t + \varepsilon_t^i,$$

where ε_t^i represents a monetary policy shock. ε_t^i follows an AR (1) process

$$\varepsilon_t^i = \rho \varepsilon_{t-1}^i + \vartheta_t^i, \qquad E_t \vartheta_{t+1}^i = 0, 0 \leq \rho < 1,$$

- Assumption: $\psi_\pi > 1, \psi_y \geq 0$.

2. Setup of the Model

2.4 Micro-foundation for the Goodwill Effect

- Households' maximization problem

$$E_t \sum_{k=0}^{\infty} \beta^k U(C_{t+k}, h_{t+k}),$$

where $C_t = \left\{\int_0^1 [C_t(j) - \alpha C_{t-1}(j)]^{\frac{\varepsilon-1}{\varepsilon}} dj\right\}^{\frac{\varepsilon}{\varepsilon-1}}$.

$\alpha(\, 0 \leq \alpha \leq 1)$ measures a degree of habit persistence.

- Two-stage budgeting procedure is applicable.

1. how much to spend on consumption.

2. how to allocate consumption expenditures among differentiated goods.

Step 1 $\Rightarrow$ intertemporal Euler equation.

Step 2 $\Rightarrow$ cost minimization problem, given consumption indices.

2. Setup of the Model

2.4 Micro-foundation for the Goodwill Effect (cont.)

- Cost minimization problem

$$\sum_{k=0}^{\infty} E_t \beta^k \frac{U_{c,t+k}}{U_{c,t}} \frac{P_t}{P_{t+k}} \int_0^1 P_{t+k}(j) C_{t+k}(j) dj \,,$$

subject to new Dixit-Stiglitz aggregator: $C_t = \left\{ \int_0^1 [C_t(j) - \alpha C_{t-1}(j)]^{\frac{\varepsilon-1}{\varepsilon}} dj \right\}^{\frac{\varepsilon}{\varepsilon-1}}$.

- FOC of cost minimization problem:

$$C_t(j) = \alpha C_{t-1}(j) + C_t \left(E_t \sum_{k=0}^{\infty} (\alpha\beta)^k \frac{U_{c,t+k}}{U_{c,t}} \frac{P_{t+k}(j)}{P_{t+k}} \right)^{-\varepsilon}.$$

- Lemma 2: If $\alpha > 0$

1. $\frac{\partial C_t(j)}{\partial (P_{t-1}(j)/P_{t-1})} < 0$: Habit persistence in consumption may be considered as a source of the goodwill effect.
2. $\frac{\partial C_t(j)}{\partial (P_{t-1}(j)/P_{t-1})} = \alpha \frac{\partial C_t(j)}{\partial (P_t(j)/P_t)}$ near a steady state.

3 Flexible Price

3.1 Optimization under Flexible Price

- Firm j's maximization problem:

$$\sum_{k=0}^{\infty} E_t \beta^k \frac{\Lambda_{t+k}}{\Lambda_t} \frac{P_t}{P_{t+k}} Y_{t+k} \left[P_{t+k}(j) \boldsymbol{\Gamma}(P_{t+k}(j), P_{t+k-1}(j), P_{t+k}, P_{t+k-1}) \right.$$
$$\left. - W_{t+k} \boldsymbol{\Gamma}(P_{t+k}(j), P_{t+k-1}(j), P_{t+k}, P_{t+k-1}) \right],$$

- FOC under symmetry:

$$0 = Y_t [1 + P_t \boldsymbol{\Gamma}_1(P_t, P_{t-1}, P_t, P_{t-1}) - W_t \boldsymbol{\Gamma}_1(P_t, P_{t-1}, P_t, P_{t-1})]$$
$$+ E_t \beta \frac{\Lambda_{t+1}}{\Lambda_t} \frac{P_t}{P_{t+1}} Y_{t+1} [P_{t+1} \boldsymbol{\Gamma}_2(P_{t+1}, P_t, P_{t+1}, P_t) - W_{t+1} \boldsymbol{\Gamma}_2(P_{t+1}, P_t, P_{t+1}, P_t)].$$

- **Steady State**:

$$w = \frac{W}{P} = 1 + \frac{1}{P(\boldsymbol{\Gamma}_1^{ss} + \beta \boldsymbol{\Gamma}_2^{ss})}.$$

3 Flexible Price

3.2 The Real Effect of a Monetary Policy Shock

- I use the method: proof by contradiction.

  Assume monetary policy does not have a real effect. Real values remain unchanged.

- From Euler equation and Taylor rule

$$E_t\pi_{t+k+1} = \psi_\pi E_t\pi_{t+k} + \rho^k \varepsilon_t^i, \tag{I}$$

- From FOC of firm j

$$0 = 1 - \frac{P_t}{P(\mathbf{\Gamma}_1^{ss} + \beta\mathbf{\Gamma}_2^{ss})}[\mathbf{\Gamma}_1(P_t, P_{t-1}, P_t, P_{t-1}) + \beta E_t\mathbf{\Gamma}_2(P_{t+1}, P_t, P_{t+1}, P_t)], \tag{7}$$

$$= \mathrm{Z}(P_{t-1}, P_t, P_{t+1})$$

- Two cases:

* Case 1: $\mathrm{Z}(P_{t-1}, P_t, P_{t+1}) \equiv 0.$

Assumption is correct. Inflation dynamics follows (I).

<u>Lemma 3.1:</u> $\mathrm{Z}(P_{t-1}, P_t, P_{t+1}) \equiv 0$ iff $\mathbf{\Gamma} = \mathrm{g}\left(\frac{P_t(j)}{P_t}, \frac{P_{t-1}(j)}{P_{t-1}}\right)$.

3 Flexible Price

- Case 2: $\mathrm{Z}(P_{t-1}, P_t, P_{t+1}) \not\equiv 0.$

<u>Lemma 3.2</u>: Taylor 1st-order approximation of (7)：

$$E_t\pi_{t+k+1} = \alpha E_t\pi_{t+k}, \alpha \neq 0, \qquad (8)$$

This inflation dynamics is inconsistent with (I): $E_t\pi_{t+k+1} = \psi_\pi E_t\pi_{t+k} + \rho^k\varepsilon_t^i$.

Assumption is wrong. There exist forms of demand function that make monetary policy have real effect under flexible price.

An example:

$$\mathbf{\Gamma}(P_t(j), P_{t-1}(j), P_t, P_{t-1}) = \left(\frac{\alpha P_t(j) + (1-\alpha)P_{t-1}(j)}{\alpha P_t + (1-\alpha)P_{t-1}}\right)^{-\varepsilon}.$$

but this form is unrealistic.

3 Flexible Price

*** Specification of the Model**

- Utility function

$$U(C_t, h_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{h_t^{1+\omega}}{1+\omega},$$

Under specification:

$$C_t^{-\sigma} = E_t[C_{t+1}^{-\sigma}(1 + i_t - \pi_{t+1})], \qquad \text{(Euler equation)}$$

$$\frac{h_t^{\omega}}{C_t^{-\sigma}} = \frac{W_t}{P_t} = w_t, \qquad \text{(labor supply)}$$

- A demand function for the intermediate good j

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon} \left(\frac{P_{t-1}(j)}{P_{t-1}}\right)^{-\eta} Y_t, \qquad \eta \geq 0.$$

- **Steady State**

$$w = \frac{W}{P} = 1 + \frac{1}{P(\Gamma_1^{ss} + \beta\Gamma_2^{ss})} = 1 - \frac{1}{\varepsilon + \beta\eta} > 1 - \frac{1}{\varepsilon}.$$

Lemma 4.1: In the steady state, if there exists a goodwill effect, i.e. $\eta > 0$, firms are better off by charging a milder markup which increases future demand.

(The content of this slide belongs to section 4 in my thesis because the results of Flexible Price section are not affected by any specifications).

4 Price Stickiness

4.2 Rotemberg-type Price Stickiness and the NKPC

- Intermediate-good firm j who wants to revise its price has to pay the adjustment cost

$$\frac{\psi}{2}\left(\frac{P_t(j)}{P_{t-1}(j)}-1\right)^2 P_t Y_t.$$

- Rotemberg model ensures symmetry among intermediate-good firms, from production function and market clearing condition

$$Y_t = h_t,$$
$$Y_t = C_t + \frac{\psi}{2}\pi_t^2 Y_t.$$

- Log-linearization

$$\hat{Y}_t = \hat{C}_t = \hat{h}_t,$$
$$-\sigma\hat{Y}_t = i_t - E_t\pi_{t+1} - \sigma E_t\hat{Y}_{t+1},$$
$$\hat{w}_t = (\omega+\sigma)\hat{Y}_t.$$

4 Price Stickiness

4.2 Rotemberg-type Price Stickiness and the NKPC (cont.)

- Firm j's optimization problem:

$$\sum_{k=0}^{\infty} E_t \beta^k \frac{\Lambda_{t+k}}{\Lambda_t} \frac{P_t}{P_{t+k}} Y_{t+k} \times \left\{ P_{t+k}(j) \left(\frac{P_{t+k}(j)}{P_{t+k}} \right)^{-\varepsilon} \left(\frac{P_{t+k-1}(j)}{P_{t+k-1}} \right)^{-\eta} \right.$$

$$\left. - W_{t+k} \left(\frac{P_{t+k}(j)}{P_{t+k}} \right)^{-\varepsilon} \left(\frac{P_{t+k-1}(j)}{P_{t+k-1}} \right)^{-\eta} - \frac{\psi}{2} \left(\frac{P_{t+k}(j)}{P_{t+k-1}(j)} - 1 \right)^2 P_{t+k} \right\}.$$

- Log-linearized FOC:

$$\pi_t = \beta E_t \pi_{t+1} + \frac{\varepsilon}{\psi} \left(1 - \frac{1}{\varepsilon + \beta\eta} \right) \widehat{w}_t + \frac{\beta\eta}{\psi} \left(1 - \frac{1}{\varepsilon + \beta\eta} \right) E_t \widehat{w}_{t+1} - \frac{\beta\eta(1-\sigma) E_t \left(\widehat{Y}_{t+1} - \widehat{Y}_t \right)}{\psi(\varepsilon + \beta\eta)}.$$

This is the NKPC of the model.

In the special case, $\eta = 0$ leads to the standard NKPC

$$\pi_t = \beta E_t \pi_{t+1} + \frac{\varepsilon - 1}{\psi} \widehat{w}_t, \text{or } \pi_t = \beta E_t \pi_{t+1} + \frac{(\varepsilon - 1)(\omega + \sigma)}{\psi} \widehat{Y}_t.$$

4 Price Stickiness

4.3 The Real Effect of a Monetary Policy Shock

- Using the relation $\widehat{w}_t = (\omega + \sigma)\widehat{Y}_t$ to rewrite the NKPC

$$\pi_t = \beta E_t \pi_{t+1} + a(\eta)\widehat{Y}_t + b(\eta) E_t \widehat{Y}_{t+1},$$

where $a(\eta) = \dfrac{\varepsilon}{\psi}\left(1 - \dfrac{1}{\varepsilon + \beta\eta}\right)(\omega + \sigma) + \dfrac{\beta\eta(1-\sigma)}{\psi(\varepsilon + \beta\eta)}, \qquad a(0) = \dfrac{\varepsilon - 1}{\psi}(\omega + \sigma),$

$$b(\eta) = \frac{\beta\eta}{\psi}\left(1 - \frac{1}{\varepsilon + \beta\eta}\right)(\omega + \sigma) - \frac{\beta\eta(1-\sigma)}{\psi(\varepsilon + \beta\eta)}, \qquad b(0) = 0.$$

- A monetary policy shock ε_t^i hits the economy. Using undetermined coefficients method:

$$\widehat{Y}_t = -\frac{1 - \rho\beta}{(\psi_\pi - \rho)[a(\eta) + \rho\, b(\eta)] + \left[\psi_y + \sigma(1-\rho)\right](1 - \rho\beta)}\varepsilon_t^i,$$

$$\pi_t = -\frac{a(\eta) + \rho\, b(\eta)}{(\psi_\pi - \rho)[a(\eta) + \rho\, b(\eta)] + \left[\psi_y + \sigma(1-\rho)\right](1 - \rho\beta)}\varepsilon_t^i.$$

and $a(\eta) + \rho\, b(\eta) \geq a(0) + \rho\, b(0)$.

- Lemma 4.3: The goodwill effect moderates the impact of a monetary policy shock on the real interest rate and the output. The magnitude of inflation, instead, is greater.

4.3 The Real Effect of a Monetary Policy Shock (cont.)

- Intuition behind Lemma 4.3:

A contractionary monetary policy shock

$\Rightarrow$ Wages decrease $\Rightarrow$ Firms lower prices.

With goodwill, firms have an incentive to reduce prices more.

$\Rightarrow$ Central bank lowers the nominal rate.

$\Rightarrow$ The real rate rises less.

$\Rightarrow$ Output decreases less compared with models without goodwill.

5 Calibration

Figure 1 Calibration of Parameters

Parameters	Value	Descriptions	Source
β	0.99	Subjective discount factor	Gali (2015).
ω	5	Inverse labor supply elasticity	
σ	1(log utility)	Inverse intertemporal elasticity of substitution	
ψ_π	1.5	Monetary rule coefficient on inflation	
ψ_y	0.5/ 4	Monetary rule coefficient on output	
ε	9	Elasticity of substitution between goods	
ρ	0.85	Persistence of shock	
ψ	93.20	Price adjustment cost	

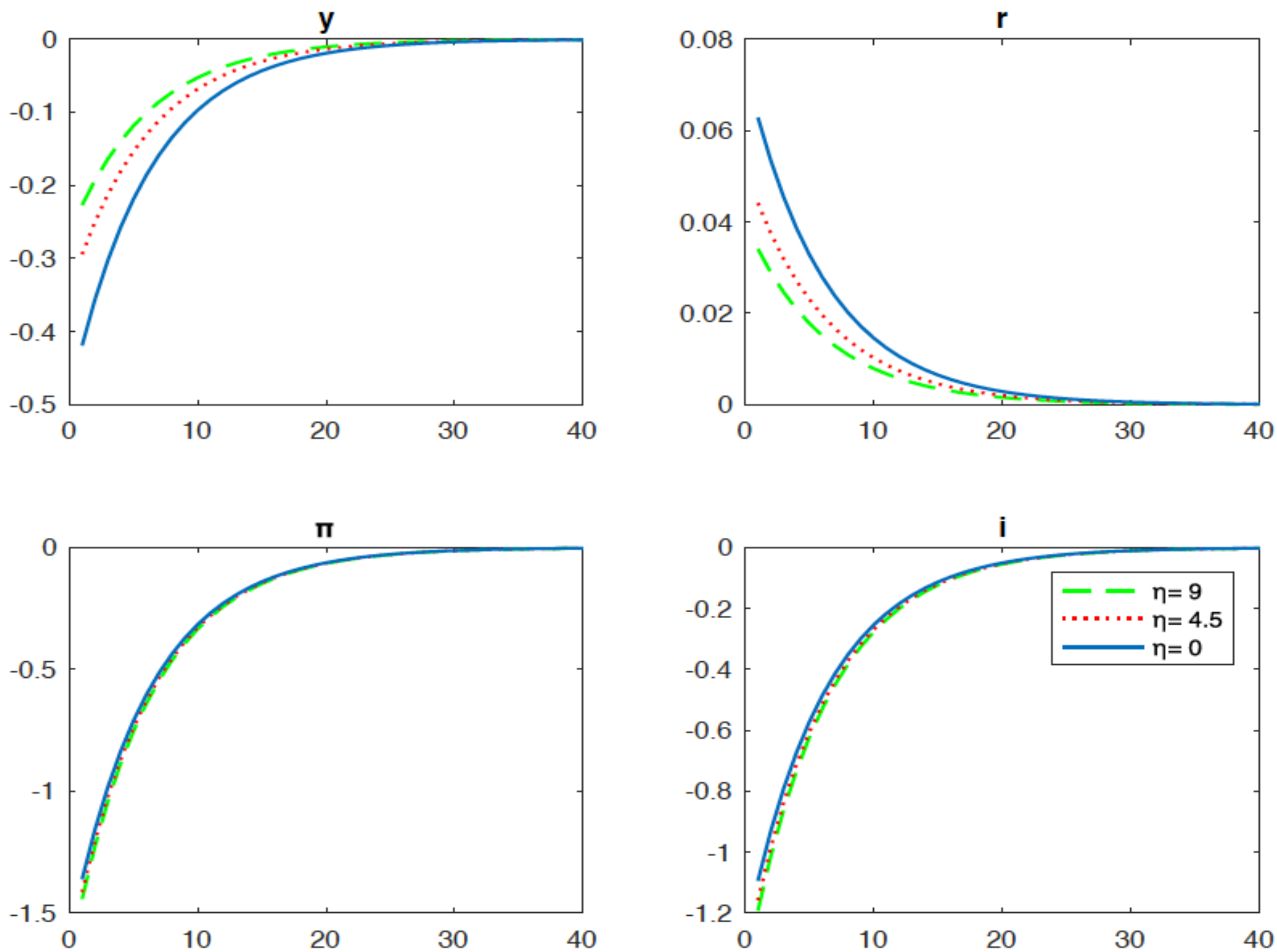
5 Calibration

- Based on the evaluation of Lemma 2 that the ratio of past to current price elasticities of demand is equal to $\alpha(0 \leq \alpha \leq 1)$ near a steady state, $\eta \leq \varepsilon$.

Consider three cases: a standard New Keynesian model without goodwill ($\eta = 0$), a moderate goodwill effect ($\eta = 4.5$) and an extreme case where the current and past price elasticities of demand are equal ($\eta = \varepsilon = 9$).

5 Calibration

Figure 2 Impulse Responses to a Contractionary Shock



6 Conclusion

- Main findings:

1. Even when prices are flexible, there exist forms of demand function that make a monetary policy have a real effect although these forms are unrealistic. Contradiction to conventional wisdom of monetary neutrality.

2. Using one of the most realistic forms of demand function under Rotemberg price stickiness, I find that the real effect of a monetary policy shock diminishes compared with the standard New Keynesian models.

- Future work: a better micro-foundation for the goodwill effect.