Distributional Effects of Monetary Policy in Developing Countries

Eswar Prasad and Boyang Zhang

Cornell University

January 30, 2014

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

Developing Countries

- Distributional effects tend to be larger in developing countries due to underdeveloped financial markets and limited access to those markets
- In open economy with nontradable goods, monetary policy tends to have asymmetric effects across sectors, often amplifying the distributional effects
- 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

- New Open Economy Macroeconomics: Obstfeld and Rogoff (1995), Clarida, Gali, and Gertler (2002), Gali and Monacelli (2005, 2008) and Benigno and Thoenissen (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: Anand and Prasad (2012) and Chang, Liu, and Spiegel (2012).

Outline

Basic Setting

- Small open economy model with tradable and non-tradable goods sectors
- Heterogeneity among households: capital owners, skilled labor and unskilled labor
- Different production functions across sectors
- 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.

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{u\,1-\sigma}}{1-\sigma} - \psi_u \frac{N_t^{u\,1+\phi}}{1+\phi} \right), \tag{1}$$

- The utility functions of skilled labor and capital owners are similar.

Household Preferences

- Consumption is derived from both tradable and nontradable goods:

$$C_t = (b^{\frac{1}{\xi}} c_{T,t}^{\frac{\xi-1}{\xi}} + (1-b)^{\frac{1}{\xi}} c_{N,t}^{\frac{\xi-1}{\xi}})^{\frac{\xi}{\xi-1}} \tag{2}$$

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

$$C_{T,t} = (a^{\frac{1}{\eta}} c_{H,t}^{\frac{\eta-1}{\eta}} + (1-a)^{\frac{1}{\eta}} c_{F,t}^{\frac{\eta-1}{\eta}})^{\frac{\eta}{\eta-1}} \tag{3}$$

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

$$C_{H,t} \equiv \left(\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{4}$$

Household Preferences

- Foreign goods consumption is given by

$$C_{F,t} \equiv \left(\int_0^1 C_{i,t}^{\frac{\gamma-1}{\gamma}} di \right)^{\frac{\gamma}{\gamma-1}} \tag{5}$$

- Country-specific imported goods are then an index of a variety of goods.

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

- Nontradable goods consumption:

$$C_{N,t} \equiv \left(\int_0^1 C_{N,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{7}$$

Budget Constraint

- Characterize financial frictions by portfolio holding costs ψ_B, which appear as a wedge in the intertemporal Euler equation.
- Budget constraint for capital owners:

$$P_t C_t^k + B_t^k + \frac{\psi_B}{2} B_t^{k2} = R_{t-1} B_{t-1}^k + R_t^k \overline{K} + \Pi_t^H \quad (8)$$

- Budget constraints for skilled labor and unskilled labor:

$$P_t C_t^s + B_t^s + \frac{\psi_B}{2} B_t^{s2} = R_{t-1} B_{t-1}^s + W_t^s N_t^s \quad (9)$$

$$P_t C_t^u + B_t^u + \frac{\psi_B}{2} B_t^{u2} = R_{t-1} B_{t-1}^u + W_t^u N_t^u + \Pi_t^N \quad (10)$$

- ψ_B can differ across households (in extended version of the model).

Optimality Condition for Households

- Labor-consumption trade-off:

$$\psi_i C_t^{i\sigma} N_t^{i\phi} = \frac{W_t^i}{P_t}, \quad i \in \{s, u\}. \tag{11}$$

- Intertemporal Euler equation:

$$E_t \left[\beta_t \frac{R_t}{1 + \psi_B B_t^j} \left(\frac{P_t}{P_{t+1}} \right) \left(\frac{C_{t+1}^j}{C_t^j} \right)^{-\sigma} \right] = 1, \quad j \in \{k, s, u\} \tag{12}$$

International Market

- The terms of trade, real exchange rate and inflation:

$$\frac{S_t}{S_{t-1}} \frac{Q_t}{Q_{t-1}} \frac{\pi_{H,t}}{\pi_t} = 1 \tag{13}$$

- Uncovered Interest Rate Parity (UIP) in nominal terms:

$$E_t[\frac{R_t^*}{R_t} \frac{\varepsilon_{t+1}}{\varepsilon_t}] = 1 \tag{14}$$

- Uncovered Interest Rate Parity (UIP) in real terms:

$$E_t[\frac{R_t^* \pi_{t+1}}{R_t \pi_{t+1}^*} \frac{Q_{t+1}}{Q_t}] = 1 \tag{15}$$

Production Technology

- The production function in the tradable sector features capital-skill complementarity.

$$Y_{T,t}(j) = A_t^H [\mu_H^{\frac{1}{\sigma_H}} N_u(j)^{\frac{\sigma_H - 1}{\sigma_H}} + (1-\mu_H)^{\frac{1}{\sigma_H}} (\lambda_H^{\frac{1}{\xi_H}} K(j)^{\frac{\xi_H - 1}{\xi_H}} + (1-\lambda_H)^{\frac{1}{\xi_H}} N_s(j)^{\frac{\xi_H - 1}{\xi_H}})^{\frac{\sigma_H - 1}{\sigma_H} \frac{\xi_H}{\xi_H - 1}}]^{\frac{\sigma_H}{\sigma_H - 1}} \tag{16}$$

- Production in the nontradable goods sector (no capital):

$$Y_{N,t}(j) = A_t^N [\mu_N^{\frac{1}{\sigma_N}} N_u(j)^{\frac{\sigma_N - 1}{\sigma_N}} + (1-\mu_N)^{\frac{1}{\sigma_N}} N_s(j)^{\frac{\sigma_N - 1}{\sigma_N}}]^{\frac{\sigma_N}{\sigma_N - 1}} \tag{17}$$

Optimal Pricing

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

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

- The optimality condition for P_t^* is:

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

$$= 0, \quad m \in \{H, N\} \tag{18}$$

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.

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) \tag{19}$$

▸ 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.
- We use the perturbation method to solve the model and implement second order approximation given the high degree of nonlinearity of the model.
- The second order approximation is needed to accurately calculate welfare. Schmitt-Grohe and Uribe (2003, 2007).

Calibration

Parameter	Definition	Calibrated Value
β	quarterly discount factor	0.99
σ	risk aversion coefficient	2
a	home bias on tradable goods	0.7
b	consumption weight of tradable goods	0.25
η	elasticity for home and foreign tradables	2
γ	elasticity of goods across foreign countries	2
ε	elasticity across varieties	6
ξ	elasticity between tradable and nontradable	0.7
ϕ	income elasticity of labor supply	2
ψ_B	portfolio holding cost	0.05
ξ_H	elasticity between skilled labor and capital	0.67
σ_H	elasticity between unskilled labor and capital	1.67
λ_1	population weight for capital owners	0.02
λ_2	population weight for skilled labor	0.08

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 by the percentage of permanent consumption gain.
- Design a set of model extensions and, for each extension, compare the welfare consequence of the choice among monetary policy rules.
- Evaluate the effects of additional features against the baseline model.

Derivation of Consumption Gain

- Define benchmark welfare as below:

$$V_0^{b,m} = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{b,1-\sigma}}{1-\sigma} - \psi_m \frac{N_t^{b,1+\phi}}{1+\phi} \right), \quad m \in \{u, s, k\} \quad (20)$$

- For welfare under an alternative environment:

$$V_0^{a,m} = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{a,1-\sigma}}{1-\sigma} - \psi_m \frac{N_t^{a,1+\phi}}{1+\phi} \right), \quad m \in \{u, s, k\} \quad (21)$$

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

$$V_t = \left[\lambda_1 u_t^k + \lambda_2 u_t^s + \lambda_3 u_t^u \right] + \beta V_{t+1} \quad (22)$$

Alternative Monetary Policy Rules

- Aggressive Inflation Targeting.
- Interest Rate Smoothing.
- Taylor Rule with Aggregate Output Gap.

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \rho_Y ln\left(\frac{Y_t}{\overline{Y}}\right) \tag{23}$$

- Taylor Rule with Sector-specific Output Gap.

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \rho_H ln\left(\frac{Y_{H,t}}{A_t^H \overline{Y}_H}\right) + \rho_N ln\left(\frac{Y_{N,t}}{A_t^N \overline{Y}_N}\right) \tag{24}$$

- Terms of Trade Augmented Taylor Rule.

$$ln\left(\frac{R_t}{\overline{R}}\right) = \rho_S \left(1 - \frac{S_{t+1}}{S_t}\right) + (1-\rho_S)\left[\rho_\pi ln\left(\frac{\pi_t}{\overline{\pi}}\right)\right] \tag{25}$$

Welfare Comparison Under Baseline Scenario

	Capital Owner	Skilled Labor	Unskilled Labor	Aggregate
Aggressive IT	0.02 %	0.02 %	0.03 %	0.03 %
Sector Output Gap	-0.11 %	-0.04 %	-0.05 %	-0.05 %
Aggregate Output Gap	-0.09 %	-0.03 %	-0.04 %	-0.04 %
Interest Rate Smoothing	-0.00 %	0.00 %	0.00 %	0.00 %
ToT Augmented	0.13 %	-0.12 %	-0.08 %	-0.08 %

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

Welfare Comparisons Under Financial Frictions

Financial Frictions for the Unskilled Labor

	Capital Owner	Skilled Labor	Unskilled Labor	Aggregate
Aggressive IT	-0.03 %	0.04 %	0.04 %	0.04 %
Sector Output Gap	-0.10 %	-0.02 %	-0.04 %	-0.04 %
Aggregate Output Gap	-0.11 %	-0.05 %	-0.06 %	-0.06 %
Interest Rate Smoothing	0.02 %	0.01 %	0.01 %	0.01 %
ToT Augmented	0.26 %	-0.14 %	-0.07 %	-0.08 %

Financial Frictions for all households

	Capital Owner	Skilled Labor	Unskilled Labor	Aggregate
Aggressive IT	-0.29 %	0.15 %	0.07 %	0.08 %
Sector Output Gap	-0.13 %	0.00 %	-0.03 %	-0.02 %
Aggregate Output Gap	-0.25 %	-0.04 %	-0.08 %	-0.07 %
Interest Rate Smoothing	0.26 %	-0.03 %	0.03 %	0.02 %
ToT Augmented	1.47 %	-0.44 %	-0.08 %	-0.13 %

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 Closed Capital Account

	Capital Owner	Skilled Labor	Unskilled Labor	Aggregate
Aggressive IT	-0.13 %	0.02 %	-0.01 %	-0.00 %
Sector Output Gap	-0.05 %	-0.00 %	-0.01 %	-0.01 %
Aggregate Output Gap	-0.10 %	0.01 %	-0.01 %	-0.01 %
Interest Rate Smoothing	0.07 %	-0.01 %	0.00 %	0.00 %
ToT Augmented	-0.03 %	0.01 %	-0.00 %	0.00 %

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 Different Weight of Sectors

	Capital Owner	Skilled Labor	Unskilled Labor	Aggregate
Aggressive IT	-0.19 %	0.10 %	0.03 %	0.03 %
Sector Output Gap	-0.10 %	-0.01 %	-0.04 %	-0.04 %
Aggregate Output Gap	-0.08 %	0.02 %	-0.00 %	-0.00 %
Interest Rate Smoothing	0.04 %	0.00 %	0.01 %	0.01 %
ToT Augmented	0.47 %	-0.29 %	-0.09 %	-0.10 %

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

Outline

Summary

- Monetary policy actions have significant distributional effects. We constructed a model with features relevant to developing economies.
- Nominal exchange rate management can have substantial distributional consequences and also negative aggregate welfare effects.
- Many of the distributional effects we find become stronger as financial frictions increase.

Aggregate Demand

- Nontradable Goods Market.

$$\begin{aligned} Y_{N,t} &= \lambda_3 C^u_{N,t} + \lambda_2 C^s_{N,t} + \lambda_1 C^k_{N,t} \\ & \quad (1-b)[b x_t^{\xi-1} + (1-b)]^{\frac{\xi}{1-\xi}} C_t \end{aligned} \tag{26}$$

- Tradable Goods Market.

$$\begin{aligned} Y_{H,t} &= C^u_{H,t} + C^s_{H,t} + C^k_{H,t} + \int_0^1 C^i_{H,t} di \\ &= ab[b + (1-b)x_t^{1-\xi}]^{\frac{\xi}{1-\xi}}[a + (1-a)S_t^{\eta-1}]^{\frac{\eta}{1-\eta}}]C_t \\ &\quad + (1-a) b S_t^{-\gamma} C^*_t \end{aligned} \tag{27}$$

Back to the Model

Aggregate Demand

- Capital Rental Market.

$$\overline{K} = \int_0^1 K_{H,t}(i)di \tag{28}$$

- Skilled Labor Market.

$$N_t^s = \int_0^1 N_{H,t}^s(i)di + \int_0^1 N_{N,t}^s(i)di \tag{29}$$

- Unskilled Labor Market.

$$N_t^u = \int_0^1 N_{H,t}^u(i)di + \int_0^1 N_{N,t}^u(i)di \tag{30}$$

Back to the Model

Aggregate Supply

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

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

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

- 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

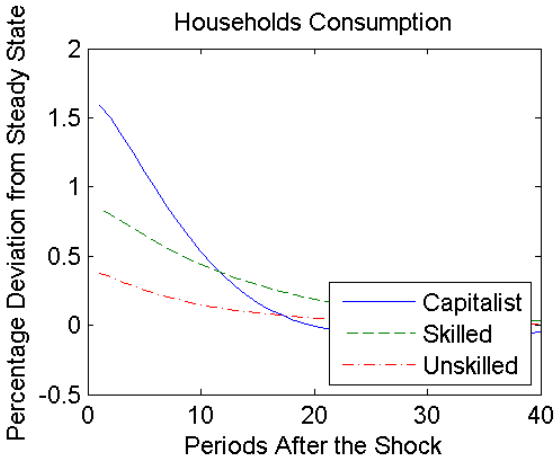
- Aggregate Inflation Dynamics

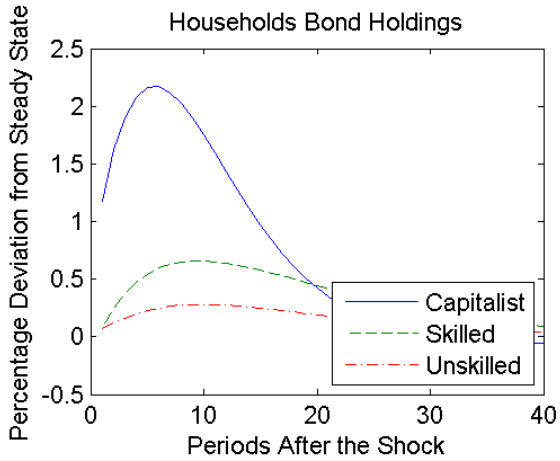
$$\pi_t = \pi_{H,t} \frac{[(a + (1-a)s_t^{\eta-1}]^{1/(1-\eta)}}{[(a + (1-a)s_{t-1}^{\eta-1}]^{1/(1-\eta)}} \frac{[b + (1-b)x^{1-\xi}]^{1/(1-\xi)}}{[b + (1-b)x_{t-1}^{1-\xi}]^{1/(1-\xi)}} \tag{33}$$

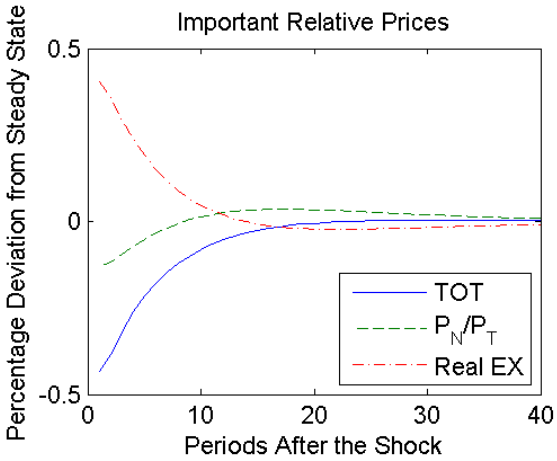
- Aggregate Supply and Price Dispersion. Although there is no aggregate production function in the New Keynesian framework, one can derive the equation linking the aggregate output with aggregate input factors, conditional on the price distribution.

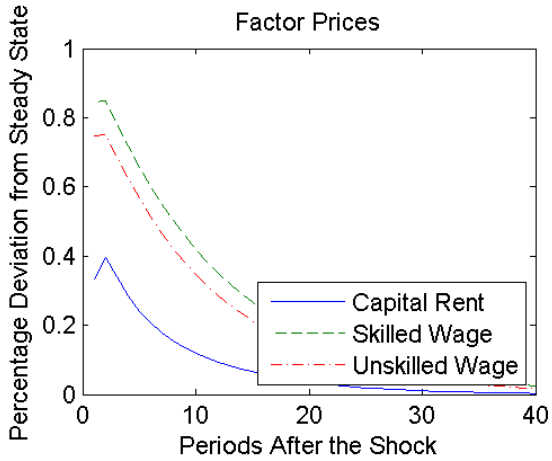
Back to the Model

Productivity Shock in Tradable Goods Sector



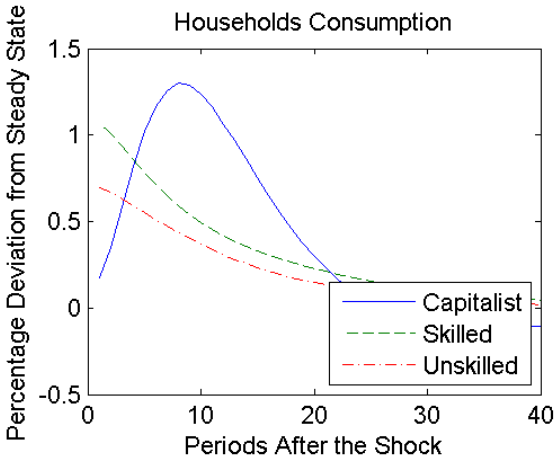


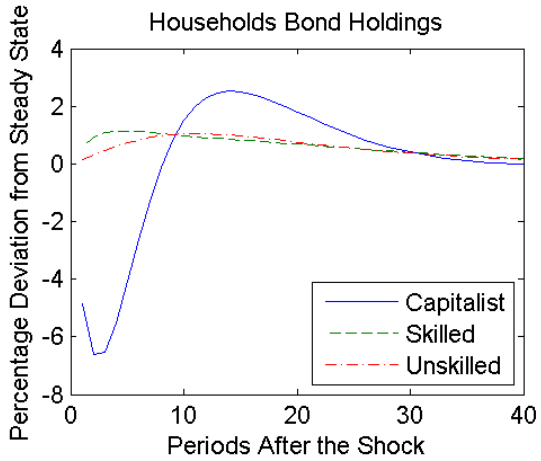


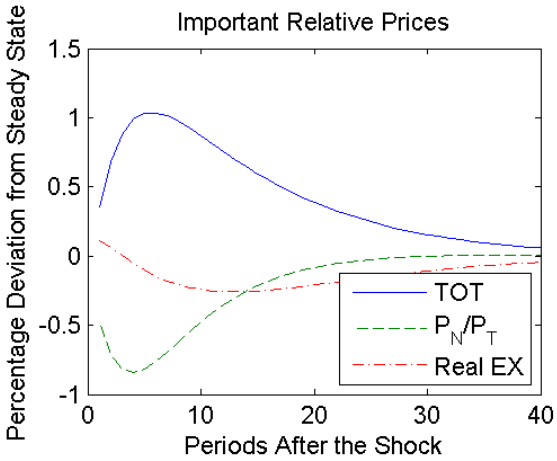


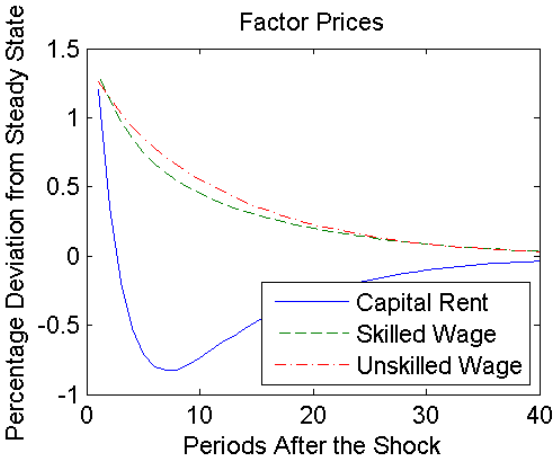
▸ Back to the Model

Productivity Shock in Nontradable Goods Sector









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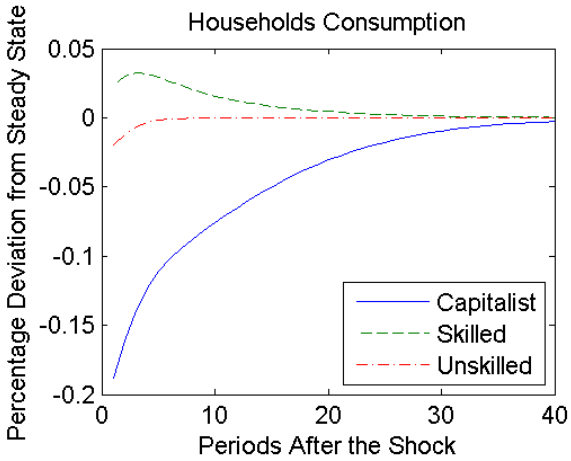
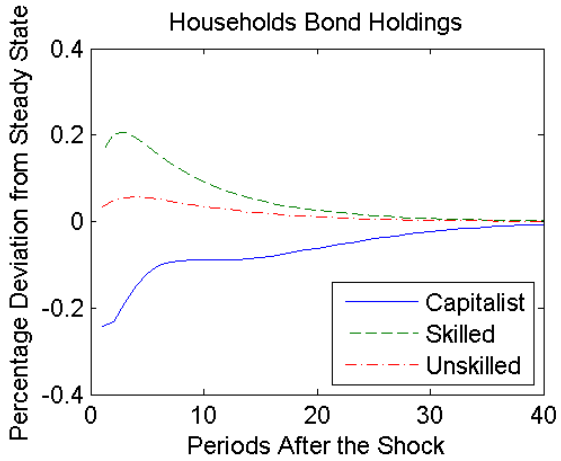
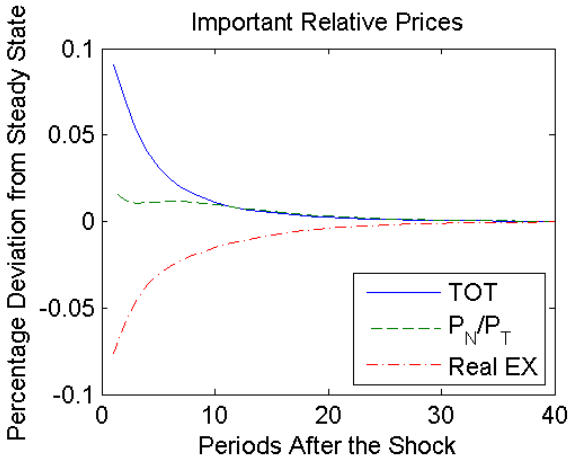
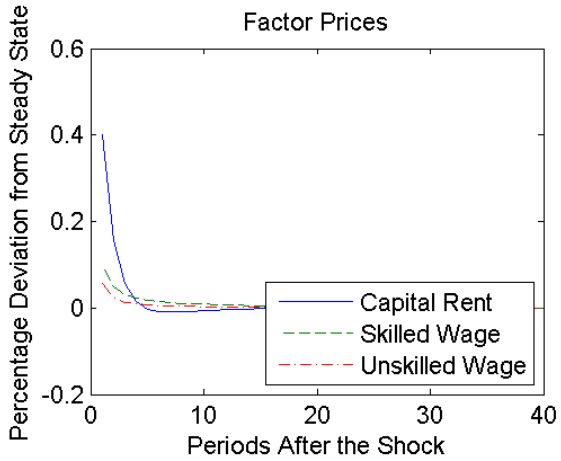
Foreign Demand Shock









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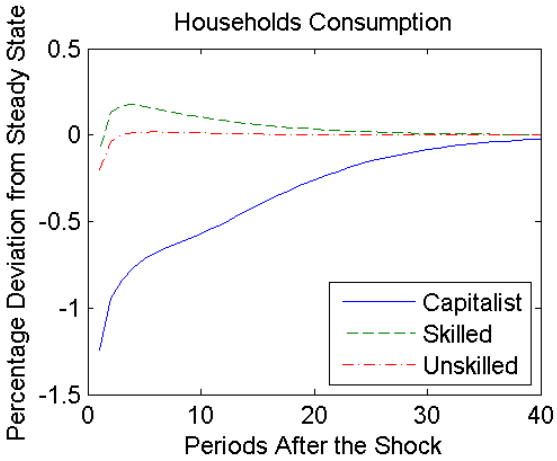
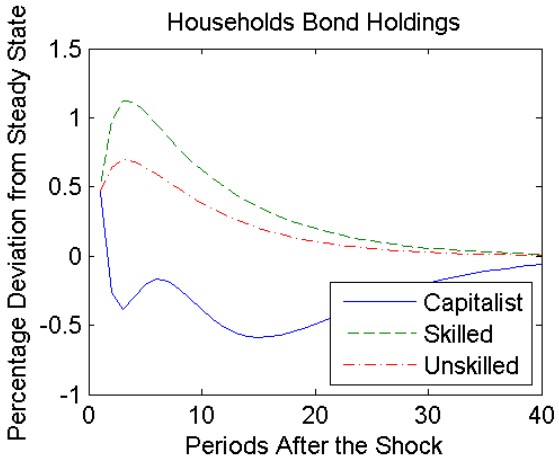
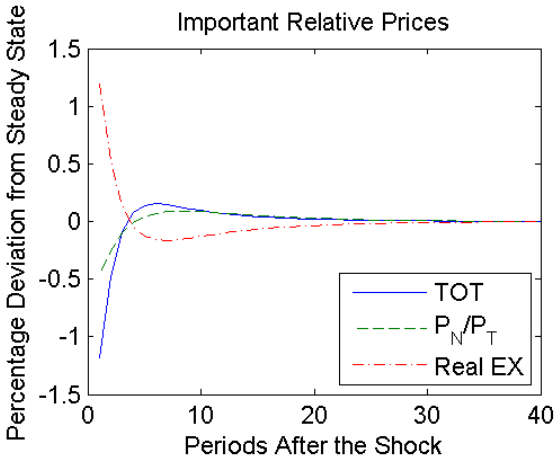
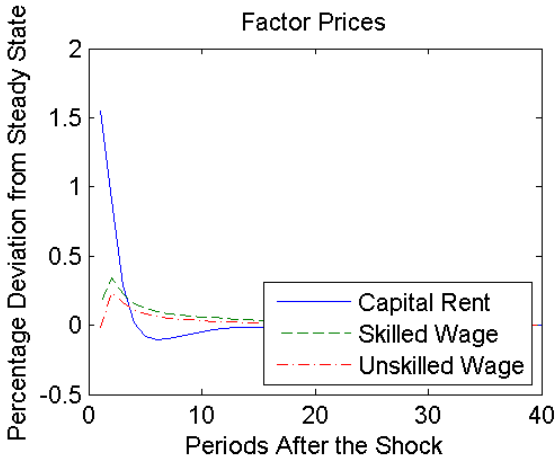
Foreign Interest Rate Shock









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