Distributional Effects of Monetary Policy in Emerging Markets

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Outline

Distributional Effect

- Macroeconomic choices have distributional consequences, which are often ignored by the mainstream literature
- Past literature mainly focuses on the distributional effects of fiscal policy, e.g. optimal taxation and risk-sharing
- The distributional effects of monetary policy are more subtle, but deserve more attention
  - monetary policy has become primary instrument
  - financial markets are imperfect and incomplete
  - external shocks are pervasive

Developing Countries

- Distributional effects tend to be larger in developing countries due to underdeveloped financial markets and limited access to those markets
- In the open economy environment, the conduct of monetary policy has another dimension of concern, the nominal exchange rate
- Certain features of monetary policy choices in developing countries further exacerbate the distributional effect

Our Contribution

- We construct a model capturing key features of emerging markets to jointly examine the aggregate welfare and distributional effects of monetary policy choices
- Heterogeneous agent model that distinguishes households by their sources of income and incorporates financial frictions
- We show that monetary policy can have significant distributional effects, even when aggregate effects are small

Relevant Literature

- Open economy macroeconomics: Obstfeld and Rogoff (1995), Clarida, Gali, and Gertler (2002), Gali and Monacelli (2005, 2008)
- Distributional effects of monetary policy: Romer and Romer (1998), Coibion et al. (2012) and Brunnermeier and Sannikov (2013)
- Household heterogeneity: Hugget (1993), Aiyagari (1994), Krusell and Smith (1998), Gali, Lopez-Salido, and Valles (2004)
- DSGE models for studying monetary policy in developing countries: Devereux, Lane and Xu (2006), Anand and Prasad (2012) and Chang, Liu, and Spiegel (2012)

Estimates of Interest Rate Smoothing Parameters

Advanced Economies	Smoothing	Emerging Markets	Smoothing
Australia	0.933	Brazil	0.760
Belgium	0.927	China	0.983
Canada	0.897	Colombia	0.739
Denmark	0.968	Czech Republic	0.899
France	0.914	Hungary	0.784
Germany	0.926	Latvia	0.559
Italy	0.906	Malaysia	0.744
Japan	0.803	Mexico	0.999
Netherlands	0.857	Philippines	0.942
Norway	0.981	Poland	0.896
Sweden	0.880	Romania	0.846
Switzerland	0.904	Russian Federation	0.691
United Kingdom	0.982	South Africa	0.952
United States	0.973	Ukraine	0.649

Data source: International Financial Statistics. Estimates are computed by the author.

Outline

Basic Setting

- Small open economy model with tradable and non-tradable goods sectors
- Heterogeneity among households:
  - labor households in the tradable goods sector (H)
  - labor households in the nontradable goods sector (N)
  - capital owners (K)
- Sector specific labor and mobile capital for tradable and non-tradable goods production
- Nominal price rigidities in both sectors
- Key characteristics of an emerging market economy: financial frictions and special features of monetary policy

Household Preferences

- Households are infinitely lived and maximize their lifetime utility

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{m\,1-\sigma}}{1-\sigma} - \psi_m \frac{N_t^{m\,1+\phi}}{1+\phi} \right), \quad m \in \{H, N\} \quad (1)$$

- Capital owners do not supply labor

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{K\,1-\sigma}}{1-\sigma} \right), \quad (2)$$

- Households mainly differ in the source of income

Household Preferences

- Consumption is derived from both tradable and nontradable goods:

$$C_t = (b^{\frac{1}{\xi}} c_{T,t}^{\frac{\xi-1}{\xi}} + (1-b)^{\frac{1}{\xi}} c_{N,t}^{\frac{\xi-1}{\xi}})^{\frac{\xi}{\xi-1}} \tag{3}$$

- Tradable goods (domestic and foreign) commodity comprises a variety of goods

$$C_{T,t} = (a^{\frac{1}{\eta}} c_{H,t}^{\frac{\eta-1}{\eta}} + (1-a)^{\frac{1}{\eta}} c_{F,t}^{\frac{\eta-1}{\eta}})^{\frac{\eta}{\eta-1}} \tag{4}$$

- Domestic goods consumption $C_{H,t}$ is defined as

$$C_{H,t} \equiv \left(\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{5}$$

- Nontradable goods consumption:

$$C_{N,t} \equiv \left(\int_0^1 C_{N,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{6}$$

Budget Constraint

- Financial frictions as portfolio holding cost ψ_B^m differ across households
- For labor households, income source includes only wage earnings and bond holdings:

$$C_t^m + \frac{B_t^m}{P_t} + \frac{\psi_B^m}{2}\left(\frac{B_t^m}{P_t}\right)^2 = R_{t-1}\frac{B_{t-1}^m}{P_t} + \frac{W_t^m}{P_t}N_t^m, \quad m \in \{H, N\} \quad (7)$$

- Budget constraint for capital owners also includes capital return, firm profit and investment decision:

$$\begin{aligned} & C_t^K + e_t\frac{B_t^{*K}}{P_t} + e_t\frac{\psi_B^{*K}}{2}\frac{B_t^{*K\,2}}{P_t} + \frac{B_t^K}{P_t} + \frac{\psi_B^K}{2}\frac{B_t^{K\,2}}{P_t} + q_t^k K_{t+1} \\ = \quad & R_{t-1}^* e_t\frac{B_{t-1}^{*K}}{P_t} + R_{t-1}\frac{B_{t-1}^K}{P_t} + ((1-\delta)q_t^k + r_t^K)K_t + \frac{\Pi_t}{P_t} \end{aligned} \quad (8)$$

Optimality Condition for Households

- Labor-consumption trade-off:

$$\psi_i C_t^{i\sigma} N_t^{i\phi} = \frac{W_t^i}{P_t}, \quad i \in \{H, N\} \tag{9}$$

- Domestic currency denominated bond:

$$E_t \left[\beta_t \frac{R_t}{1 + \psi_B^j B_t^j} \left(\frac{P_t}{P_{t+1}} \right) \left(\frac{C_{t+1}^j}{C_t^j} \right)^{-\sigma} \right] = 1, \quad j \in \{H, N, K\} \tag{10}$$

- Foreign currency denominated bond:

$$E_t \left[\beta_t \frac{R_t^*}{1 + e_t \psi_B^{*K} B_t^{*K}} \left(\frac{P_t}{P_{t+1}} \frac{e_{t+1}}{e_t} \right) \left(\frac{C_{t+1}^K}{C_t^K} \right)^{-\sigma} \right] = 1 \tag{11}$$

- Asset pricing equation:

$$q_t^k = \beta E_t \left(\frac{C_{t+1}^K}{C_t^K} \right)^{-\sigma} \left(r_{t+1}^k + q_{t+1}^k (1 - \delta) \right) \tag{12}$$

International Market

- The terms of trade:

$$\frac{S_t}{S_{t-1}} = \frac{e_{t-1}}{e_t}\pi_{H,t} \tag{13}$$

- Export demand:

$$C^F_{H,t} = S_t^{-\eta} C^*_t \tag{14}$$

$$\begin{aligned} C^*_t &= \overline{C}^* e^{\mu_t} && (15)\\ \mu_t &= \rho_\mu \mu_{t-1} + \varepsilon^\mu_t && (16) \end{aligned}$$

- Foreign interest rate:

$$\begin{aligned} R^*_t &= R^* + e^{\nu_t - 1} - 1 && (17)\\ log(\nu_t) &= \rho_\nu log(\nu_{t-1}) + \varepsilon_{\nu,t} && (18) \end{aligned}$$

Production Technology

- In each sector, the production needs sector-specific labor and mobile capital
- The production function is given by:

$$Y_t^i(j) = A_t^i K_t^i(j)^{\alpha_i} N_t^i(j)^{1-\alpha_i}, \quad i \in \{H, N\} \tag{19}$$

- Firms face sector-wide productivity shocks to A_t^H and A_t^N. The productivity shock follows the following AR(1) process

$$\begin{aligned} A_t^i &= A^i e^{a_{i,t}}, \quad i \in \{H, N\} && (20) \\ a_{i,t} &= \rho_a a_{i,t-1} + \varepsilon_{i,t}^a, \quad i \in \{H, N\} && (21) \end{aligned}$$

Optimal Pricing

- Firms set their prices in a staggered manner, à la Calvo (1983) and maximize discounted profits:

$$\max_{P_{i,t}} E_t \sum_{s=0}^{\infty} \left\{ (\beta\theta)^s \left(\frac{C_{t+s}^{k\ -\sigma}}{P_{t+s}} \right) \left[P_{i,t}(j) - MC_{i,t+s} \right] Y_{i,t+s}(j) \right\}, \quad i \in \{H, N\}$$

- The optimality condition for $P_{i,t}^*$ is:

$$E_t \sum_{s=0}^{\infty} \left\{ (\beta\theta)^s \left(\frac{C_{t+s}^{k\ -\sigma}}{P_{t+s}} \right) Y_{i,t+s} P_{i,t+s}^{\varepsilon+1} \left[\frac{P_{i,t}(j)}{P_{i,t+s}} - \frac{\varepsilon}{\varepsilon - 1} \frac{MC_{i,t+s}}{P_{i,t+s}} \right] \right\} = 0 \tag{22}$$

Monetary Policy Rule

- In the cashless environment of the New Keynesian model, an interest rate rule is needed to close the system

- We use a simple inflation-targeting rule for the baseline model

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho ln\left(\frac{R_{t-1}}{\overline{R}}\right) + (1-\rho)\phi_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) \qquad (23)$$

▸ Equilibrium Condition

Shocks

- Sector-specific productivity shocks in tradable and nontradable goods sectors follow AR(1) processes
- The economy also faces foreign demand shocks and foreign interest rate shocks. These shocks follow AR(1) processes as well

▸ Impulse Response Function

Outline

Computational Technique

- Two major solution methods are widely used: the projection method and the perturbation method
- Use the perturbation method to solve the model and implement second order approximation
- The second order approximation is needed to accurately calculate welfare (Schmitt-Grohe and Uribe, 2003, 2007)

Parameter Choice

Parameter	Definition	Calibration Value
β	quarterly discount factor	0.99
σ	risk aversion coefficient	2
α_H	capital income share in the tradable goods sector	0.36
α_N	capital income share in the nontradable goods sector	0.36
δ	capital depreciation rate	0.02
a	home bias on tradable goods	0.6
b	consumption weight of tradable goods	0.45
η	elasticity for home and foreign tradable goods	2
γ	elasticity across goods from foreign countries	2
ε	elasticity across varieties	11
ξ	elasticity between tradable and nontradable	0.7
ϕ	income elasticity of labor supply	3
θ	probability for firms to reset price	0.66
ρ	interest rate smoothing factor	0.75
ϕ_π	interest rate rule coefficient for inflation	1.5
λ_K	population weight for capital owners in T	0.1

Matching Key Moments

Variables	Hand-to-mouth	Complete Market	Emerging Markets	Advanced Economies
$\sigma(Y)$	3.80	4.36	3.98	2.07
$\sigma(C)/\sigma(Y)$	0.95	0.55	1.23	0.87
$\sigma(I)/\sigma(Y)$	3.67	5.30	3.79	3.62
$\sigma(TB/Y)$	2.20	3.91	2.92	0.98

Notes: The table compares the simulated moments with the data generated moments. Empirical moments are borrowed from Schmitt-Grohe and Uribe (manuscript).

Distributional Effect

- Propose a few alternative simple rules and compare the distributional and aggregate effects of monetary policy rules
- Use simple inflation targeting as the benchmark case and measure welfare under alternative policy rules
- Design some robustness check and compare the welfare consequence under each environment
- Look for the optimal and implementable simple rule for the aggregate economy as well as each type of households

Derivation of Consumption Gain

- Define benchmark welfare as below:

$$V_0^{b,m} = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{b,1-\sigma}}{1-\sigma} - \psi_m \frac{N_t^{b,1+\phi}}{1+\phi} \right), \quad m \in \{H, N, K\} \tag{24}$$

- For welfare under an alternative environment:

$$V_0^{a,m} = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{a,1-\sigma}}{1-\sigma} - \psi_m \frac{N_t^{a,1+\phi}}{1+\phi} \right), \quad m \in \{H, NK\} \tag{25}$$

- The consumption gain ω is the multiplier to consumption that equates the two welfare:
- Aggregate welfare is evaluated based on a utilitarian criterion

$$V_t = \left[\lambda_K u_t^K + \lambda_H u_t^H + \lambda_N u_t^N \right] + \beta V_{t+1} \tag{26}$$

Alternative Monetary Policy Rules

- Aggressive Inflation Targeting
- Leaning Against the Wind Rule

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho ln\left(\frac{R_{t-1}}{\overline{R}}\right) + (1-\rho)\left[\phi_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \phi_e ln\left(\frac{e_{t-1}}{e_{t-2}}\right)\right]$$

- Reduced Interest Rate Smoothing
- Taylor Rule with Sector-specific Output Gap

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho ln\left(\frac{R_{t-1}}{\overline{R}}\right) + (1-\rho)\left[\phi_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \phi_H ln\left(\frac{Y_{H,t-1}}{Y_{H,t-2}}\right) + \phi_N ln\left(\frac{Y_{N,t-1}}{Y_{N,t-2}}\right)\right]$$

- Taylor Rule with Aggregate Output Difference

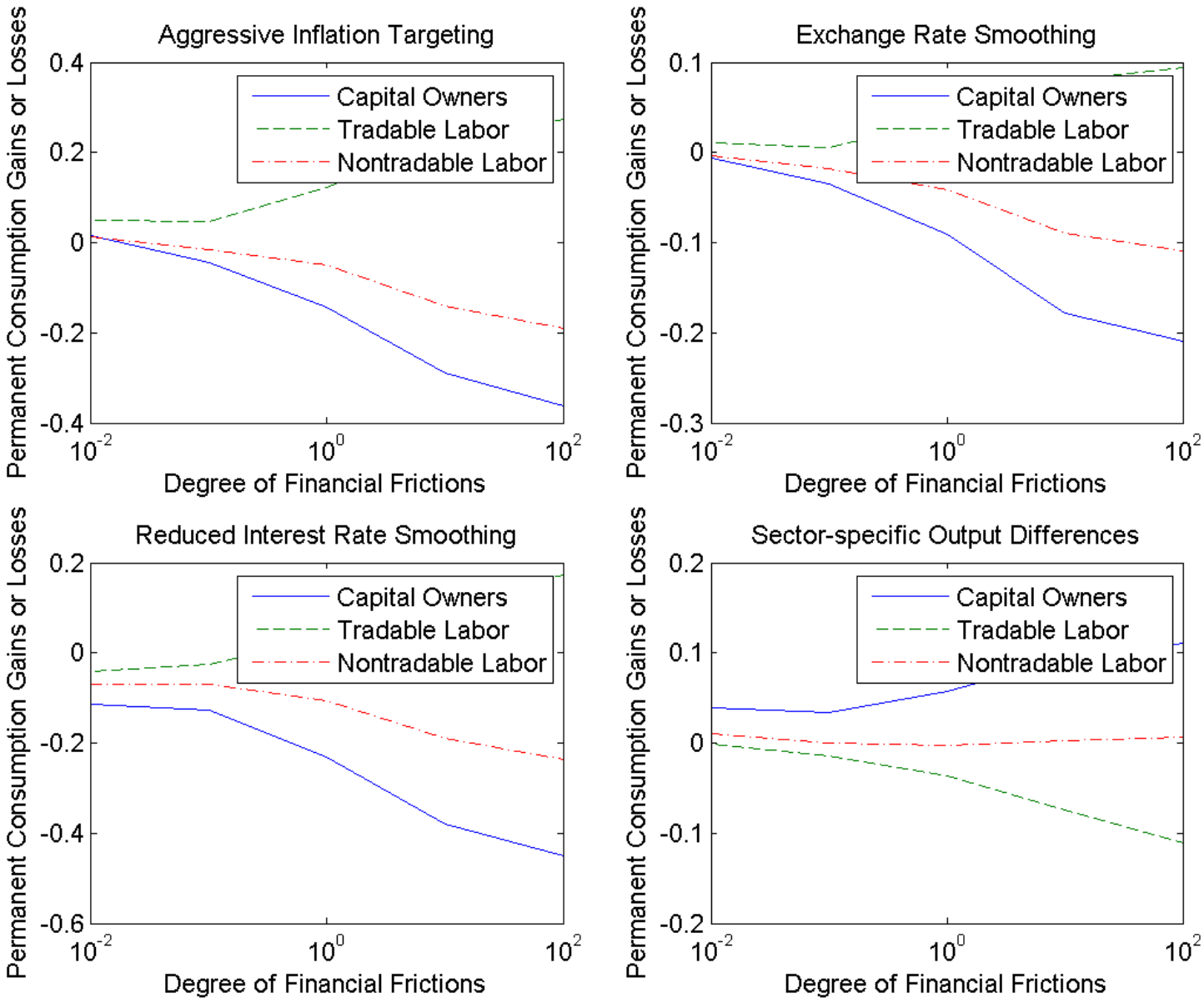
$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho ln\left(\frac{R_{t-1}}{\overline{R}}\right) + (1-\rho)\left[\phi_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \phi_Y ln\left(\frac{Y_{t-1}}{Y_{t-2}}\right)\right]$$

Welfare Comparison Under Baseline Scenario

	Capital	T Sector Labor	NT Sector Labor	Aggregate
Aggressive IT	-0.14 %	0.12 %	-0.05 %	0.02 %
Leaning Against the Wind	-0.09 %	0.04 %	-0.04 %	-0.01 %
Reduced Interest Smoothing	-0.23 %	0.03 %	-0.11 %	-0.06 %
Sector-specific Output	0.06 %	-0.04 %	-0.00 %	-0.01 %
Aggregate Output	-0.23 %	0.00 %	-0.06 %	-0.05 %

Notes: The table shows welfare gains (positive numbers) or losses (negative numbers) relative to the benchmark case of a simple inflation targeting rule.

Welfare Comparison Under Financial Frictions



Optimal and Implementable Simple Rule

Optimal simple rule parameter

	Capital Owners	Tradable Labor	Nontradable Labor	Aggregate
Inflation Target	1.5	2	1.7	2
Smoothing Parameter	0.85	0.7	0.85	0.85
FX Rate Smoothing	0	0.2	0	0
Tradable Output	0.3	0	0.2	0.1
Nontradable Output	0	0.2	0	0

Welfare changes comparing with the level under aggregate optimal rule

	Capital Owners	Tradable Labor	Nontradable Labor	Aggregate
Optimal Rule of Capital	0.16 %	-0.13 %	0.00 %	-0.04 %
Optimal Rule of T Labor	-0.34 %	0.07 %	-0.12 %	-0.05 %
Optimal Rule of NTLabor	0.09 %	-0.06 %	0.01 %	-0.02 %

Notes: The table shows welfare gains (positive numbers) or losses (negative numbers) relative to the level under the optimal rule for the aggregate welfare.

Outline

Summary

- Monetary policy actions have significant distributional effects. We constructed a model with features relevant to emerging market economies
- Exchange rate management and aggressive inflation-targeting is welfare-enhancing for labor households in the tradable goods sector at the cost of other households
- A higher degree of interest rate smoothing is beneficial for capital owners by reducing return volatility
- Many of the distributional effects we find become stronger as financial frictions increase

Aggregate Demand

- Nontradable Goods Market.

$$\begin{aligned} Y_{N,t} &= \lambda_K C^K_{N,t} + \lambda_H C^H_{N,t} + \lambda_N C^N_{N,t} + I_{N,t} \\ &= (1-b)[b x_t^{\xi-1} + (1-b)]^{\frac{\xi}{1-\xi}} (C_t + I_t) \end{aligned} \tag{27}$$

- Tradable Goods Market.

$$\begin{aligned} Y_{H,t} &= \lambda_K C^K_{H,t} + \lambda_H C^H_{H,t} + \lambda_N C^N_{H,t} + I_{H,t} + C^F_{H,t} \\ &= ab[b + (1-b)x_t^{1-\xi}]^{\frac{\xi}{1-\xi}} [a + (1-a)S_t^{\eta-1}]^{\frac{\eta}{1-\eta}} (C_t + I_t) \\ &\quad + S_t^{-\gamma} C_t^* \end{aligned} \tag{28}$$

Back to the Model

Aggregate Demand

- Capital Rental Market.

$$K_t = \int_0^1 K_t^H(i)di + \int_0^1 K_t^N(i)di \tag{29}$$

- Labor Market.

$$N_t^k = \int_0^1 N_t^k(i)di, \quad k \in \{H, N\} \tag{30}$$

Back to the Model

Aggregate Supply

- Optimal Pricing and Marginal Cost. Define the reoptimized price relative to current price as $\tilde{p}_t = \frac{\tilde{P}_t}{P_t}$.

$$\tilde{p}_{m,t} = \frac{E_t \sum_{j=0}^{\infty} (\beta\theta)^j \left(C_{t+j}^{K}{}^{-\sigma} Y_{m,t+j}\right) X_{t,j}^{m\,-\varepsilon} \frac{\varepsilon}{\varepsilon-1} mc_{m,t+j}}{E_t \sum_{j=0}^{\infty} (\beta\theta)^j \left(C_{t+j}^{J}{}^{-\sigma} Y_{m,t+j} \left(\frac{P_{t+j}^{m}}{P_{t+j}}\right)\right) X_{t,j}^{m\,1-\varepsilon}} = \frac{G_t}{F_t} \tag{31}$$

  where $m \in \{H, N\}$, and $X_{t,j}^{m} = \frac{1}{\prod_{i=1}^{j} \pi_{t+i}^{m}}$.

- Sector Inflation Dynamics.

$$\pi_{m,t} = \frac{P_{m,t}}{P_{m,t-1}} = \left(\frac{1 - (1-\theta)\tilde{p}_{m,t}^{1-\varepsilon}}{\theta}\right)^{\frac{1}{\varepsilon-1}}, \quad m \in \{H, N\} \tag{32}$$

Back to the Model

Aggregate Supply

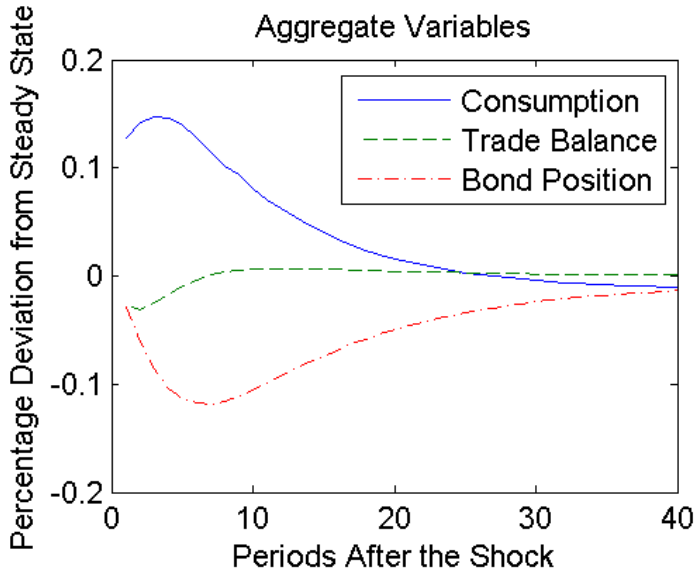
- Aggregate Inflation Dynamics

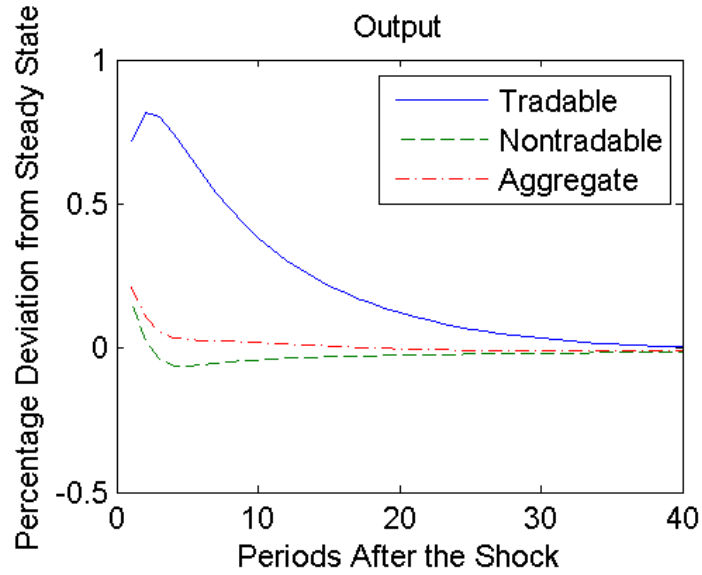
$$\pi_t = \pi_{H,t} \frac{[(a + (1-a)s_t^{\eta-1}]^{1/(1-\eta)}}{[(a + (1-a)s_{t-1}^{\eta-1}]^{1/(1-\eta)}} \frac{[b + (1-b)x_t^{1-\xi}]^{1/(1-\xi)}}{[b + (1-b)x_{t-1}^{1-\xi}]^{1/(1-\xi)}} \tag{33}$$

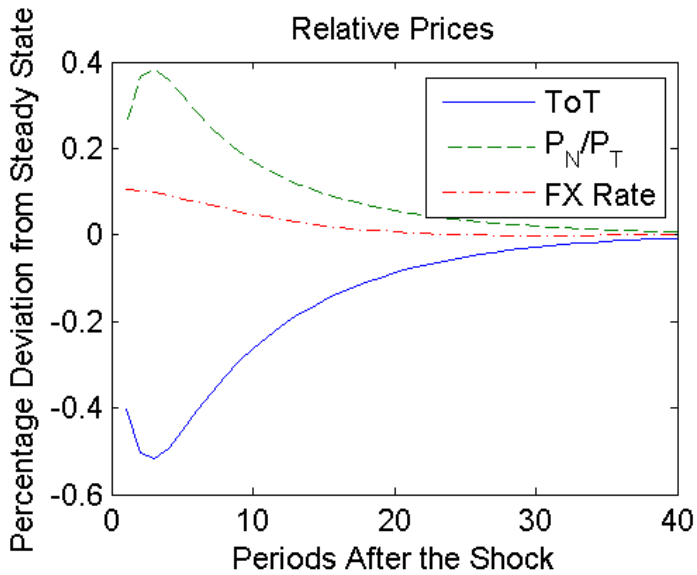
- Aggregate Supply and Price Dispersion. Although there is no aggregate production function in the New Keynesian framework, one can derive the equation linking the aggregate output with aggregate input factors, conditional on the price distribution.

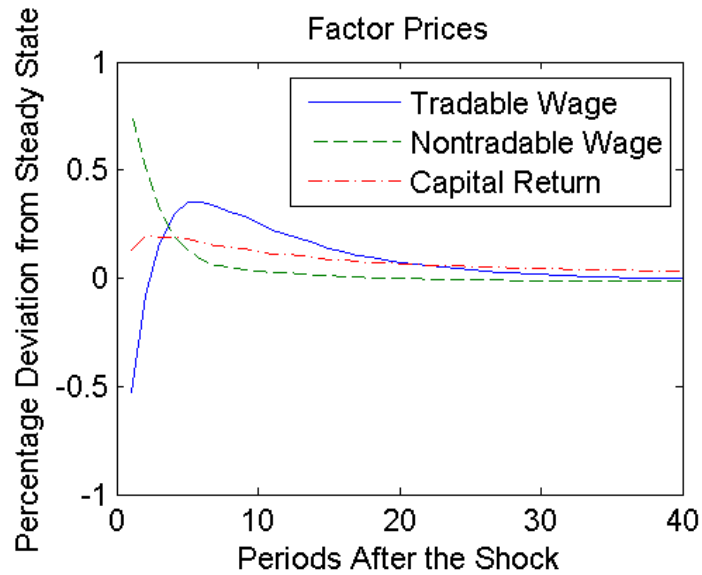
Back to the Model

Productivity Shock in Tradable Goods Sector



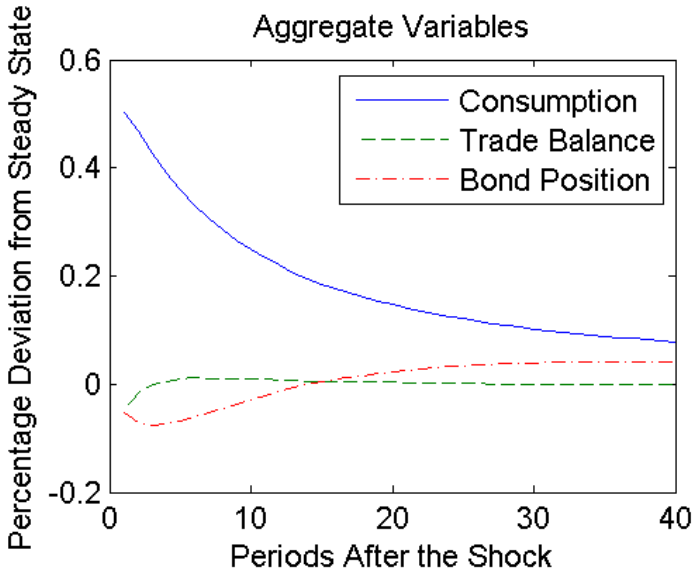


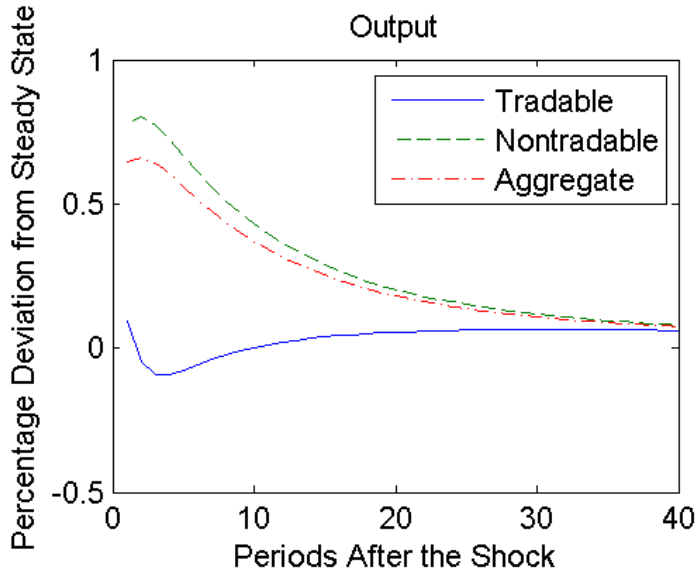


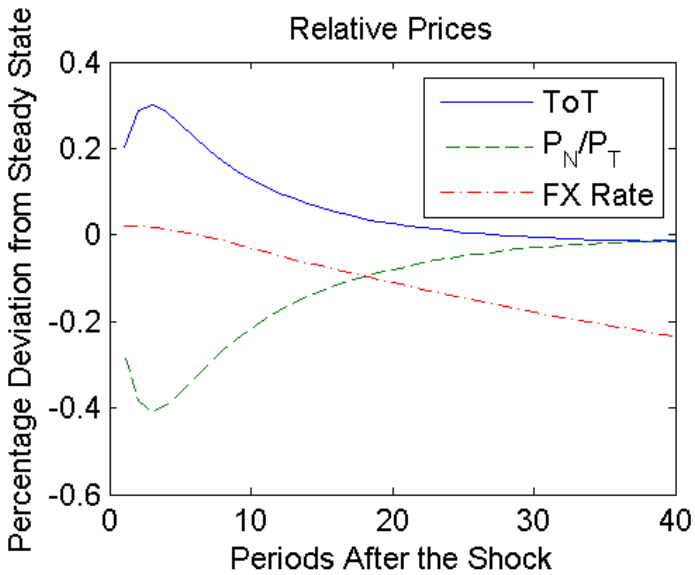


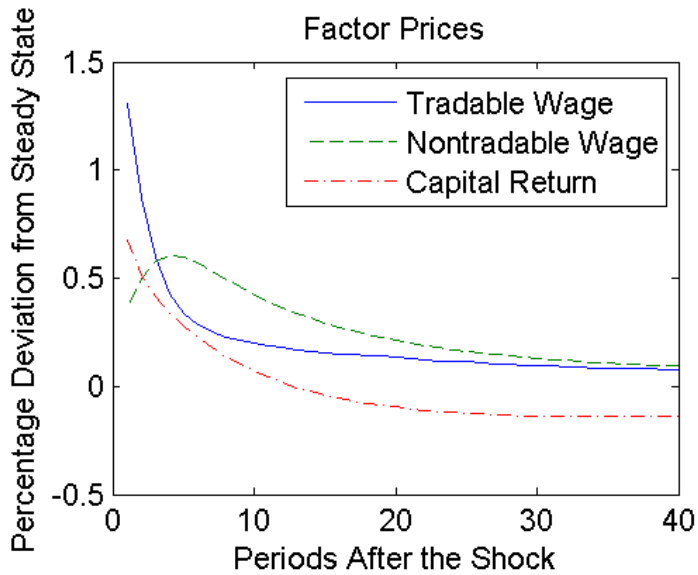
▸ Back to the Model

Productivity Shock in Nontradable Goods Sector



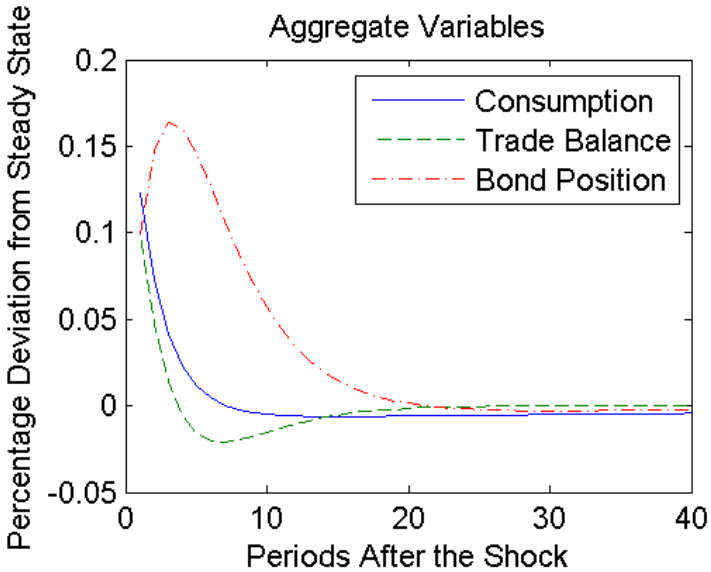


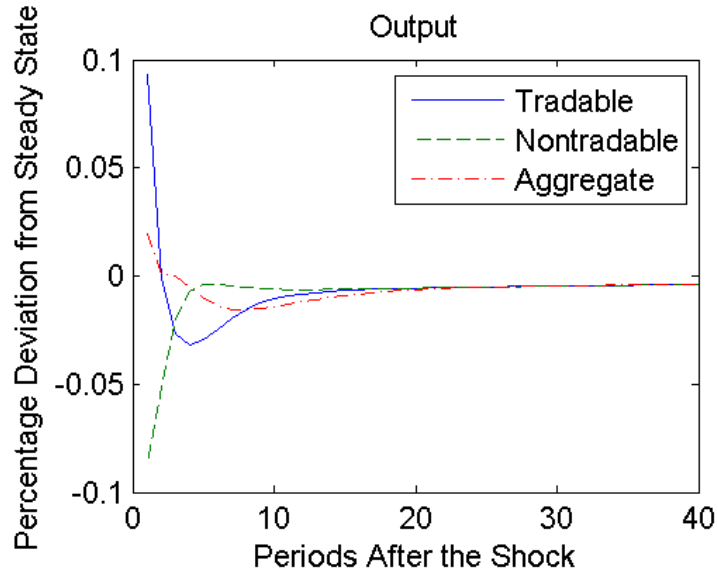


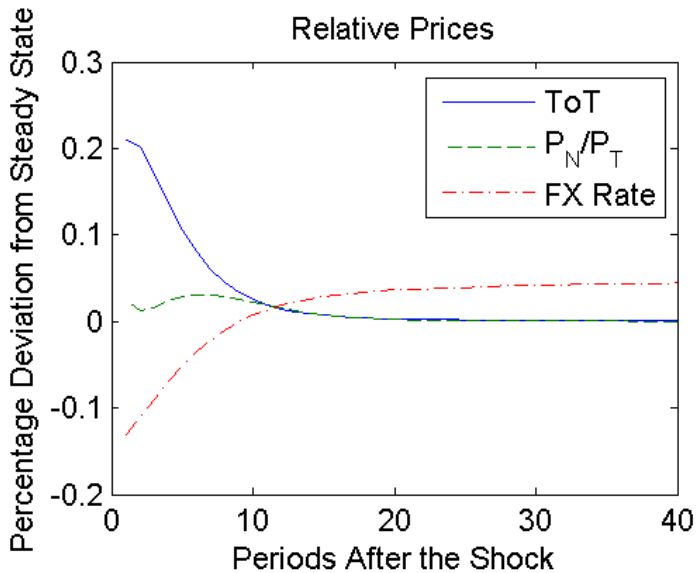


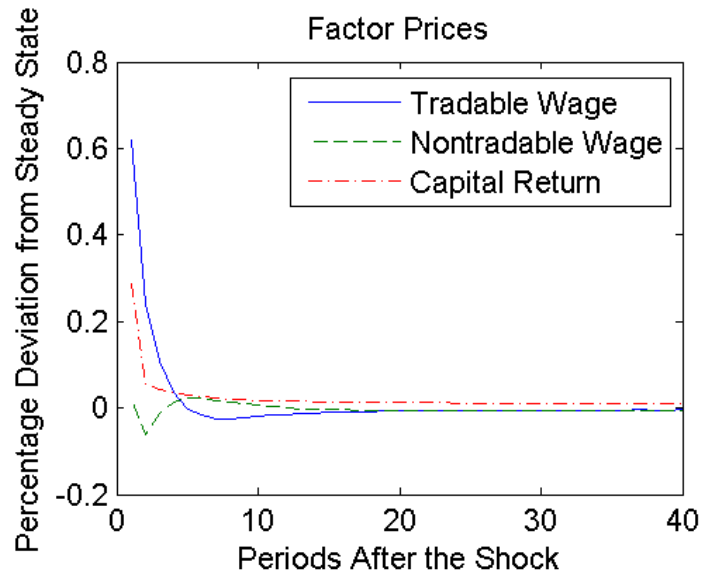
▸ Back to the Model

Foreign Demand Shock









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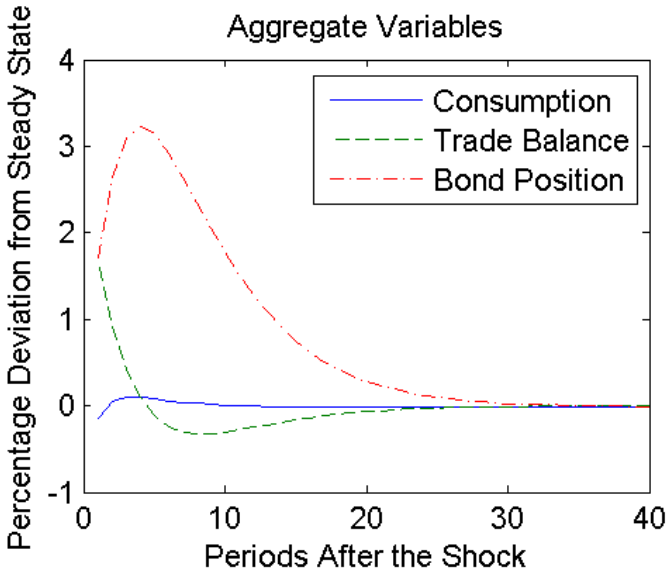
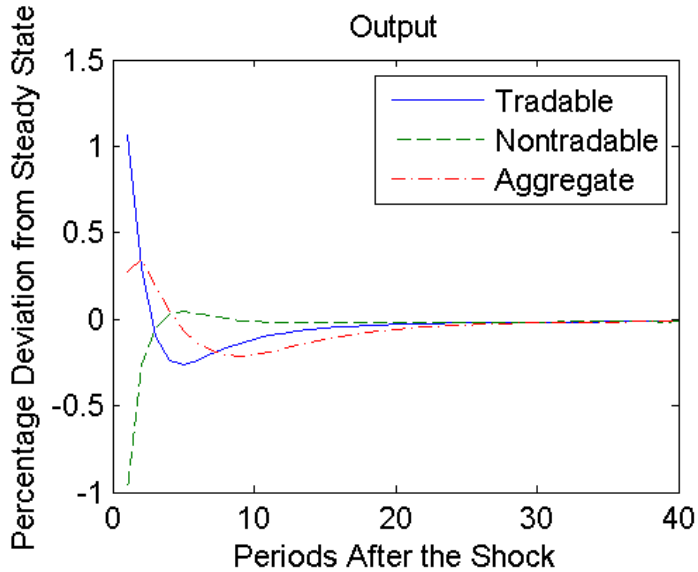
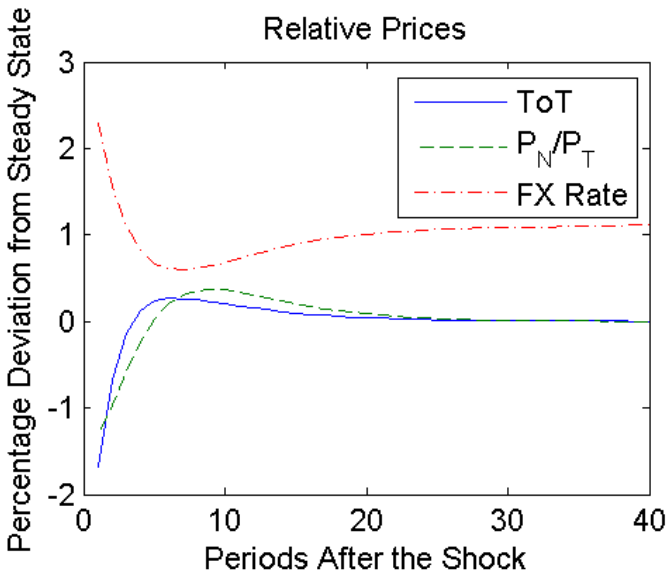
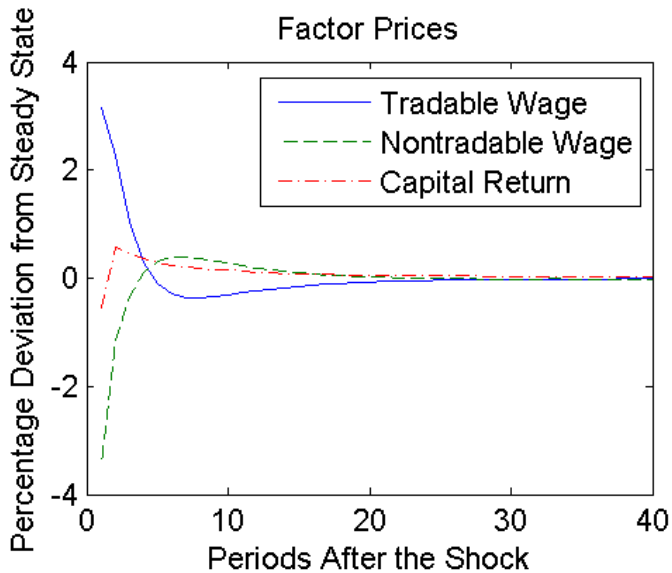
Foreign Interest Rate Shock









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