# Growth, Employment, and Business Cycles

Chetan Ghate[1]

Indian Statistical Institute, Delhi Centre.

ICRIER G20 Conference, 2013

[1]This presentation draws on joint work with Pawan Gopalakrishnan (ISI, Delhi) and Suchismita Tarafdar (SNU).

# G20 Agenda on Jobs and Employment

- Jobs and Growth have been a top priority for the Russian presidency
- In the G20 Leader's declaration (September 2013):
  - Unemployment and underemployment in many countries, particularly among young people, remains one of the key challenges confronting the global economy and a top priority for the G20.
- A Task Force on Employment has been set up to address the following topics:
  - Job creation through sound monetary and fiscal policies, structural policies to foster innovation and promotion of smaller enterprises;
  - Labour activation for vulnerable groups;
  - Monitoring of labour market development and progress on the previous G20 commitments.
- The G20 Task Force on Employment has been extended by another year.

# G20 Agenda on Jobs and Employment

- Jobs and Growth have been a top priority for the Russian presidency
- In the G20 Leader's declaration (September 2013):
  - Unemployment and underemployment in many countries, particularly among young people, remains one of the key challenges confronting the global economy and a top priority for the G20.
- A Task Force on Employment has been set up to address the following topics:
  - Job creation through sound monetary and fiscal policies, structural policies to foster innovation and promotion of smaller enterprises;
  - Labour activation for vulnerable groups;
  - Monitoring of labour market development and progress on the previous G20 commitments.
- The G20 Task Force on Employment has been extended by another year.

# G20 Agenda on Jobs and Employment

- Jobs and Growth have been a top priority for the Russian presidency
- In the G20 Leader's declaration (September 2013):
  - Unemployment and underemployment in many countries, particularly among young people, remains one of the key challenges confronting the global economy and a top priority for the G20.
- A Task Force on Employment has been set up to address the following topics:
  - Job creation through sound monetary and fiscal policies, structural policies to foster innovation and promotion of smaller enterprises;
  - Labour activation for vulnerable groups;
  - Monitoring of labour market development and progress on the previous G20 commitments.
- The G20 Task Force on Employment has been extended by another year.

# G20 Agenda on Jobs and Employment

- Jobs and Growth have been a top priority for the Russian presidency
- In the G20 Leader's declaration (September 2013):
  - Unemployment and underemployment in many countries, particularly among young people, remains one of the key challenges confronting the global economy and a top priority for the G20.
- A Task Force on Employment has been set up to address the following topics:
  - Job creation through sound monetary and fiscal policies, structural policies to foster innovation and promotion of smaller enterprises;
  - Labour activation for vulnerable groups;
  - Monitoring of labour market development and progress on the previous G20 commitments.
- The G20 Task Force on Employment has been extended by another year.

# India: some facts

- Labor force roughly 600 million
- Work force is roughly 470 million
- Formal sector: (10%); informal sector (90%)
- A lot of self employment in the 90% category
- 47 million (20 million - public sector - including PSUs; 10 million - quasi-public sector; 17 million "corporate sector")

# Key policy questions

- How can we think about employment, business cycles, and fiscal policy in EMEs?
- What are the labor market implications of interest rate shocks?
- *Some recent examples:*
  - Tapering of QE3 $\longrightarrow R \uparrow$
  - European sovereign debt crisis $\longrightarrow R \uparrow$
  - Current EME currency crisis $\longrightarrow R \uparrow$
- Need a model that qualitatively matches EME business cycles stylized facts. With this model, we can run counter-factual experiments.
- Our approach: Interest rate shocks $\longrightarrow$ Fiscal Policy $\longrightarrow$ Labor market outcomes

# Key policy questions

- How can we think about employment, business cycles, and fiscal policy in EMEs?
- What are the labor market implications of interest rate shocks?
- *Some recent examples:*
  - Tapering of QE3 $\longrightarrow R \uparrow$
  - European sovereign debt crisis $\longrightarrow R \uparrow$
  - Current EME currency crisis $\longrightarrow R \uparrow$
- Need a model that qualitatively matches EME business cycles stylized facts. With this model, we can run counter-factual experiments.
- Our approach: Interest rate shocks $\longrightarrow$ Fiscal Policy $\longrightarrow$ Labor market outcomes

# Key policy questions

- How can we think about employment, business cycles, and fiscal policy in EMEs?
- What are the labor market implications of interest rate shocks?
- *Some recent examples:*
  - Tapering of QE3 $\longrightarrow R \uparrow$
  - European sovereign debt crisis $\longrightarrow R \uparrow$
  - Current EME currency crisis $\longrightarrow R \uparrow$
- Need a model that qualitatively matches EME business cycles stylized facts. With this model, we can run counter-factual experiments.
- Our approach: Interest rate shocks $\longrightarrow$ Fiscal Policy $\longrightarrow$ Labor market outcomes

# Characteristics of EME business cycles

- A large empirical literature (Agénor et al. (2000), Male (2010), Rand and Tarp (2002), and Ghate et al. (2013)) has identified the key stylized facts in EME business cycles.
- Compared to Advanced Economies (AEs), in Emerging Market Economies (EMEs)
  - output ($Y$) is more volatile
  - interest rates ($R$) are counter-cyclical
  - consumption ($C$) is pro-cyclical and more volatile
  - net exports ($NX$) are more volatile than output and are more counter-cyclical than in AEs
  - and there is no consensus on the cyclical property of government expenditures ($G$).
- Theory : Neumeyer and Perri (2005) and Aguiar and Gopinath (2007)

# Characteristics of EME business cycles

- A large empirical literature (Agénor et al. (2000), Male (2010), Rand and Tarp (2002), and Ghate et al. (2013)) has identified the key stylized facts in EME business cycles.
- Compared to Advanced Economies (AEs), in Emerging Market Economies (EMEs)
  - output ($Y$) is more volatile
  - interest rates ($R$) are counter-cyclical
  - consumption ($C$) is pro-cyclical and more volatile
  - net exports ($NX$) are more volatile than output and are more counter-cyclical than in AEs
  - and there is no consensus on the cyclical property of government expenditures ($G$).
- Theory : Neumeyer and Perri (2005) and Aguiar and Gopinath (2007)

# Characteristics of EME business cycles

- A large empirical literature (Agénor et al. (2000), Male (2010), Rand and Tarp (2002), and Ghate et al. (2013)) has identified the key stylized facts in EME business cycles.
- Compared to Advanced Economies (AEs), in Emerging Market Economies (EMEs)
  - output ($Y$) is more volatile
  - interest rates ($R$) are counter-cyclical
  - consumption ($C$) is pro-cyclical and more volatile
  - net exports ($NX$) are more volatile than output and are more counter-cyclical than in AEs
  - and there is no consensus on the cyclical property of government expenditures ($G$).
- Theory : Neumeyer and Perri (2005) and Aguiar and Gopinath (2007)

# Characteristics of EME business cycles

- A large empirical literature (Agénor et al. (2000), Male (2010), Rand and Tarp (2002), and Ghate et al. (2013)) has identified the key stylized facts in EME business cycles.
- Compared to Advanced Economies (AEs), in Emerging Market Economies (EMEs)
  - output $(Y)$ is more volatile
  - interest rates $(R)$ are counter-cyclical
  - consumption $(C)$ is pro-cyclical and more volatile
  - net exports $(NX)$ are more volatile than output and are more counter-cyclical than in AEs
  - and there is no consensus on the cyclical property of government expenditures $(G)$.
- Theory : Neumeyer and Perri (2005) and Aguiar and Gopinath (2007)

# Characteristics of EME business cycles

- A large empirical literature (Agénor et al. (2000), Male (2010), Rand and Tarp (2002), and Ghate et al. (2013)) has identified the key stylized facts in EME business cycles.
- Compared to Advanced Economies (AEs), in Emerging Market Economies (EMEs)
  - output $(Y)$ is more volatile
  - interest rates $(R)$ are counter-cyclical
  - consumption $(C)$ is pro-cyclical and more volatile
  - net exports $(NX)$ are more volatile than output and are more counter-cyclical than in AEs
  - and there is no consensus on the cyclical property of government expenditures $(G)$.
- Theory : Neumeyer and Perri (2005) and Aguiar and Gopinath (2007)

# Emerging Economies vs Advanced Economies

Business cycle statistics for developed and emerging economies using quarterly data.

| | Developed economies | | | Emerging economies | | |
|---|---|---|---|---|---|---|
| | Std. dev. | Rel. std. dev. | Cont. cor. | Std. dev. | Rel. std. dev. | Cont. cor. |
| Real GDP | 1.34 | 1.00 | 1.00 | 2.74 | 1.00 | 1.00 |
| Private consumption | | 0.94 | 0.66 | | 1.45 | 0.72 |
| Investment | | 3.41 | 0.67 | | 3.91 | 0.77 |
| Trade balance | | 1.02 | –0.17 | | 3.22 | –0.51 |

*Source*: Aguiar and Gopinath, 2007.

# The Indian business cycle

Ghate et al. (2013)

Business cycle stylized facts using quarterly data (1999 Q2–2010 Q2).

| | Std. dev. | Rel. std. dev. | Cont. corr. | First ord. auto corr. |
|---|---|---|---|---|
| Real GDP | 1.18 | 1.00 | 1.00 | 0.73 |
| Private consumption | 1.54 | 1.31 | 0.51 | 0.67 |
| Investment | 4.08 | 3.43 | 0.69 | 0.80 |
| CPI | 1.30 | 1.09 | −0.29 | 0.70 |
| Exports | 8.79 | 7.40 | 0.31 | 0.77 |
| Imports | 8.93 | 7.52 | 0.45 | 0.54 |
| Govt expenditure | 6.69 | 5.53 | −0.35 | 0.005 |
| Net exports | 1.24 | 1.04 | −0.15 | 0.45 |
| Real interest rate | 2.11 | 1.77 | 0.38 | 0.372 |
| Nominal exchange rate | 4.61 | 3.88 | −0.54 | 0.82 |
| M1 (narrow money) | 3.13 | 2.64 | 0.5 | 0.105 |
| M3 (broad money) | 1.79 | 1.50 | 0.06 | 0.40 |
| Reserve money | 4.53 | 3.82 | 0.47 | 0.50 |
| CPI inflation | 0.88 | 0.74 | 0.05 | 0.66 |

# The Neumeyer and Perri model

- Neumeyer and Perri (2005) build a SOE-RBC model with interest rate shocks.
- Firms face a working capital constraint + preferences are GHH.
- $R \uparrow \Rightarrow L^D \downarrow$
- Because GHH utility $\Rightarrow L^S$ remain unchanged $\Rightarrow$ equilibrium labor falls, $Y$ falls $\Rightarrow \rho(R, Y)_{EME} < 0$
- Intertemporal substitution effect $\Rightarrow C \downarrow$ instantaneously, $S \uparrow$
- $R \uparrow \Rightarrow X \downarrow$
- $(S - X) \uparrow \Rightarrow \rho(NX, Y) < 0$
- Does not explain government expenditure counter-cyclicality and pro/a-cyclicality of interest rates

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lesseqgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lesseqgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lesseqgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lessgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lessgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lessgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lessgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lessgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lessgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lessgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lessgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lessgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lesseqgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lesseqgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lesseqgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lesseqgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lesseqgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lesseqgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lesseqgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lesseqgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lesseqgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# A single model for EMEs?

- We need to explain the following stylized facts:
  1. $\sigma(X) > \sigma(C) > \sigma(Y)$
  2. $\rho(NX, Y) < 0$
  3. $\rho(G, Y) \lesseqgtr 0$ (in India, $\rho(G, Y) < 0 \Rightarrow$ Govt exp. are stabilizing)
  4. $\rho(R, Y) \lesseqgtr 0$ (in India, $\rho(R, Y) > 0$, puzzling but true in many EMEs, see Male (2010))
- We need a better understanding of fiscal policy and labor market dynamics
- To answer this we extend Neumeyer and Perri (2005)
  - We add fiscal policy
  - We make preferences Cobb-Douglas - enables $\rho(R, Y) \lesseqgtr 0$
- We then calibrate the model to qualitatively match EME business cycles using
  - TFP shocks
  - interest rate and country spread shocks.

# The Model: Firms

- The firm maximizes

$$\begin{aligned}\pi_t &= A_t k_{t-1}^{\alpha}\left[(1+\gamma)^t l_t\right]^{1-\alpha} - w_t l_t - r_t k_{t-1} \\ &\quad - \left(R_{t-1}^{G} - 1\right)\theta_G w_t l_t - \left(R_{t-1}^{P} - 1\right)(\theta - \theta_G) w_t l_t.\end{aligned} \tag{1}$$

- The government lends $\theta_G < \theta$ portion of the working capital at

$$R_{t-1}^{G} = R_{t-1}^{P}(1-s) > 1, \quad 0 < s < 1. \tag{2}$$

- We obtain $w_t$ and $r_t$.

# The Model: Households

- A stand-in representative agent maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[ (c_t^*)^{\mu} (1 - l_t)^{(1-\mu)} \right]^{(1-\sigma)}}{(1-\sigma)}, \tag{3}$$

$$\text{where } \forall t \; c_t^* = c_t + \Theta G_t, 0 < \Theta < 1$$

- subject to

$$\begin{aligned} (1+\tau_c)c_t + x_t + b_t + \kappa(b_t) \leq & (1-\tau_w) w_t l_t \\ & + (1-\tau_k) r_t k_{t-1} + R_{t-1}^P b_{t-1}. \end{aligned} \tag{4}$$

- $\kappa(b_t)$ is the bond holding cost, $x_t$ is private investment such that;

$$x_t = k_t - (1-\delta) k_{t-1} + \Phi(k_t, k_{t-1}). \tag{5}$$

- $\Phi(k_t, k_{t-1})$ is the investment adjustment cost.

# The Model: Government

- The government balances it's budget $\forall t$

$$\underbrace{TR_t}_{\text{After Prod.}} + \underbrace{R^G_{t-1}\theta_G w_t l_t}_{\text{After Prod}} = \underbrace{G_t}_{\text{After Prod.}} + \underbrace{S_t}_{\text{Before Prod.}}$$

- where $TR_t$ is

$$TR_t = \tau_c c_t + \tau_w w_t l_t + \tau_k r_t k_{t-1}. \tag{6}$$

- $S_t$ is the loan extended to firms

$$S_t = \theta_G w_t l_t.$$

- Therefore

$$G_t = \tau_c c_t + \left\{ \left[ R^P_{t-1}(1-s) - 1 \right] \theta_G + \tau_w \right\} w_t l_t + \tau_k r_t k_{t-1}. \tag{7}$$

# The Labor Market Equilibrium

- We get $l_t^s$ from the representative agent's FOC

$$(1 - l_t^s) = \frac{(1-\mu)}{\mu}\left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\widetilde{c}_t^*}{\widetilde{w}_t}. \tag{8}$$

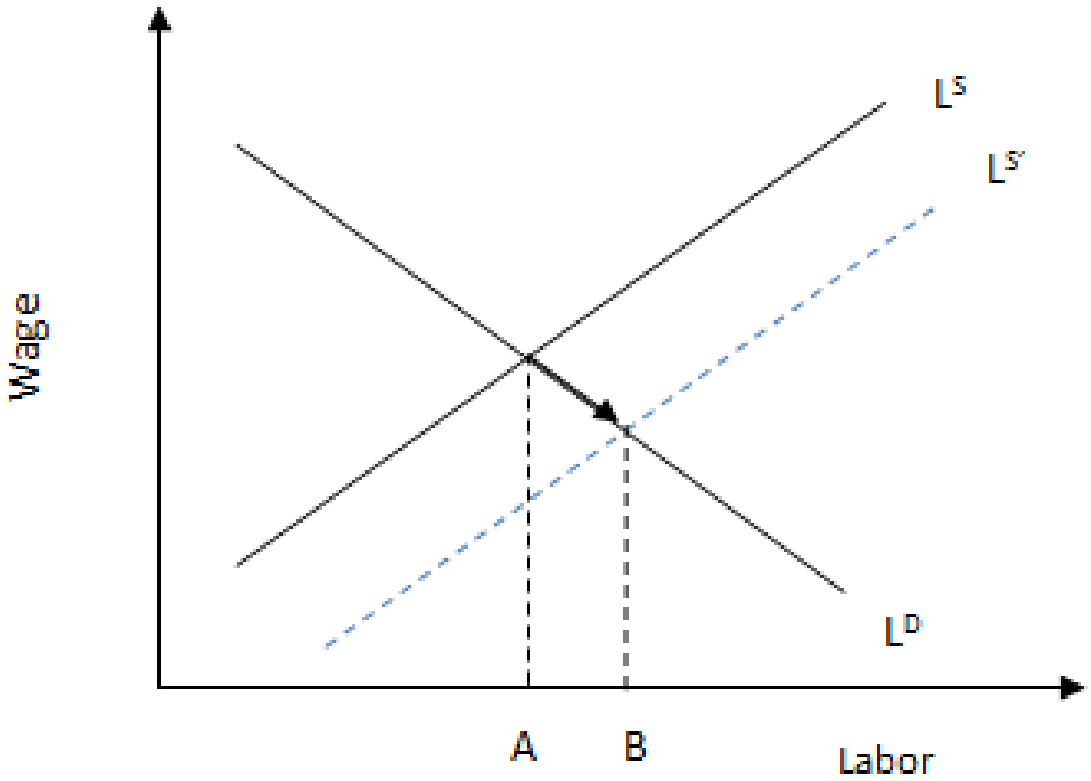
- Magnitude of shift depends on the tax wedge : $\left(\frac{1+\tau_c}{1-\tau_w}\right)$
- We get $l_t^d$ from the firm's FOC

$$l_t^D = \left[\frac{(1-\alpha)A_t}{\widetilde{w}_t\left[(1-\theta) + R_{t-1}^P\left(\theta - s\theta_G\right)\right]}\right]^{\frac{1}{\alpha}} \frac{\widetilde{k}_{t-1}}{(1+\gamma)}.$$

- Magnitude of shift depends on : $\theta_G$ and $s$

# Labor market dynamics with interest rate shocks

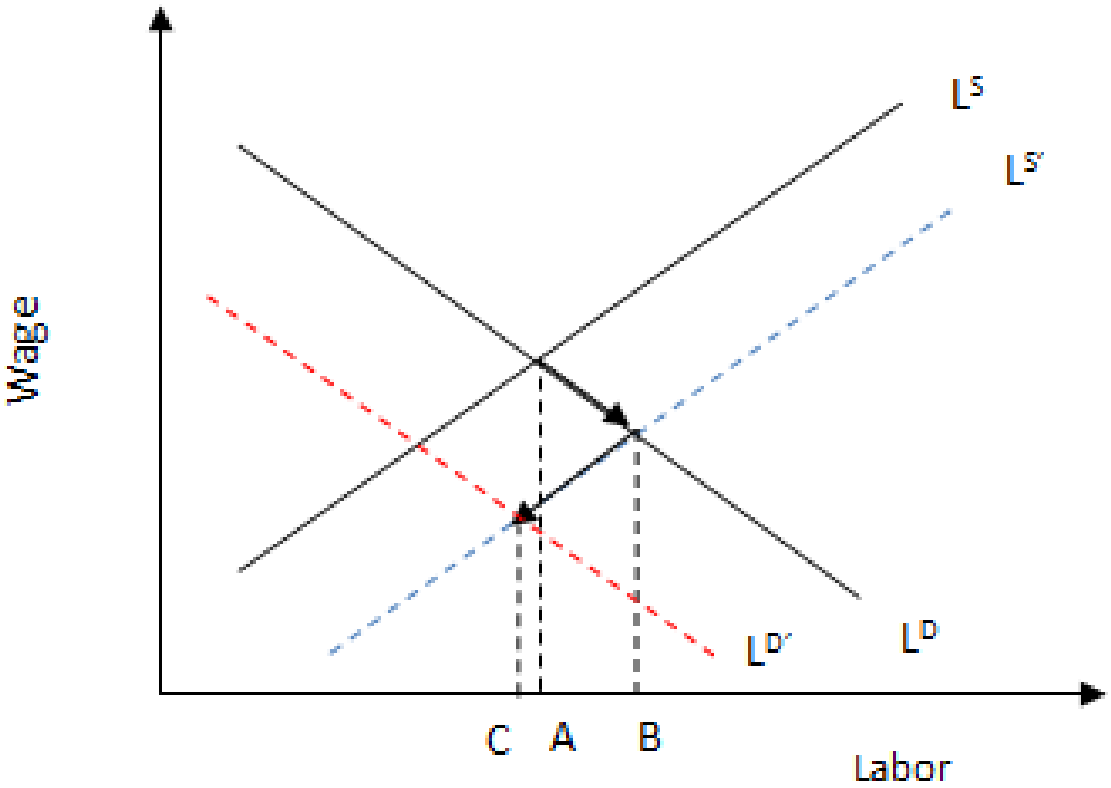
From a one period shock in $R$ at time period $t$




$I_t^s \uparrow$ and $I_t^d$ remains unchanged because $\widetilde{c}_t$ instantaneously falls due to the intertemporal substitution effect, whereas $I_t^d$ depends on $R_{t-1}^P$.

# Labor market dynamics with interest rate shocks

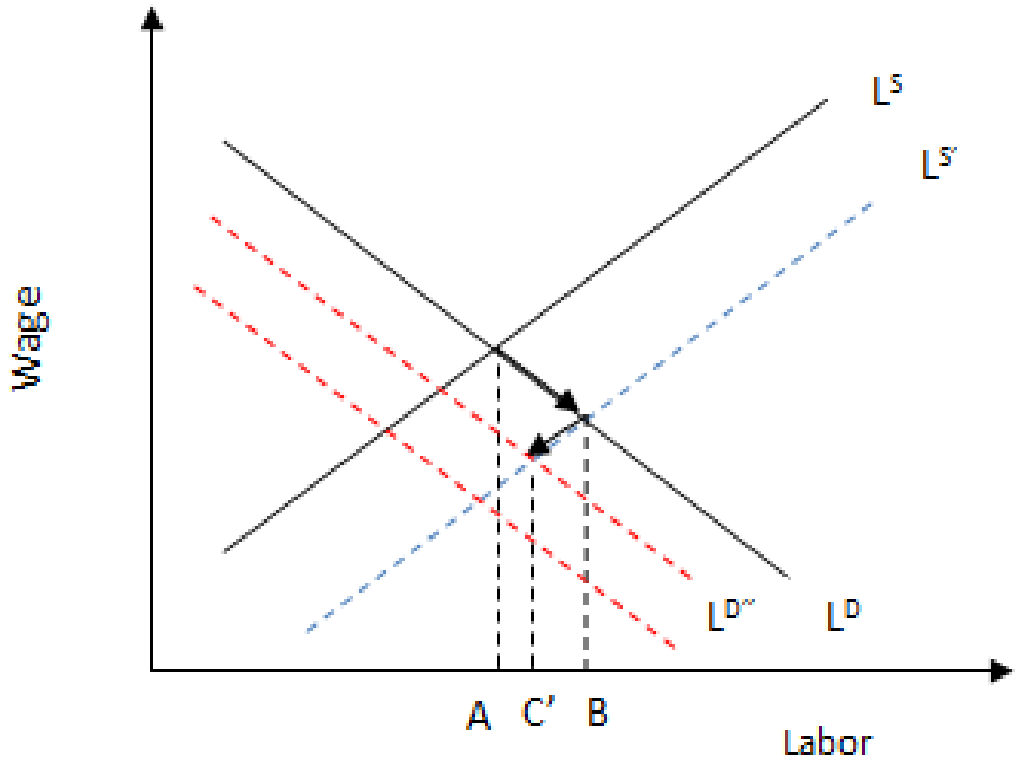
At time period $t+1$




$I^d_{t+1} \downarrow$ because it depends on $R^P_t$

# Labor market dynamics with interest rate shocks

At time period $t+1$ - with a working capital loan subsidy



# Data generating process

- Annual HP-filtered de-trended series from 1980 - 2008. All shocks are assumed to be uncorrelated.
- TFP (Bhattacharya et al. (2013))

$$\begin{aligned} \widehat{A}_t &= \rho_A \widehat{A}_{t-1} + \varepsilon_{At}. \\ \rho_A &= 0.485^{***} \ (0.0147) \end{aligned}$$

- We use annual World Bank data on real lending rates, i.e.,

$$R_t^P = R_t^* D_t. \tag{9}$$

- $R_t^P$ is the Indian real interest rate, $R_t^*$ is the US real interest rate and $D_t$ is the country spread over $R_t^*$ such that

$$D_t = \frac{R_t^P}{R_t^*}.$$

- Therefore,

$$\widehat{R}_t^P = \widehat{R}_t^* + \widehat{D}_t.$$

# Interest rates and country spreads

- $\widehat{R}_t^*$ is estimated as

$$\begin{aligned} \widehat{R}_t^* &= \rho_R \widehat{R}_{t-1}^* + \varepsilon_{Rt}. \\ \rho_R &= 0.455^{***} \ (0.0105) \end{aligned}$$

- We conduct two sets of experiments
  - the *exogenous country risk case* (not statistically significant)

$$\begin{aligned} \widehat{D}_t &= \rho_D \widehat{D}_{t-1} + \varepsilon_t \\ \rho_D &= 0.143 \ (0.0167) \end{aligned}$$

  - the *induced country risk case*

$$\begin{aligned} \widehat{D}_t &= -\eta E_t \widehat{A}_{t+1} + u_t. \\ \eta &= 0.9268^{***} \ (0.0146) \end{aligned}$$

$u_t$ is a random shock

# Interest rates and country spreads

- $\widehat{R}_t^*$ is estimated as

$$\begin{aligned} \widehat{R}_t^* &= \rho_R \widehat{R}_{t-1}^* + \varepsilon_{Rt}. \\ \rho_R &= 0.455^{***} \ (0.0105) \end{aligned}$$

- We conduct two sets of experiments
  - the *exogenous country risk case* (not statistically significant)

$$\begin{aligned} \widehat{D}_t &= \rho_D \widehat{D}_{t-1} + \varepsilon_t \\ \rho_D &= 0.143 \ (0.0167) \end{aligned}$$

  - the *induced country risk case*

$$\begin{aligned} \widehat{D}_t &= -\eta E_t \widehat{A}_{t+1} + u_t. \\ \eta &= 0.9268^{***} \ (0.0146) \end{aligned}$$

$u_t$ is a random shock

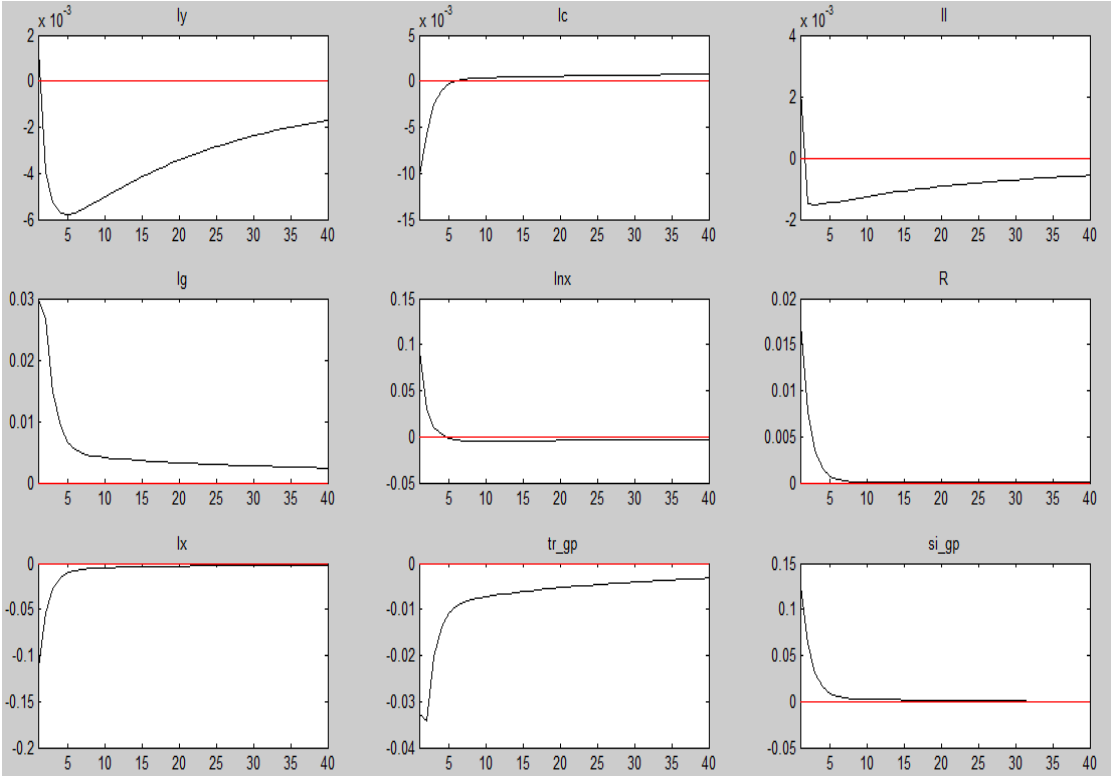
# Parameters

Table 1: Parameters

| Parameter Name | Symbol | Value |
|---|---|---|
| Coefficient of risk aversion (calibrated) | $\sigma$ | 3 |
| Share of consumption in utility function (Chakraborty, (2008)) | $\mu$ | 0.82 |
| Depreciation rate* | $\delta$ | 0.025 |
| Rate of technical progress (Bhattacharya et al. (2013)) | $\gamma$ | 0.047 |
| Ratio of wage bill to be paid in advance* | $\theta$ | 0.6, 1 |
| Discount rate (calibrated) | $\beta$ | 0.99 |
| Effective discount rate (calibrated) | $\tilde{\beta}$ | $\beta(1+\gamma)^{\mu(1-\sigma)}$ |
| Real interest rate (calibrated) | $\overline{R}$ | $\frac{(1+\gamma)}{\beta}$ |
| Share of capital in production (Ghate et al. (2012)) | $\alpha$ | 0.4 |
| Bond holding costs (Tiryaki (2012)) | $\kappa$ | 0.0001 |
| Capital adjustment costs* | $\phi$ | 50 |
| Subsidized portion of the advance wage bill ratio* | $\theta_G$ | 0.5* |
| Subsidy on working capital loans* | $s$ | 0.5* |
| Tax on consumption* | $\tau_c$ | 0.12 |
| Tax on labor income* | $\tau_w$ | 0.15 |
| Tax on capital income* | $\tau_k$ | 0.15 |
| Edgeworth substitutability of government consumption* | $\Theta$ | 0.5* |
| Steady state TFP* | $\overline{A}$ | 1 |

(* indicates that values for these parameters have been assumed)

# Single period interest rate shock - Exogenous case



# Transmission of the interest rate shock

- On impact,
  - $R_t^* \uparrow \Rightarrow R_t^P \uparrow \Rightarrow C_t \downarrow \Rightarrow I_t \uparrow \Rightarrow Y_t \uparrow$ since $Y_t = Y\left(k_{t-1}, I_t\right)$ and $k_{t-1}$ is pre-determined
  - $C_t \downarrow \Rightarrow S_t \uparrow$; $R_t^P \uparrow \Rightarrow X_t \downarrow \Rightarrow (S_t - X_t) \uparrow$
  - $R_t^P \uparrow \Rightarrow G_t \uparrow$ and $TR_t \downarrow$ because $C_t \downarrow$ dominates$\Rightarrow (TR_t - G_t) \downarrow$
  - $|S_t - X_t| > |TR_t - G_t| \Rightarrow NX_t \uparrow$
- A single period interest rate shock leads to a worsening public sector imbalance.
- Output does not return to the steady state value even after 40 quarters!

# Transmission of the interest rate shock

- On impact,
  - $R_t^* \uparrow \Rightarrow R_t^P \uparrow \Rightarrow C_t \downarrow \Rightarrow I_t \uparrow \Rightarrow Y_t \uparrow$ since $Y_t = Y\left(k_{t-1}, I_t\right)$ and $k_{t-1}$ is pre-determined
  - $C_t \downarrow \Rightarrow S_t \uparrow$; $R_t^P \uparrow \Rightarrow X_t \downarrow \Rightarrow (S_t - X_t) \uparrow$
  - $R_t^P \uparrow \Rightarrow G_t \uparrow$ and $TR_t \downarrow$ because $C_t \downarrow$ dominates$\Rightarrow (TR_t - G_t) \downarrow$
  - $|S_t - X_t| > |TR_t - G_t| \Rightarrow NX_t \uparrow$
- A single period interest rate shock leads to a worsening public sector imbalance.
- Output does not return to the steady state value even after 40 quarters!

# Transmission of the interest rate shock

- On impact,
  - $R_t^* \uparrow \Rightarrow R_t^P \uparrow \Rightarrow C_t \downarrow \Rightarrow I_t \uparrow \Rightarrow Y_t \uparrow$ since $Y_t = Y\left(k_{t-1}, I_t\right)$ and $k_{t-1}$ is pre-determined
  - $C_t \downarrow \Rightarrow S_t \uparrow$; $R_t^P \uparrow \Rightarrow X_t \downarrow \Rightarrow (S_t - X_t) \uparrow$
  - $R_t^P \uparrow \Rightarrow G_t \uparrow$ and $TR_t \downarrow$ because $C_t \downarrow$ dominates$\Rightarrow (TR_t - G_t) \downarrow$
  - $|S_t - X_t| > |TR_t - G_t| \Rightarrow NX_t \uparrow$
- A single period interest rate shock leads to a worsening public sector imbalance.
- Output does not return to the steady state value even after 40 quarters!

# Transmission of the interest rate shock

- On impact,
  - $R_t^* \uparrow \Rightarrow R_t^P \uparrow \Rightarrow C_t \downarrow \Rightarrow I_t \uparrow \Rightarrow Y_t \uparrow$ since $Y_t = Y\left(k_{t-1}, I_t\right)$ and $k_{t-1}$ is pre-determined
  - $C_t \downarrow \Rightarrow S_t \uparrow$; $R_t^P \uparrow \Rightarrow X_t \downarrow \Rightarrow (S_t - X_t) \uparrow$
  - $R_t^P \uparrow \Rightarrow G_t \uparrow$ and $TR_t \downarrow$ because $C_t \downarrow$ dominates$\Rightarrow (TR_t - G_t) \downarrow$
  - $|S_t - X_t| > |TR_t - G_t| \Rightarrow NX_t \uparrow$
- A single period interest rate shock leads to a worsening public sector imbalance.
- Output does not return to the steady state value even after 40 quarters!

# Calibration Results - Exogenous case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $\widehat{D}$)
- We observe:
  - $\rho(C, Y) > 0$ (rising interest income makes $C$ pro-cyclical)
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - $\rho(R, Y) > 0$
  - But: $\rho(G, Y) > 0$, $\rho(X, Y) < 0$ and $\rho(NX, Y) > 0$.

# Calibration Results - Exogenous case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $\widehat{D}$)
- We observe:
  - $\rho(C, Y) > 0$ (rising interest income makes $C$ pro-cyclical)
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - $\rho(R, Y) > 0$
  - But: $\rho(G, Y) > 0$, $\rho(X, Y) < 0$ and $\rho(NX, Y) > 0$.

# Calibration Results - Exogenous case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $\widehat{D}$)
- We observe:
  - $\rho(C, Y) > 0$ (rising interest income makes $C$ pro-cyclical)
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - $\rho(R, Y) > 0$
  - But: $\rho(G, Y) > 0$, $\rho(X, Y) < 0$ and $\rho(NX, Y) > 0$.

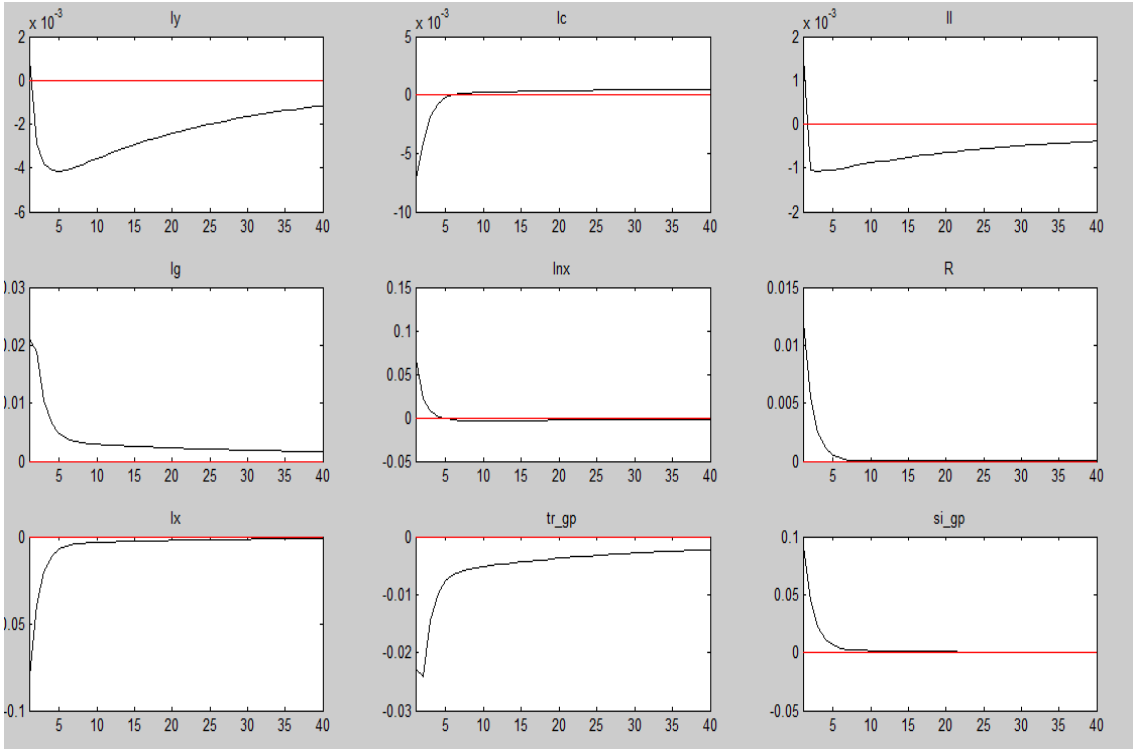
# Calibration Results - Exogenous case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $\widehat{D}$)
- We observe:
  - $\rho(C, Y) > 0$ (rising interest income makes $C$ pro-cyclical)
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - $\rho(R, Y) > 0$
  - But: $\rho(G, Y) > 0$, $\rho(X, Y) < 0$ and $\rho(NX, Y) > 0$.

# Calibration Results - Exogenous case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $\widehat{D}$)
- We observe:
  - $\rho(C, Y) > 0$ (rising interest income makes $C$ pro-cyclical)
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - $\rho(R, Y) > 0$
  - But: $\rho(G, Y) > 0$, $\rho(X, Y) < 0$ and $\rho(NX, Y) > 0$.

# Single period interest rate shock - Induced case




- Observation : IRFs similar to the exogenous case, except that the magnitudes are dampened.
  - This is because TFP shocks offset interest rate shocks (which changes the policy functions).

# Calibration Results - Induced case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $u$)
- The transmission of shocks on impact are identical. However, we observe:
  - $\rho(C, Y) > 0$, $\rho(X, Y) > 0$ and $\rho(NX, Y) < 0$
  - $\rho(G, Y) < 0$
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - But: $\rho(R, Y) < 0$.
- Observation 1 : We recover the standard EME business cycle stylized facts
- Observation 2 : The magnitudes of $\rho(G, Y)$ and $\rho(R, Y)$ crucially depend on $s$ and $\theta_G$.

# Calibration Results - Induced case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $u$)
- The transmission of shocks on impact are identical. However, we observe:
  - $\rho(C, Y) > 0$, $\rho(X, Y) > 0$ and $\rho(NX, Y) < 0$
  - $\rho(G, Y) < 0$
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - But: $\rho(R, Y) < 0$.
- Observation 1 : We recover the standard EME business cycle stylized facts
- Observation 2 : The magnitudes of $\rho(G, Y)$ and $\rho(R, Y)$ crucially depend on $s$ and $\theta_G$.

# Calibration Results - Induced case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $u$)
- The transmission of shocks on impact are identical. However, we observe:
  - $\rho(C, Y) > 0$, $\rho(X, Y) > 0$ and $\rho(NX, Y) < 0$
  - $\rho(G, Y) < 0$
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - But: $\rho(R, Y) < 0$.
- Observation 1 : We recover the standard EME business cycle stylized facts
- Observation 2 : The magnitudes of $\rho(G, Y)$ and $\rho(R, Y)$ crucially depend on $s$ and $\theta_G$.

# Calibration Results - Induced case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $u$)
- The transmission of shocks on impact are identical. However, we observe:
  - $\rho(C, Y) > 0$, $\rho(X, Y) > 0$ and $\rho(NX, Y) < 0$
  - $\rho(G, Y) < 0$
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - But: $\rho(R, Y) < 0$.
- Observation 1 : We recover the standard EME business cycle stylized facts
- Observation 2 : The magnitudes of $\rho(G, Y)$ and $\rho(R, Y)$ crucially depend on $s$ and $\theta_G$.

# Calibration Results - Induced case (with multi period shocks)

- With all three shocks ($\widehat{A}$, $\widehat{R}^*$ and $u$)
- The transmission of shocks on impact are identical. However, we observe:
  - $\rho(C, Y) > 0$, $\rho(X, Y) > 0$ and $\rho(NX, Y) < 0$
  - $\rho(G, Y) < 0$
  - $\sigma(X) > \sigma(C) \simeq \sigma(Y)$
  - $\sigma(G) > \sigma(Y)$
  - But: $\rho(R, Y) < 0$.
- Observation 1 : We recover the standard EME business cycle stylized facts
- Observation 2 : The magnitudes of $\rho(G, Y)$ and $\rho(R, Y)$ crucially depend on $s$ and $\theta_G$.

# Comparison

$$\begin{bmatrix} \text{Correlations} & \text{Exogenous} & \text{Induced} \\ \rho(R, Y) & > 0 & < 0 \\ \rho(G, Y) & > 0 & < 0 \\ \rho(C, Y) & > 0 & > 0 \\ \rho(X, Y) & < 0 & > 0 \\ \rho(NX, Y) & > 0 & < 0 \end{bmatrix}$$

# Intuition

- Unlike in the exogenous case
  - A positive and persistent productivity shock $E_t \widehat{A}_{t+1}$ causes a reduction in interest rates
  - At the same time positive productivity shock causes positive income effects
  - Private investments become pro-cyclical because of TFP shocks, and due to dampened interest rates.
  - This reinforces $\rho(R, Y) < 0$.
- The positive income effects due to TFP causes $\rho(NX, Y) < 0$

# Intuition

- Unlike in the exogenous case
  - A positive and persistent productivity shock $E_t \widehat{A}_{t+1}$ causes a reduction in interest rates
  - At the same time positive productivity shock causes positive income effects
  - Private investments become pro-cyclical because of TFP shocks, and due to dampened interest rates.
  - This reinforces $\rho(R, Y) < 0$.
- The positive income effects due to TFP causes $\rho(NX, Y) < 0$

# Intuition

- Unlike in the exogenous case
  - A positive and persistent productivity shock $E_t \widehat{A}_{t+1}$ causes a reduction in interest rates
  - At the same time positive productivity shock causes positive income effects
  - Private investments become pro-cyclical because of TFP shocks, and due to dampened interest rates.
  - This reinforces $\rho(R, Y) < 0$.
- The positive income effects due to TFP causes $\rho(NX, Y) < 0$

# Intuition

- Unlike in the exogenous case
  - A positive and persistent productivity shock $E_t \widehat{A}_{t+1}$ causes a reduction in interest rates
  - At the same time positive productivity shock causes positive income effects
  - Private investments become pro-cyclical because of TFP shocks, and due to dampened interest rates.
  - This reinforces $\rho(R, Y) < 0$.
- The positive income effects due to TFP causes $\rho(NX, Y) < 0$

# Implication for Fiscal Policy

- A positive shock in $R^P$ or $D$ increases $G$ on impact
- However, $\rho(G, Y) < 0$ because
  - higher TFP raises incomes and also reduces interest rates which
    - reduces interest incomes for the government
    - causes a reduction in overall $G$
  - This is reinforced by a high subsidy on working capital loans

# Implication for Fiscal Policy

- A positive shock in $R^P$ or $D$ increases $G$ on impact
- However, $\rho(G, Y) < 0$ because
  - higher TFP raises incomes and also reduces interest rates which
    - reduces interest incomes for the government
    - causes a reduction in overall $G$
  - This is reinforced by a high subsidy on working capital loans

# Implication for Fiscal Policy

- A positive shock in $R^P$ or $D$ increases $G$ on impact
- However, $\rho(G, Y) < 0$ because
  - higher TFP raises incomes and also reduces interest rates which
    - reduces interest incomes for the government
    - causes a reduction in overall $G$
  - This is reinforced by a high subsidy on working capital loans

# Implication for Fiscal Policy

- A positive shock in $R^P$ or $D$ increases $G$ on impact
- However, $\rho(G, Y) < 0$ because
  - higher TFP raises incomes and also reduces interest rates which
    - reduces interest incomes for the government
    - causes a reduction in overall $G$
  - This is reinforced by a high subsidy on working capital loans

# Takeaway for G20

- Interest rate shocks have implications for labor market dynamics and EME business cycles
- TFP shocks can moderate the negative effects of interest rate shocks
- Fiscal policy matters for the transmission of interest rate shocks to labor market dynamics
- Our framework allows us to quantify this mechanism
- These issues are relevant to the G20

Thank you!