# Sovereign Default Risk, Monetary Policy and Global Financial Conditions

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# Introduction

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  - U.S. interest rate can explain the large movements seen in their domestic rates and aggregate activity (Neumeyer and Perri (2005), Uribe and Yue (2006))

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  - increasing policy rates: to control inflation and prevent capital outflows (Vicondoa (2019), Huertas (2022))
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**This paper studies how movements in the world interest rate affect emerging economies in a model where default risk and monetary policy interact**

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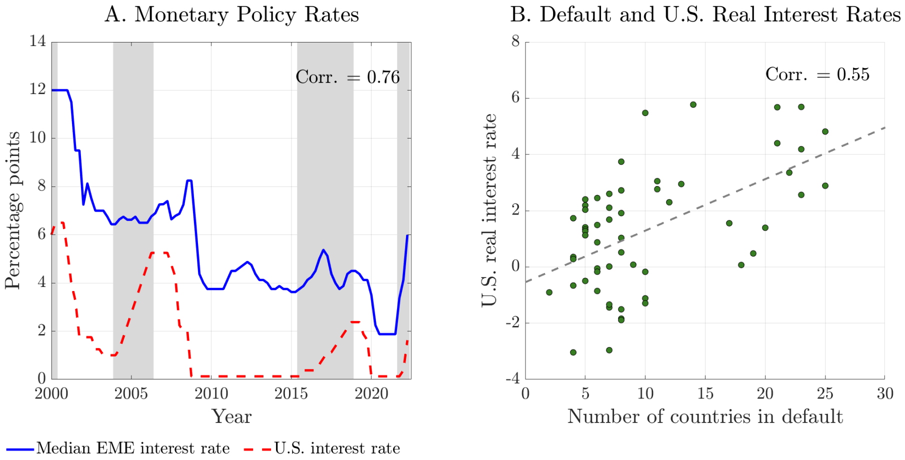
  - Can a depreciation (appreciation) be contractionary (expansionary) for output?
    Auclert, Ronglie, Souchier, Straub (2021), Bianchi and Coulibaly (2023)

# What I find

- The model is able to account for salient features of business cycles in Mexico
- The response of macro variables to an increase in the world interest rate is highly state-contingent
  - With low or very high debt, no effect on probability of default.
    Standard mechanism of the NK model
  - With intermediate debt levels, probability of default increases sharply
    Default risk shapes the response.
- Default risk is able to break monetary policy comovement between U.S. and EMEs
- The model can generate a negative comovement between exchange rate and output

# Policy rates and default during U.S. monetary tightenings




- Correlation between U.S. and EME interest rates is 0.76
- Mixed evidence during U.S. monetary tightenings
- Positive correlation between countries in default and U.S. interest rate

# Model

# Environment

- Small open economy populated by households, firms, a central bank, and a government
- Three types of goods: domestic final, domestic intermediates, and foreign imported
- Government borrows from abroad using long-term bonds and can default on its debt
- Default leads to:
  - Temporary exclusion from financial markets
  - Productivity loss
  - Utility cost for the government
- Central bank conducts monetary policy following a Taylor rule

# Households

- Representative consumer with preferences:

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - v(n_t)\right] \quad \text{where} \quad c_t = \left[\theta \left(c_t^D\right)^{\frac{\rho-1}{\rho}} + (1-\theta)\left(c_t^F\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$$

- Budget constraint (in nominal terms):

$$P_t^D c_t^D + (1+\tau_F) P_t^F c_t^F + q_t^D B_{t+1}^D \leq W_t n_t + B_t^D + \Psi_t + T_t$$

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- Optimality conditions

Labor supply: $$w_t = -\frac{v_{n_t}}{u_{c_t^D}} \quad \text{where} \quad w_t := \frac{W_t}{P_t^D}$$

Relative demand: $$\frac{u_{c_t^F}}{u_{c_t^D}} = (1+\tau_F) e_t \quad \text{where} \quad e_t := \frac{P_t^f}{P_t^d}$$

Euler equation: $$u_{c_t^D} = \beta i_t \mathbb{E}_t \left[ \frac{u_{c_{t+1}^D}}{\pi_{t+1}} \right] \quad \text{where} \quad i_t := \frac{1}{q_t^D} \quad \text{and} \quad \pi_t := \frac{P_t^D}{P_{t-1}^D}$$

# Firms

**Domestic final goods:**

- Produced by competitive firms using intermediate goods: $Y_t = \left[\int_0^1 (y_{jt})^{\frac{\epsilon-1}{\epsilon}} dj\right]^{\frac{\epsilon}{\epsilon-1}}$
- Standard demand functions and price index: $y_{jt} = \left(\frac{p_{jt}}{P_t^D}\right)^{-\epsilon} Y_t$ and $P_t^D = \left[\int_0^1 p_{jt}^{1-\epsilon} dj\right]^{\frac{1}{1-\epsilon}}$

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**Domestic intermediate goods:**

- Produced by monopolistic firms using labor: $y_{jt} = z_t N_{jt}$
- Maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} Q_{t,0} \left\{ p_{jt} y_{jt} - (1-\tau) W_t N_{jt} - \frac{\varphi}{2} \left(\frac{p_{jt}}{p_{jt-1}} - \bar{\pi}\right)^2 P_t^D Y_t \right\}$ s.t. demand
- Phillips curve:

$$\varphi(\pi_t - \bar{\pi})\pi_t = (\epsilon - 1)\left(\frac{w_t}{z_t} - 1\right) + \beta\varphi\mathbb{E}_t\left[\frac{u_{c_{t+1}^D} Y_{t+1}}{u_{c_t^D} Y_t}(\pi_{t+1} - \bar{\pi})\pi_{t+1}\right]$$

# Central Bank and Foreign Sector

**Central bank**

- Conducts monetary policy following a Taylor rule: $i_t = \bar{i}\left(\frac{\pi_t}{\bar{\pi}}\right)^{\psi}$

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**Foreign lenders**

- Long-term bonds denominated in foreign currency:
  - Bond pays $(r_t^\star + \delta) \left[1, (1-\delta), (1-\delta)^2, (1-\delta)^3 ...\right]$
  - Law of motion for bonds: $B_{t+1} = (1-\delta) B_t + I_t$
- Competitive, deep-pocketed, and risk-neutral:

$$\text{Bond price:} \quad q_t = \frac{1}{1 + r_t^\star} \mathbb{E}_t \left[ (1 - D_{t+1}) ((r_t^\star + \delta) + (1-\delta) q_{t+1}) \right]$$

- World interest rate follows an AR(1) process:

$$r_t^\star = \rho_r r_{t-1}^\star + (1 - \rho_r) \bar{r^\star} + \epsilon_{rt}$$

# Government and Balance of Payments

- Maximizes household's utility, and discounts future with $\beta_g < \beta$
- Borrows from foreign lenders and can default on its debt: $D_t \in \{0, 1\}$
- Government budget constraint:

$$t_t + \tau w_t N_t = \begin{cases} \tau_f e_t c_t^F + e_t \left[ q_t (B_{t+1} - (1-\delta) B_t) - (r_t^\star + \delta) B_t \right] & \text{if } D_t = 0 \\ \tau_F e_t c_t^F & \text{if } D_t = 1 \end{cases}$$

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- Balance of payments:

$$e_t^\gamma - e_t c_t^F = (1 - D_t) e_t \left( (r_t^\star + \delta) B_t - q_t \left( B_{t+1} - (1-\delta) B_t \right) \right)$$

# Private and Monetary Equilibrium

**Definition 1**

Let $s := \{z, r^{\star}\}$ be the exogenous state. Given $S = \{s, B, D, B'\}$, the government policy function for future default $\mathcal{D}'(s', \nu', B')$, future borrowing $\mathcal{B}'(s', B')$, and the transfer function $t(S)$, a *private and monetary equilibrium* consists of households' policies $\{c(S), c^F(S), n(S), B^D(S)\}$, firms' policies $\{N(S), \pi(S)\}$ and prices $\{w(S), i(S), e(S)\}$ such that:

1. Households optimize
2. Firms optimize
3. Export demand is satisfied
4. Central Bank's interest rate rule is satisfied
5. Labor, domestic goods, and domestic bond markets clear
6. The balance of payments condition is satisfied.

## Recursive Problem

- Let $s = \{z, r^\star\}$. The value with the option to default is:

$$V(s, v, B) = \max_{D \in \{0,1\}} \left\{ (1 - D) W(s, B) + D \left[ W^d(s) - v \right] \right\}$$

where $v$ is an *iid* utility shock.

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- **Value of repayment**:

$$W(s, B) = \max_{B'} \left\{ u\Big( c(s, B, B') \Big) - v\Big( n(s, B, B') \Big) + \beta_g \mathbb{E}\left[ V\left(s', v', B'\right) \right] \right\}$$

s.t. the private equilibrium and the bond price schedule

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$$W^d(s) = u\Big( c(s, 0, 0) \Big) - v\Big( n(s, 0, 0) \Big) + \beta_g \mathbb{E} \left[ \iota V(s', v', 0) + (1 - \iota) W^d(s') \right]$$

s.t. the private equilibrium with $B = 0$, $B' = 0$ and $z = \tilde{z} - \max\{0, \lambda_0 \tilde{z} + \lambda_1 \tilde{z}^2\} < \tilde{z}$.

# Recursive Equilibrium

**Definition 2**

Given the aggregate state $\{s, v, B\}$, a *recursive equilibrium* consists of government policies for default $\mathcal{D}(s, v, B)$ and borrowing $\mathcal{B}(s, B)$, and government value functions $\{V(s, v, B), W(s, B), W^d(s)\}$ such that:

1. Taking as given future policy and value functions $\mathcal{D}'(s', v', B'), \mathcal{B}'(s', B'), V(s', v', B')$, $W(s', B'), W^d(s')$, government policies and value functions solve its optimization problem

2. Government policies and values are consistent with future values and policies

# Default Amplification

- Higher probability of default next period implies a future productivity loss $z(D=1) < z(D=0)$
- Two equations that link current allocations to expected future allocations:

Euler equation: $$u_{c_t^D} = \beta i_t \mathbb{E}_t \left[ \frac{u_{c_{t+1}^D}}{\pi_{t+1}} \right]$$

Phillips curve: $$\varphi(\pi_t - \bar{\pi})\pi_t = (\epsilon - 1)\left(\frac{w_t}{z_t} - 1\right) + \beta\varphi\mathbb{E}_t \left[ \frac{u_{c_{t+1}^D} Y_{t+1}}{u_{c_t^D} Y_t} (\pi_{t+1} - \bar{\pi})\pi_{t+1} \right]$$

- Productivity loss in the future means:
  - Lower output next period $\Rightarrow$ lower expected consumption $\Rightarrow$ lower consumption today
  - Higher marginal costs next period $\Rightarrow$ higher expected inflation $\Rightarrow$ higher inflation today

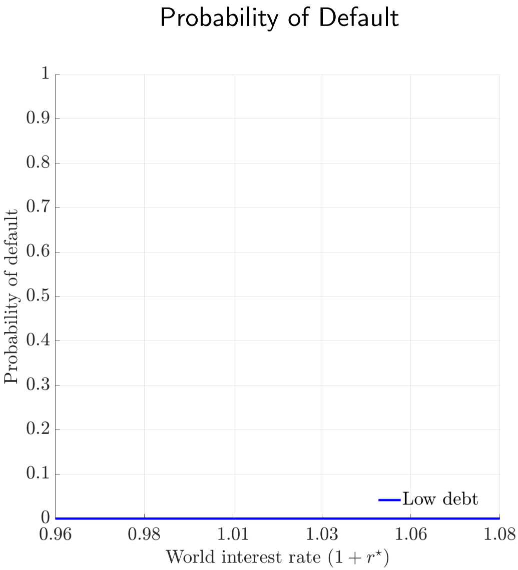
# Results

# Model Fit

| Moment | Data | Model |
|---|---|---|
| *Means* | | |
| CPI inflation | 4.11 | 4.17 |
| Nominal interest rate | 5.90 | 5.89 |
| Spread | 2.20 | 2.25 |
| Cons.-to-output ratio | 66 | 63 |
| *Standard Deviations* | | |
| CPI inflation | 1.00 | 0.81 |
| Nominal interest rate | 1.94 | 1.92 |
| Output | 1.68 | 2.47 |
| Consumption | 1.85 | 1.28 |
| Spread | 0.71 | 0.81 |
| *Correlations* | | |
| Output, spread | -0.39 | -0.37 |
| Inflation, spread | 0.23 | 0.28 |

- I calibrate the model using SMM for Mexico using data for 2001Q1-2019Q4
- Model matches closely targeted means
- Model delivers similar volatilities of the CPI inflation, spreads and nominal int. rate
- It overestimates output volatility and underestimates cons. volatility
- Model replicates countercyclicality of spreads, and positive corr. of inflation and spreads.

# World Interest Rate and Default Risk




- No effect on the probability of default when the economy has low debt

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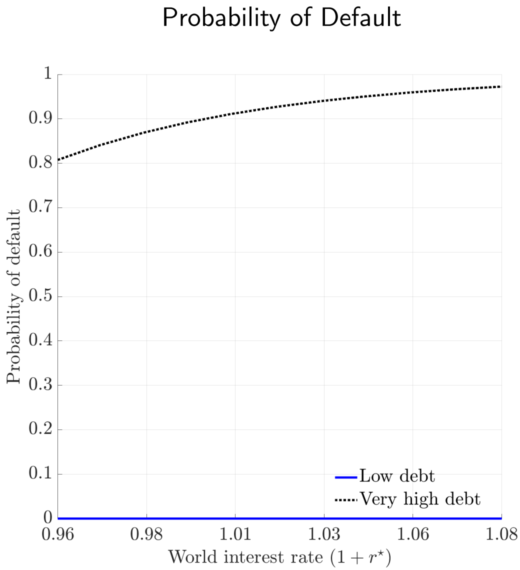


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- Modest increase in default risk when the economy has very high debt.

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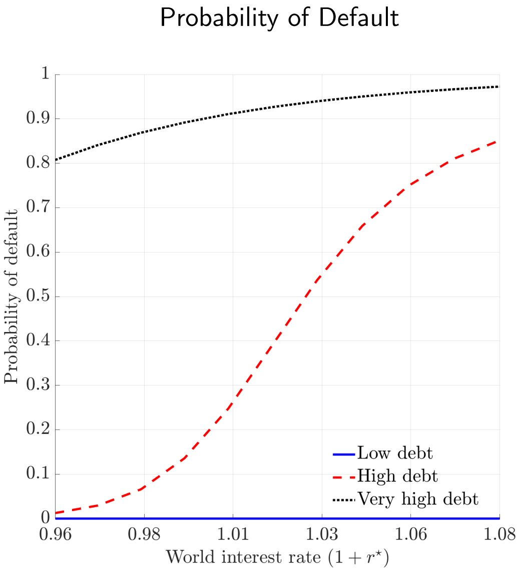
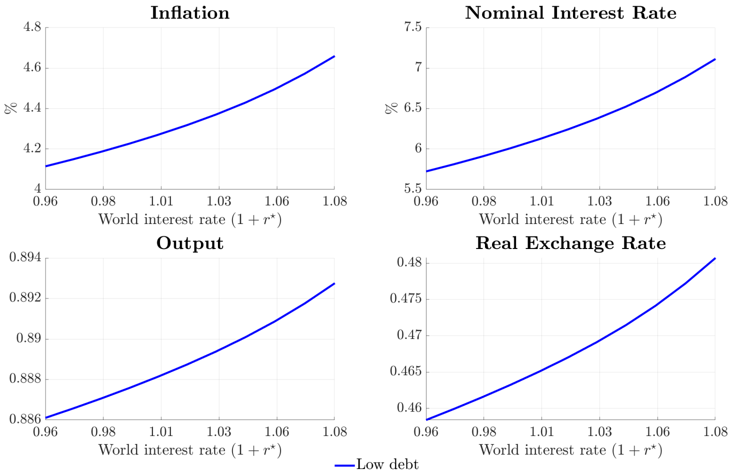



- No effect on the probability of default when the economy has low debt
- Modest increase in default risk when the economy has very high debt.
- Large increase in the region in-between

  ⇒ State-contingent sensitivity to U.S. monetary tightenings

# Policy Functions with No Default Risk




- Higher cost of borrowing reduces debt and leads to a depreciation
- Increase in export demand raises output, and firms increase prices
- Central Bank increases nom. rate

  $\Rightarrow$ Comovement between U.S. and domestic interest rates

  $\Rightarrow$ Expansionary depreciation

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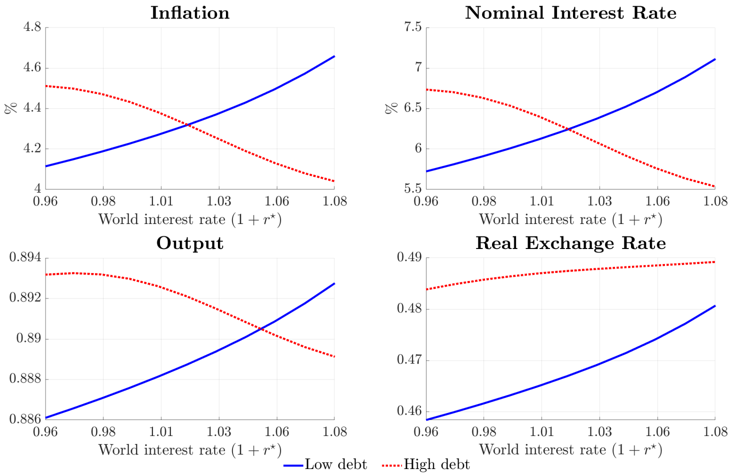
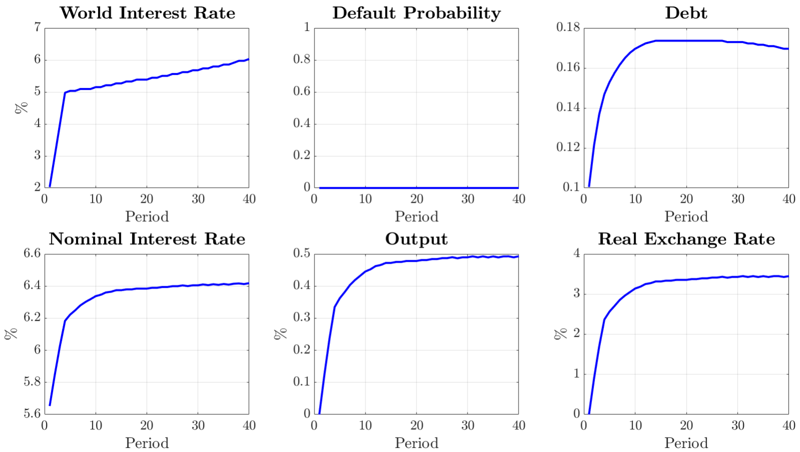



- Higher default risk lowers consumption and output
  ⇒Default amplification
- Inflation falls due to fall in domestic demand
- Central Bank reduces nom. rate
  ⇒ Neg. comovement between U.S. and domestic int. rates
  ⇒ Contractionary depreciation

# Simulations

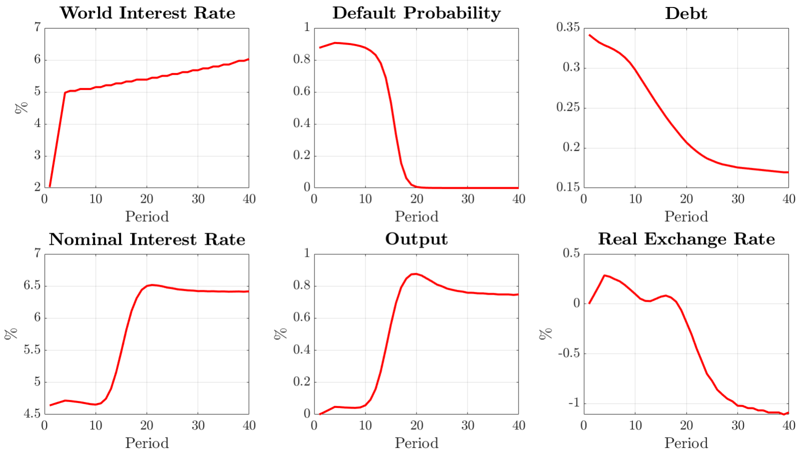
- Feed into the model the observed Federal funds effective rate for the period 2022Q2-2023Q3
- Simulate the model forward under constant productivity, starting from two different initial levels of debt: "low" and "high".
- I assume U.S. monetary tightening continues at a slower pace for the remaining periods in the simulation

# U.S. Monetary Tightening with Low Initial Debt




- Simulation rationalizes monetary policy synchronization
- Expenditure-switching dominates effect of exchange rate on output

# U.S. Monetary Tightening with High Initial Debt




- Default amplification breaks the monetary policy synchronization between U.S. and EMEs (in line with De Leo, Gopinath and Kalemli-Ozkan (2023))
- The model delivers an expansionary appreciation

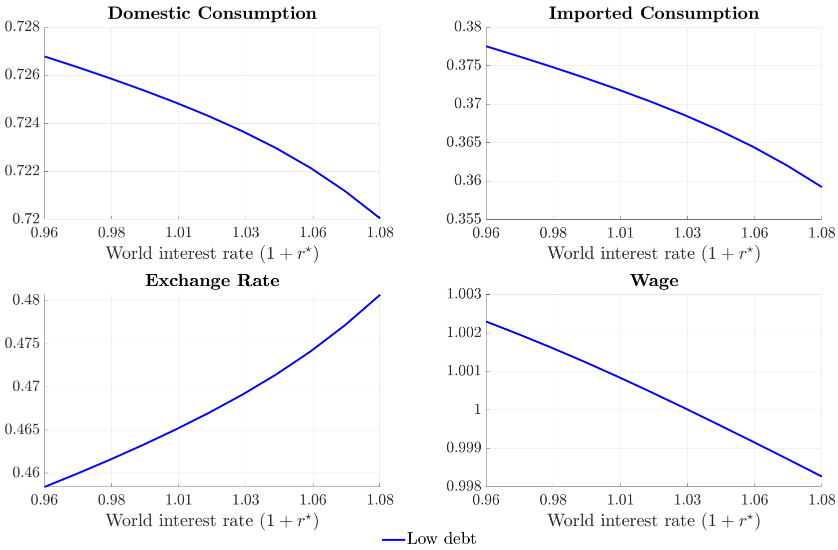
Consumption

# Conclusion

- An increase in the world interest rate can increase the probability of default
- Default amplification is able to break monetary policy synchronization between U.S. and EMEs
- The model can generate a negative comovement between exchange rate and output

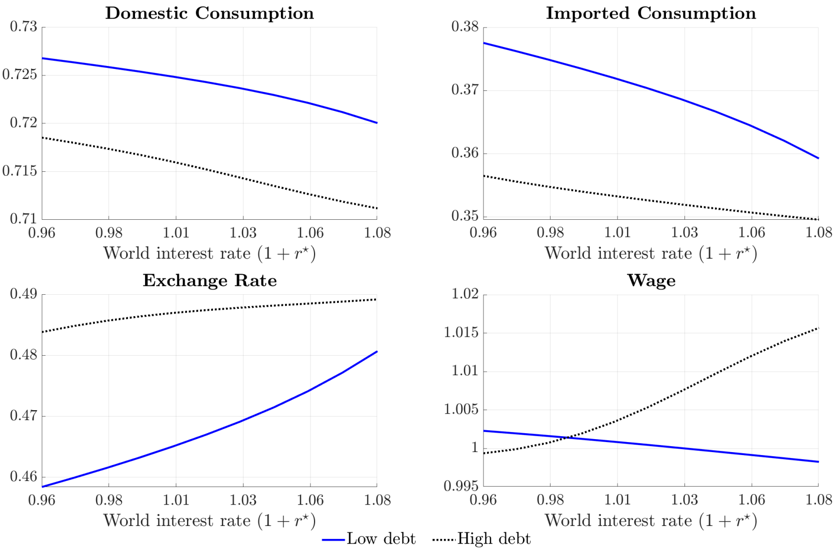
# Back-Up Slides

# Policy Functions with No Default Risk




Back

# Policy Functions with Default Risk

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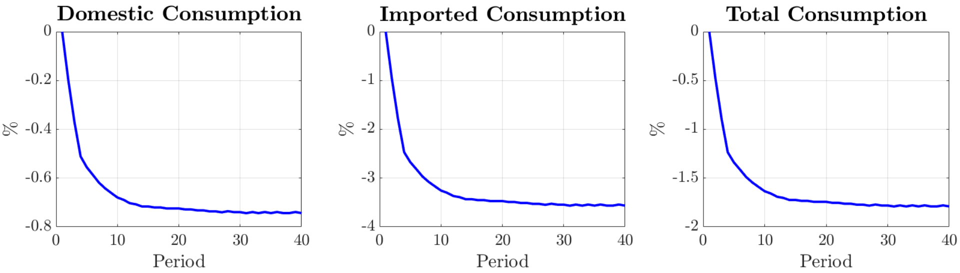


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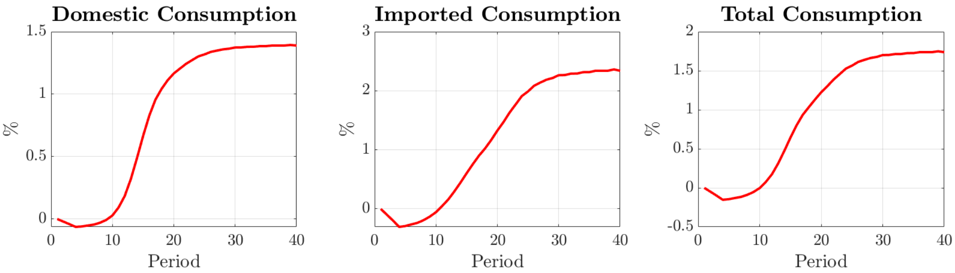


Back

# Default Decision

- Let $v^{\star}(s, B)$ be a cutoff cost: the sovereign is indifferent between repaying and defaulting:

$$v^{\star}(s, B) = W^{d}(s) - W(s, B)$$

Then

$$D(s, B) = \begin{cases} 1 & \text{if } v \leq v^{\star}(s, B) \\ 0 & \text{otherwise} \end{cases}$$

- Let $\Phi$ be the cumulative distribution of $v$. We assume $v \sim \text{Logistic}(0, \rho_D)$:

$$\begin{aligned} \text{Prob}(D = 1 | s, B) &= \Phi(v^{\star}(s, B)) \\ &= \frac{\exp\left(\frac{W^{d}(s)}{\rho_D}\right)}{\exp\left(\frac{W^{d}(s)}{\rho_D}\right) + \exp\left(\frac{W(s,B)}{\rho_D}\right)} \end{aligned}$$