Currency Choice in Contracts

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Introduction and Motivation

- Central role of currency: serve as unit of account in credit contracts
  - Coexistence of currencies in denomination of contracts
  - Especially so in emerging economies
- Use of foreign currency linked to policy instability
- Recent attempts by governments to prevent dollarization

What We Do

- Questions:
  - What determines currency denomination of private contracts?
  - What are the implications for optimal policy?
- Framework:
  - Economy with private contracts & endogenous monetary policy
  - Optimal currency choice trades-off **price risk** & **insurance property**
  - Government chooses inflation and is subject to policy risk
  - **Complementarities** btw effectiveness of monetary policy & use of LC contracts

Overview of Main Results

1. Nature of equilibrium depends on level of policy risk
   - Countries with high (low) policy risk $\rightarrow$ use of FC more (less) likely
   - Intermediate policy risk $\rightarrow$ multiple equilibria
2. Room for policy regulation of currency in contracts
   - Equilibria can feature underuse of local currency
3. Applications
   - Trade-offs extend to model with on-equilibrium default
   - International contracts - larger use of dollar, mon. pol. less effective
   - Hysteresis due to currency matching of prior debt stocks

▸ Literature Review

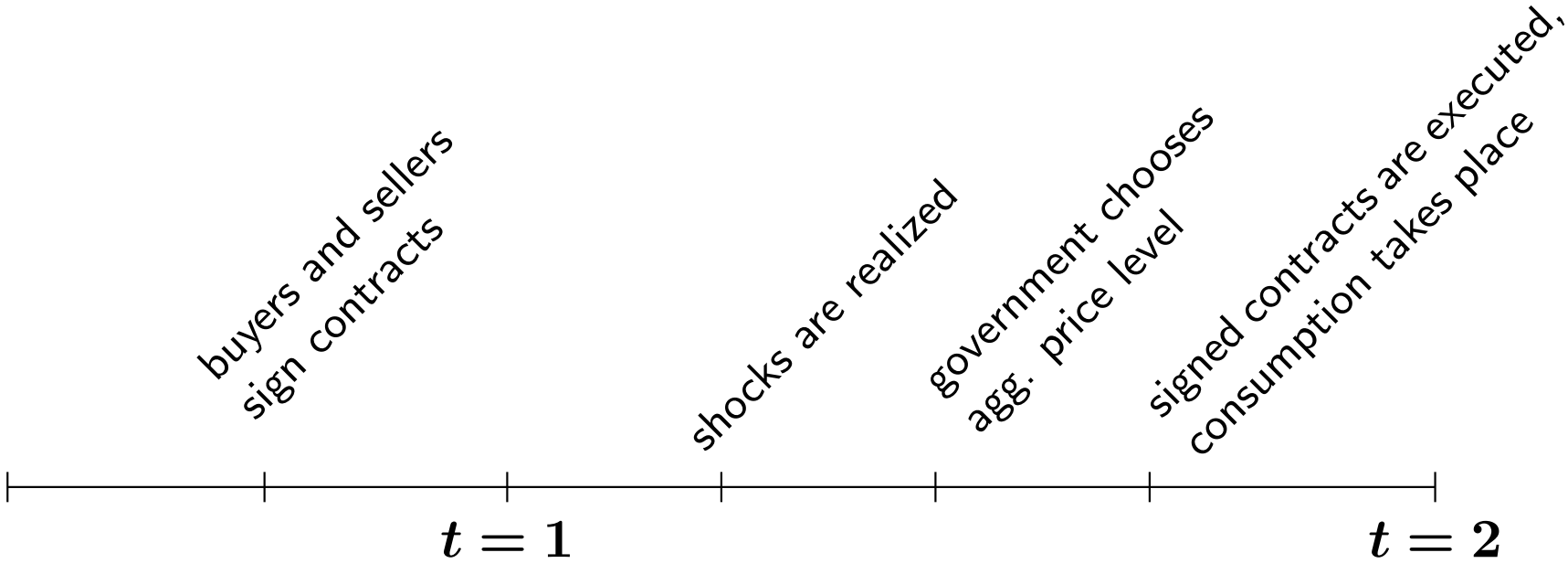
Outline

1. **Baseline Model**
    - 1.1 **Competitive Equilibria**
    - 1.2 Constrained Efficiency
2. Applications & Extensions
    - 2.1 Model with Default
    - 2.2 International Contracts
    - 2.3 Hysteresis

Environment

- Two periods
- Agents: private agents and government
- Buyers and sellers sign bilateral contract
  - Sellers provide special good in exchange of future payments
  - Payments denominated in local and/or foreign currency
- Government chooses price level in local currency
- Foreign currency price exogenous and stochastic
  - Captures real exchange rate risk

Timing


buyers and sellers sign contracts
shocks are realized
government chooses agg. price level
signed contracts are executed, consumption takes place
$t = 1$
$t = 2$

Buyers and Sellers

- Sellers' preferences:

$$u_s = -x + \mathbb{E}[\theta_s c_s]$$

- Buyers' preferences:

$$u_b = (1+\lambda)x + \mathbb{E}[\theta_b c_b]$$

  - x provision of special good. $\lambda > 0 \rightarrow$ gains of trade
  - c_s, c_b consumption of numeraire good
  - θ_s, θ_b stochastic taste shocks w/ support $[\underline{\theta}_i, \overline{\theta}_i]$ and $\mathbb{E}[\theta_i]$
    - captures reasons for why its desirable to shift resources btw agents
  - both endowed with y numeraire good in $t = 2$

- **Assumption 1:** $(1+\lambda)\mathbb{E}[\theta_s] - \mathbb{E}[\theta_b] \geq 0$
  - Guarantees seller wants to sell and buyers want to buy

Bilateral Contracts

- Bilateral contract: (x, b_l, b_f)
  - x units of special good provided to buyer in $t = 1$
  - b_c units of currency c promised to seller in $t = 2$
- Assumptions:
  1. Non state-contingent
  2. Denominated in currencies: local (l) and foreign (f)
  3. Payments always feasible
- Currencies: units of account, stochastic at $t = 1$
  - ϕ_c: value of currency c in terms of numeraire good
    - High $\phi_l \leftrightarrow$ low inflation in local currency

Bilateral Contracts

Optimal contract for the buyer solves

$$\max_{x\geq 0, b_l \geq 0, b_f \geq 0} (1+\lambda)x + \mathbb{E}[\theta_b \underbrace{(y - b_l\phi_l - b_f\phi_f)}_{c_b}]$$

subject to

Participation Const.: $$\mathbb{E}[\theta_s \underbrace{(b_l\phi_l + b_f\phi_f)}_{c_s}] \geq x$$

Payments Feasibility: $$b_l\phi_l + b_f\phi_f \leq y \quad \forall \phi_l, \phi_f$$

Bilateral Contracts

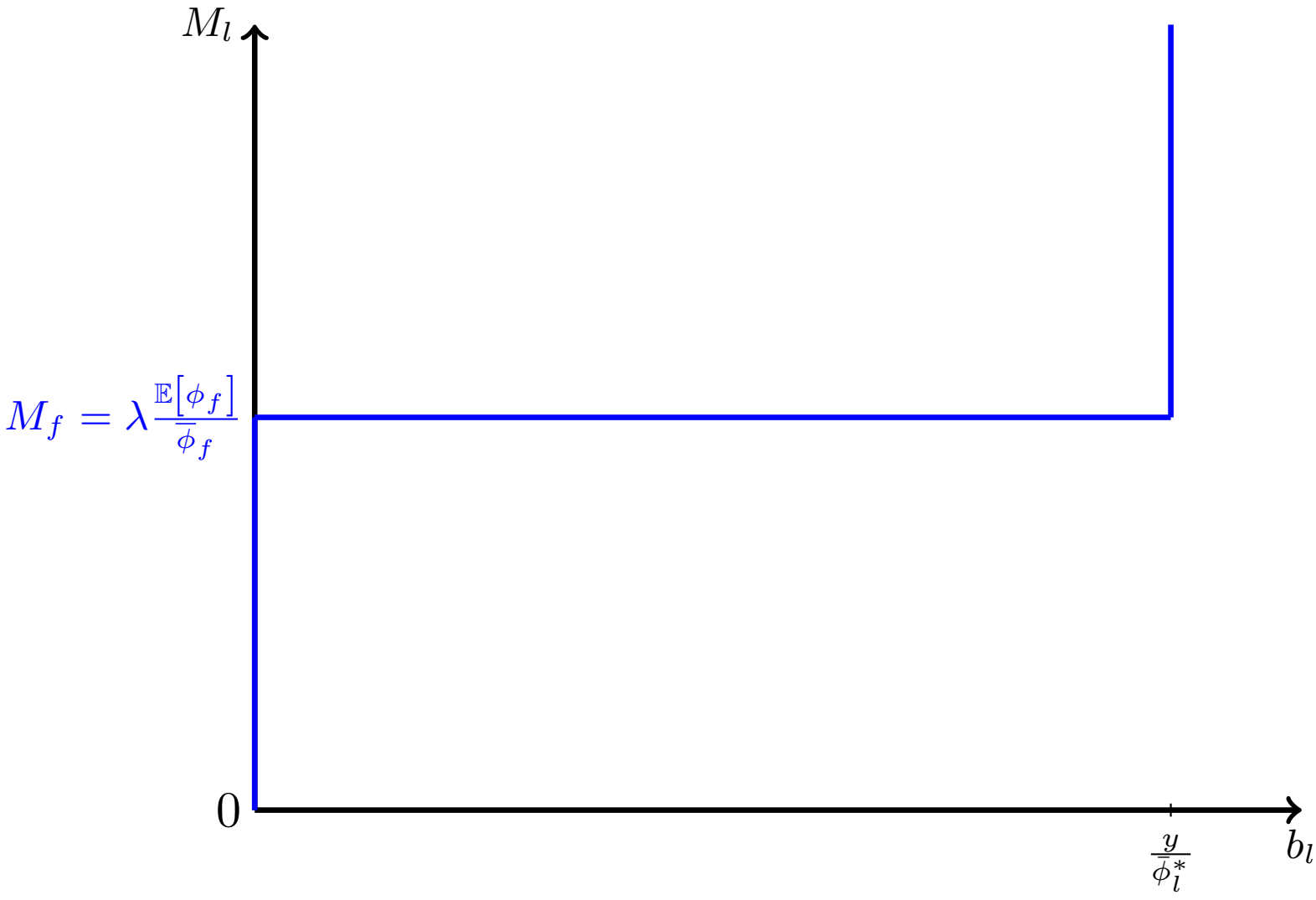
- Participation constraint always binds
- Payment feasibility binds for worst deflation realizations: $\overline{\phi}_l, \overline{\phi}_f$
- Problem simplifies to

$$\max_{b_l \geq 0, b_f \geq 0} \mathbb{E}\left[\left((1+\lambda)\theta_s - \theta_b\right)\left(b_l \phi_l + b_f \phi_f\right)\right]$$
$$\text{s.t.} \quad b_l \overline{\phi}_l + b_f \overline{\phi}_f = y$$

- Solution: choose currency with highest marginal benefit M_c

$$M_c \equiv \left((1+\lambda)\,\mathbb{E}\left[\theta_s\right] - \mathbb{E}\left[\theta_b\right]\right) \underbrace{\frac{\mathbb{E}[\phi_c]}{\overline{\phi}_c}}_{\text{Price Risk}} + \underbrace{\text{cov}\left(\theta_s(1+\lambda) - \theta_b, \frac{\phi_c}{\overline{\phi}_c}\right)}_{\text{Insurance Properties}}$$

Bilateral Contracts: Optimal Currency Choice



Government's Problem

- Government's problem is

$$\begin{aligned} \max_{\phi_l} \quad & \theta_b C_b + \theta_s C_s - l\left(\phi_l\right) \\ \text{where} \quad & C_b = y - \phi_l B_l - \phi_f B_f \\ & C_s = y + \phi_l B_l + \phi_f B_f \end{aligned}$$

- $l\left(\phi_l\right) = \frac{\psi}{2}\left(\phi_l - \phi^\dagger\right)^2$, loss from deviating from inflation target
- $\phi^\dagger$ stochastic inflation target w/ support $[\underline{\phi}^\dagger, \overline{\phi}^\dagger]$
  - $\frac{\mathbb{E}[\phi^\dagger]}{\overline{\phi}^\dagger}$ captures policy risk, main source of cross-country variation

What is the Inflation Loss?

- Third agent (household)
  - Linear preferences on consumption & quadratic disutility of labor
  - Endowed w/ money claims & consumption s.t. cash-in-advance constraint
- Government
  - Needs to finance stochastic g
  - Can tax labor τ & choose inflation
- HH utility can be expressed as

$$\text{const} - \psi \left(\phi_l - \underbrace{\left(\frac{\hat{\tau}(1-\hat{\tau}) - g}{m} \right)}_{\phi^\dagger} \right)^2$$

▸ Figure

Optimal Monetary Policy

- Optimal inflation policy given by

$$\phi_l^* (B_l) = \phi^\dagger + \frac{1}{\psi} (\theta_s - \theta_b) B_l$$

- High inflation when buyers value consumption more relative to sellers
- How does B_l affect M_l?
  - Higher $B_l \to$ inflation reacts more to $\theta_s, \theta_b \leftrightarrow$ more insurance
  - Higher $B_l \to$ higher inflation volatility $\leftrightarrow$ more price risk

Assumptions

Assumption 2:

$$\frac{1}{2}\text{var}\left(\theta_s - \theta_b\right) + \lambda\left[\text{var}\left(\theta_s\right) - \text{cov}\left(\theta_s, \theta_b\right)\right] \geq \kappa_1$$

where κ_1 depends on model parameters

Assumptions

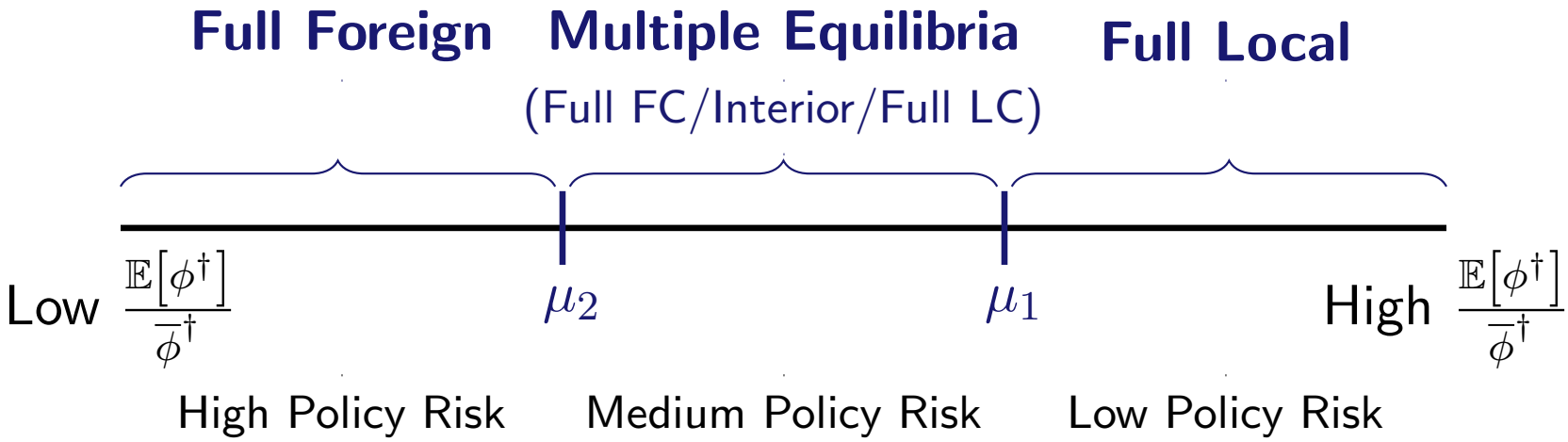
Assumption 2:
When θ_b, θ_s are iid:

$$\text{var}(\theta) > (\overline{\theta} - \underline{\theta})$$

1. What is needed?
   - Sufficiently large variation in state-contingent mg. utilities
2. What does it imply?
   - Insurance channel $>$ Price risk channel
   - Guarantees M_l increasing in B_l
3. What if it does not hold?
   - Similar characterization of equilibria, policy prescriptions change

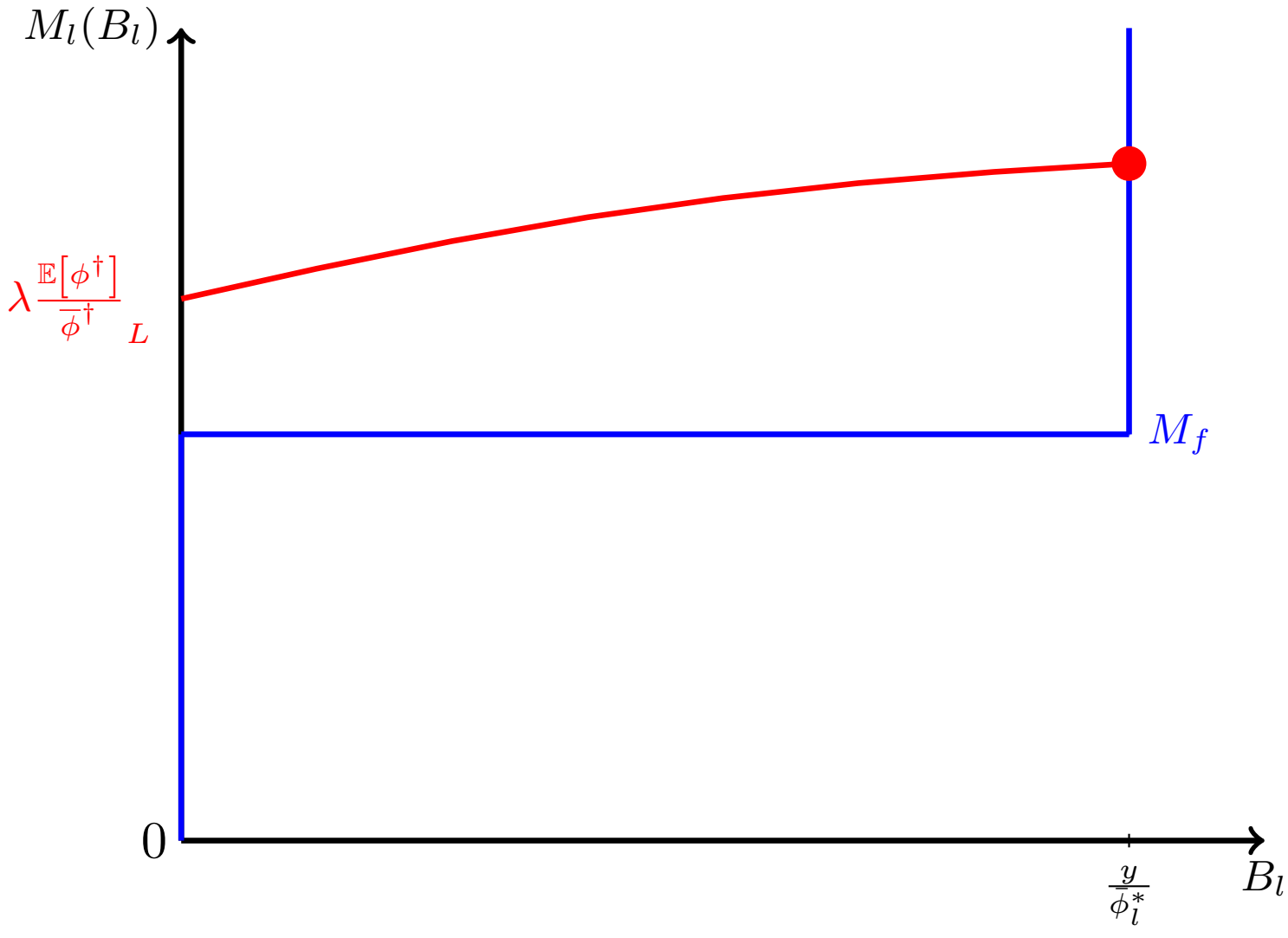
Competitive Equilibria for Different Policy Risk

Proposition:

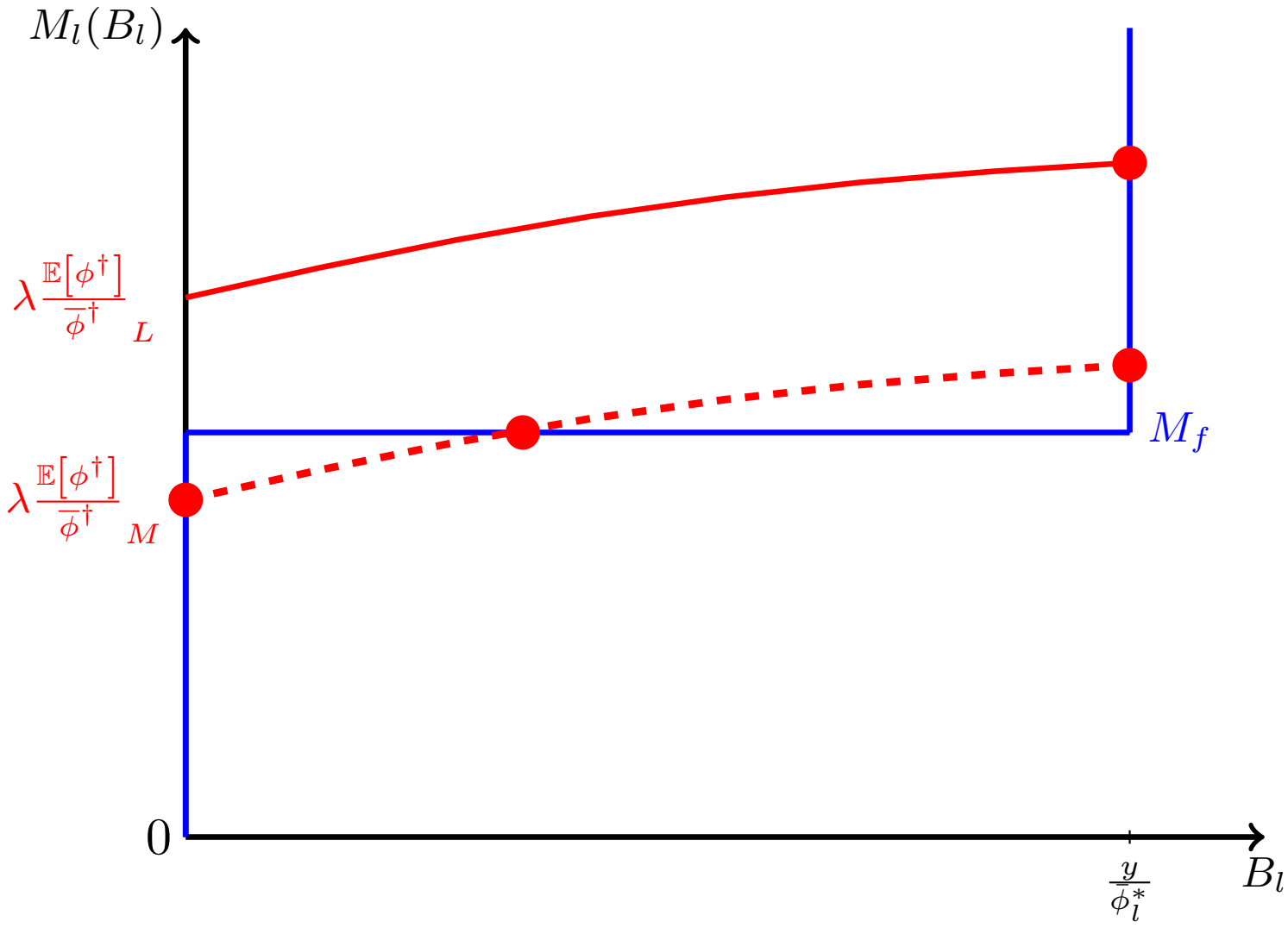


- Definition of Equilibrium

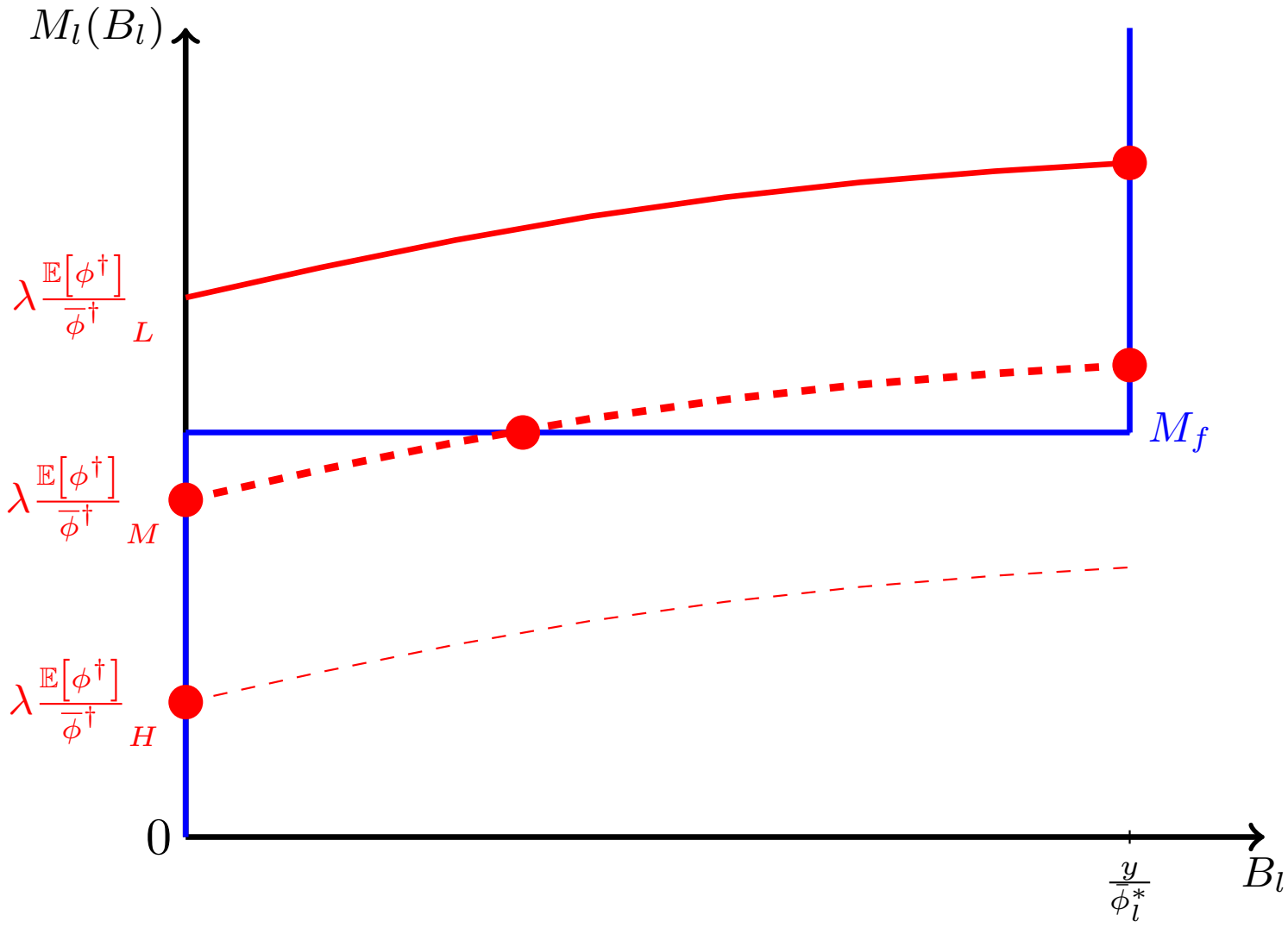
Competitive Equilibria



Competitive Equilibria



Competitive Equilibria



Global Games Approach

- Policy risk is no longer common knowledge
- Each buyer-seller pair receives noisy signal

$$\xi_i = \mathbb{E}\left[\phi^{\dagger}\right] + \epsilon_i$$

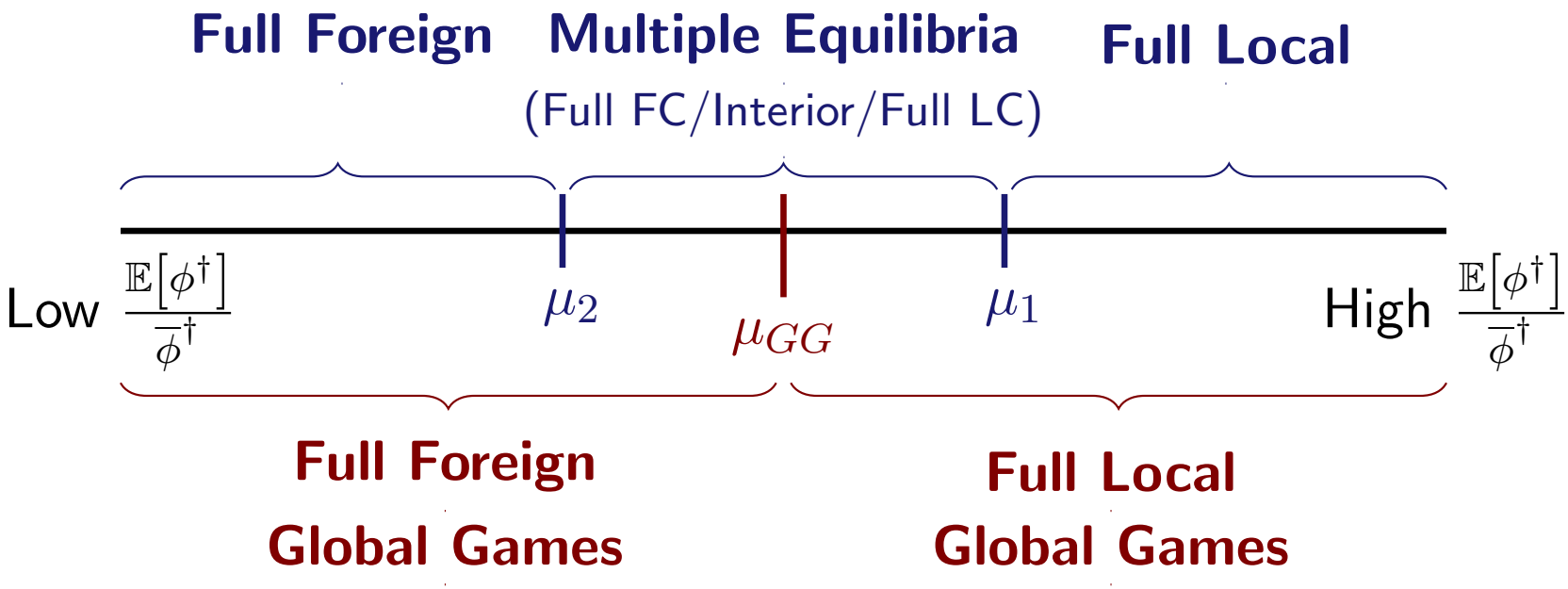
where $\epsilon_i \sim U\left[-\eta, \eta\right]$

Proposition: For η small enough, there is a unique eq that satisfies:

$$b_l\left(\xi\right) = \begin{cases} 0 & \xi < \xi^* \\ \frac{y}{\phi_l^{**}} & \xi > \xi^* \end{cases}$$

where $\mu_1 > \frac{\xi^*}{\phi^{\dagger}} > \mu_2$

Equilibrium Selection for Different Policy Risk



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Recent Examples of Policy Regulation

- Is regulating currency denomination of contracts optimal?
- Full prohibition of foreign currency contracts
  - Brazil, Colombia
- Restrictions in foreign currency borrowing
  - Croatia, Hungary, India, Poland and Turkey
- Restrictions on foreign currency pricing
  - Peru
- Full dollarization in 2000
  - Ecuador, El Salvador

Social Planner's Problem

- Choose allocation & inflation s.t. same constraints as private agents

$$\max_{\substack{x\geq 0,\phi_l,\\ B_l\geq 0,B_f\geq 0}} \underbrace{\mathbb{E}\left[-x+\theta_s c_s\right]}_{u_s}+\underbrace{\mathbb{E}\left[(1+\lambda)x+\theta_b c_b\right]}_{u_b}-\mathbb{E}\left[l\left(\phi_l\right)\right]$$

subject to

Budget Const.:
$$c_b = y - B_l\phi_l - B_f\phi_f$$
$$c_s = y + B_l\phi_l + B_f\phi_f$$

Participation Const.:
$$\mathbb{E}\left[\theta_s(B_l\phi_l + B_f\phi_f)\right] \geq x$$

Payments Feasibilty:
$$B_l\phi_l + B_f\phi_f \leq y \quad \forall(\phi_l,\phi_f)$$

Monetary Policy:
$$\phi_l = \phi^\dagger + \frac{1}{\psi}\left(\theta_s - \theta_b\right)B_l$$

Constrained Efficiency for Different Policy Risk

- Given assumption 2, problem of SP is strictly convex

  $\Rightarrow$ compare utilities at $B_l = 0$ and $B_l = \frac{y}{\bar{\phi}^*}$

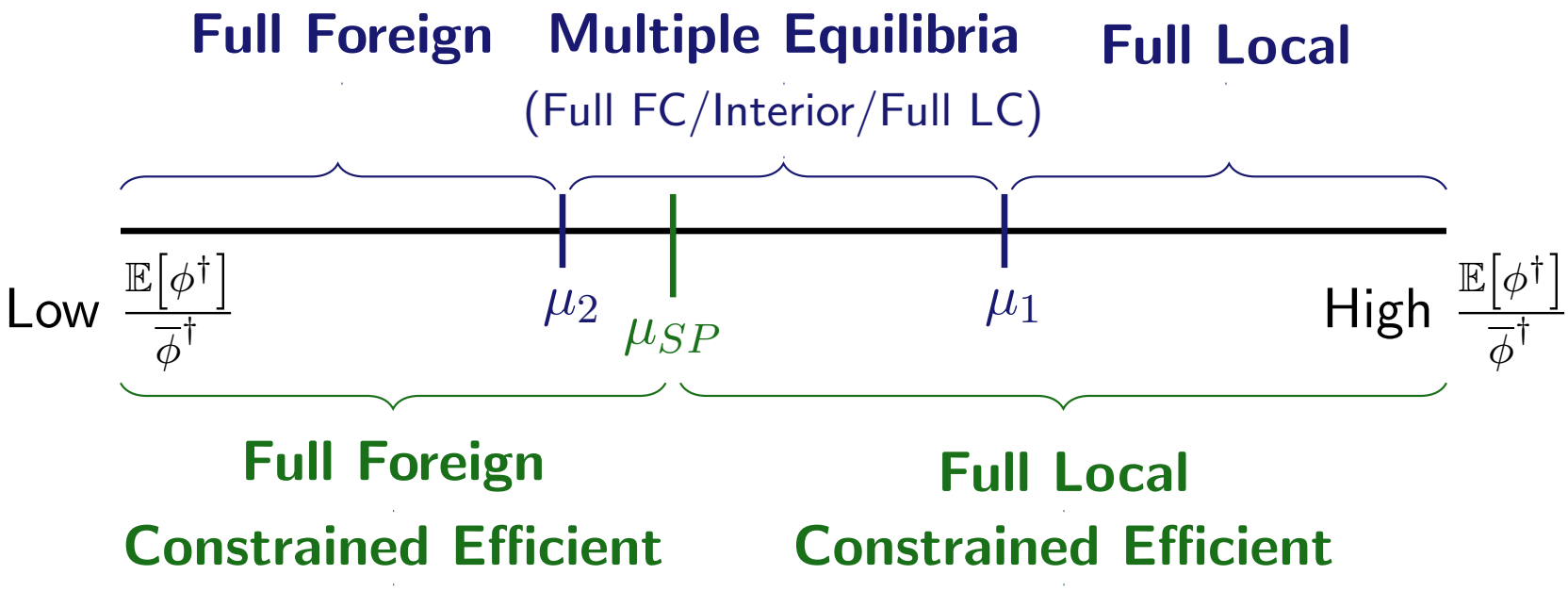
- Trade-off given by:

  Local price risk + Insurance - Cost of Inflation $\gtrless$ Foreign price risk

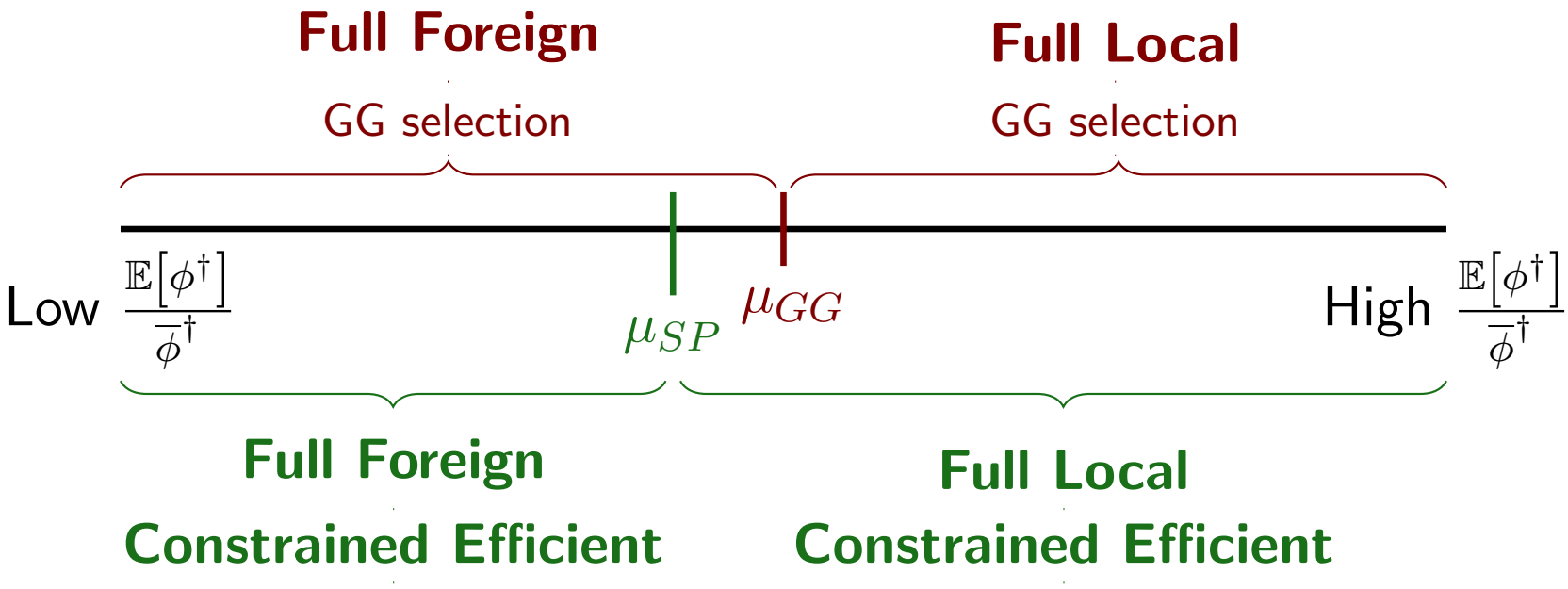
Proposition: There exists μ^{sp} with $\mu_2 < \mu^{sp} < \mu_1$ such that:

1. if $\frac{\mathbb{E}\left[\phi^\dagger\right]}{\bar{\phi}^\dagger} \geq \mu^{sp}$, solution to Social Planner's problem is $B_l^{sp} = \frac{y}{\bar{\phi}^*}$;
2. if $\frac{\mathbb{E}\left[\phi^\dagger\right]}{\bar{\phi}^\dagger} \leq \mu^{sp}$, solution to Social Planner's problem is $B_l^{sp} = 0$.

Constrained Efficiency for Different Policy Risk



Constrained Efficiency for Different Policy Risk



Applications and Extensions

1. Model with Strategic Default
2. International Contracts
3. Hysteresis

Model with Strategic Default

- Allow buyers to default on payments in period 2
- No taste shocks
- Default is full, seller receives nothing
- If buyers default, suffer cost $\chi(\phi_l b_l + \phi_l b_l)$
  - Cost of default stochastic: $\chi \sim F_\chi[0, \overline{\chi}]$
  - Default costs depend on the level of defaulted debt
  - Implies buyers optimally default when $\chi < 1$
- If buyers default, government partially inflates away cost of default

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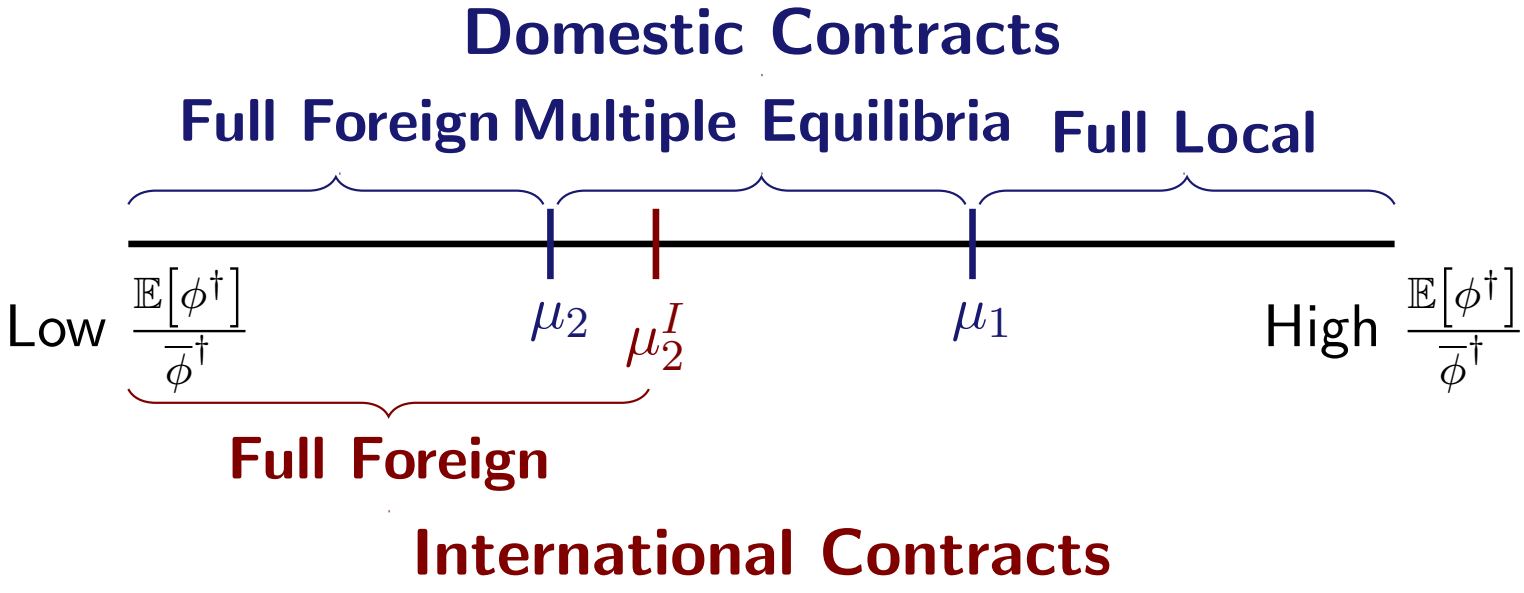
Proposition:
The baseline model with taste shocks is identical to the model with default in eq outcomes

Economy with International Contracts

- International contracts more likely to be denominated in FC ▸ Figure
- Economy with two symmetric countries: i, j
  - Continuum of buyers trade with continuum of sellers of other country
- Three available currencies: i, j, f
  - Assumption: both countries have same level of policy risk

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Hysteresis in Model with Credit Chains

- Dollarization persists after episodes of inflation stabilization ▸ Figure
- Buyers endowed with y and claims $\hat{b}_l, \hat{b}_f$
- Assumption: $var(\theta)$ not too large

Hysteresis in Model with Credit Chains

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Proposition: Optimal contract is given by:

$$\text{if } M_l \geq M_f: \qquad b_l = \hat{b}_l + \frac{y}{\phi_l} \qquad b_f = \hat{b}_f$$

$$\text{if } M_l < M_f: \qquad b_l = \hat{b}_l \qquad b_f = \hat{b}_f + \frac{y}{\phi_f}$$

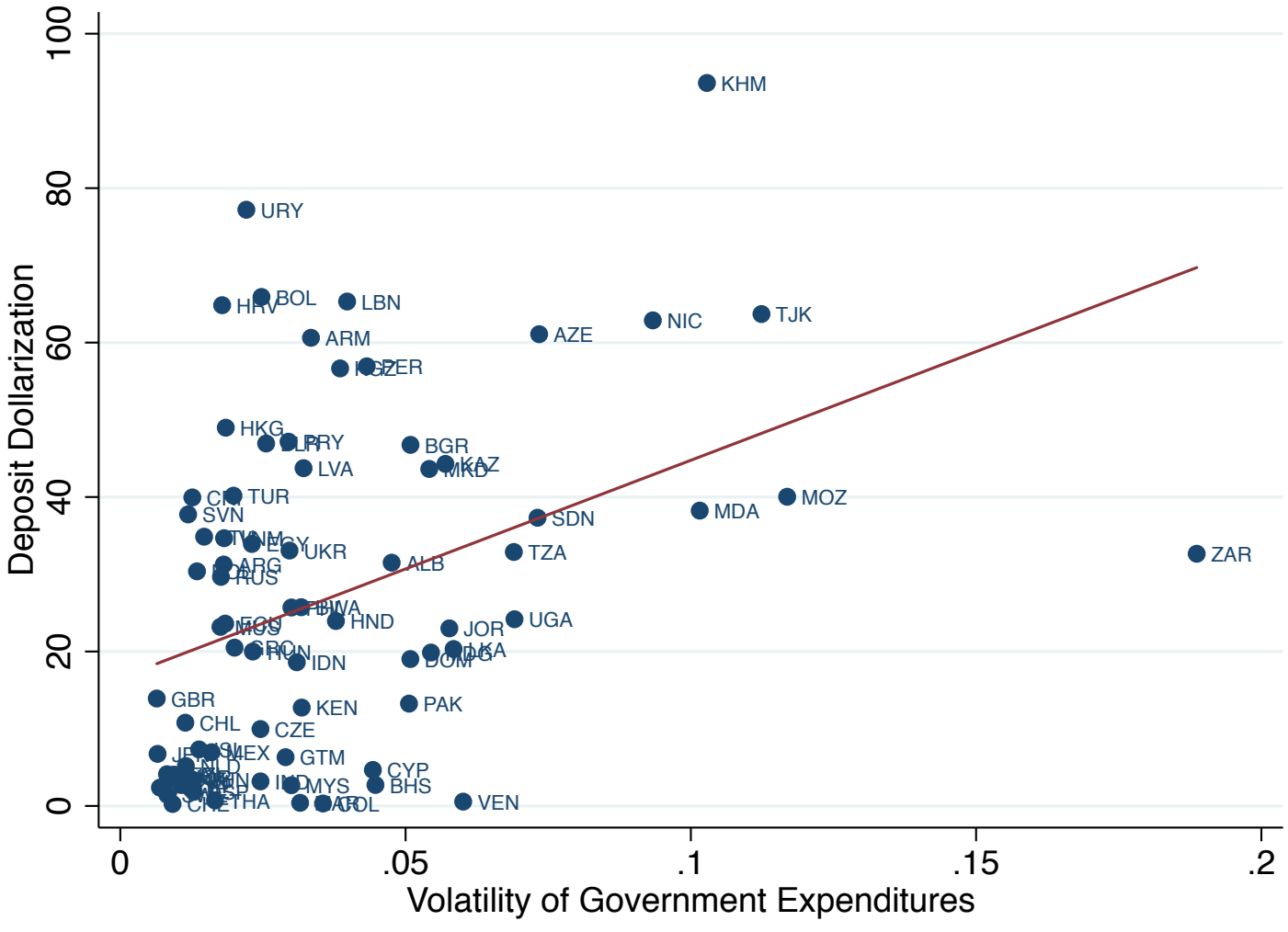
- Policy risk only determines currency of *new* borrowing flows
- Currency matching of stocks is optimal $\Rightarrow$ path dependence
  - Allows for more borrowing and provision of special good

Conclusion

- Study general equilibrium of economy with private contracts & endogenous monetary policy
- Nature of equilibria depend on degree of policy risk
- Room for policy regulation of currency in contracts

Dollarization and Fiscal Policy Risk

Back



Literature Review

- Currency choice in debt contracts, price setting, means of payment
  - Matsutama et al (1993), Uribe (1997), Ize & Levy Yeyati (2003), Caballero & Krishnamurthy (2003), Schneider & Tornell (2004), Engel (2006), Gopinath et al (2010), Doepke & Schneider (2017), Bocola & Lorenzoni (2018), Drenik & Perez (2018)
- Global role of dollar
  - Farhi & Maggiori (2017), Gopinath & Stein (2018), Maggiori et al (2018), Chahrour & Valchev (2018), Eren & Malamud (2019), Jiang, Krishnamurthy & Lustig (2019)
- Currency and policy choice
  - Neumeyer (1998), Chang and Velasco (2006), Rappoport (2009), Arellano & Heathcote (2010), Ottonello & Perez (2018), Du et al (2018), Fanelli (2018), Mukhin (2018)

Back

Equilibrium

Definition: A competitive equilibrium is an allocation for private citizens (x, b_l, b_f), aggregate denomination choices (B_l, B_f), and govt policy ϕ_l such that:

1. Given ϕ_l, and (B_l, B_f) the private allocation solves the contracting problem
2. Given B_l, ϕ_l solves govt problem
3. Aggregate choices coincide with private ones, $b_l = B_l$ and $b_f = B_f$

▸ Back

Model with Strategic Default

- Allow buyers to default on payments in period 2
  - Allows private contracts to introduce state contingency
- No taste shocks
- Default is full, seller receives nothing
- If buyers choose to default, suffer cost $\chi(\phi_l b_l + \phi_l b_l)$
  - Cost of default stochastic: $\chi \sim F_\chi[0, \overline{\chi}]$
  - Default costs depend on the level of defaulted debt
  - Implies buyers optimally default when $\chi < 1$

▸ Fixed Costs of Default Model

Contract Problem

- Optimal contract for the buyer solves

$$\max_{x\geq 0, b_l \geq 0, b_f \geq 0} (1+\lambda)x$$

$$+\mathbb{E}\left[\underbrace{(y-\phi_l b_l-\phi_f b_f)}_{c_b \text{ if repay}}\mathbb{I}_{\chi\geq 1}+\underbrace{(y-\chi(\phi_l b_l+\phi_f b_f))}_{c_b \text{ if default}}\mathbb{I}_{\chi<1}\right]$$

subject to

$$\text{Partipation constraint:} \quad \mathbb{E}\left[(b_l\phi_l+b_f\phi_f)\,\mathbb{I}_{\chi\geq 1}\right]\geq x$$

$$\text{Payments feasibility:} \quad b_l\phi_l+b_f\phi_f\leq y \quad \forall \phi_l,\phi_f$$

Default Model: Government Problem

- Government maximizes utility of buyers and sellers

$$\max_{\phi_l} \quad \underbrace{-\chi \phi_l B_l}_{\text{loss from default}} \quad \mathbb{I}_{\chi \geq 1} - l\left(\phi_l\right)$$

- Optimal inflation choice

$$\phi_l = \begin{cases} \phi^\dagger & \text{if } \chi \geq 1 \\ \phi^\dagger - \frac{1}{\psi} \chi B_l & \text{if } \chi < 1 \end{cases}$$

- If buyers default, government partially inflates away cost of default
  - Given policy risk, local currency has a higher marginal benefit

Mapping of Default Model into Baseline

- Define

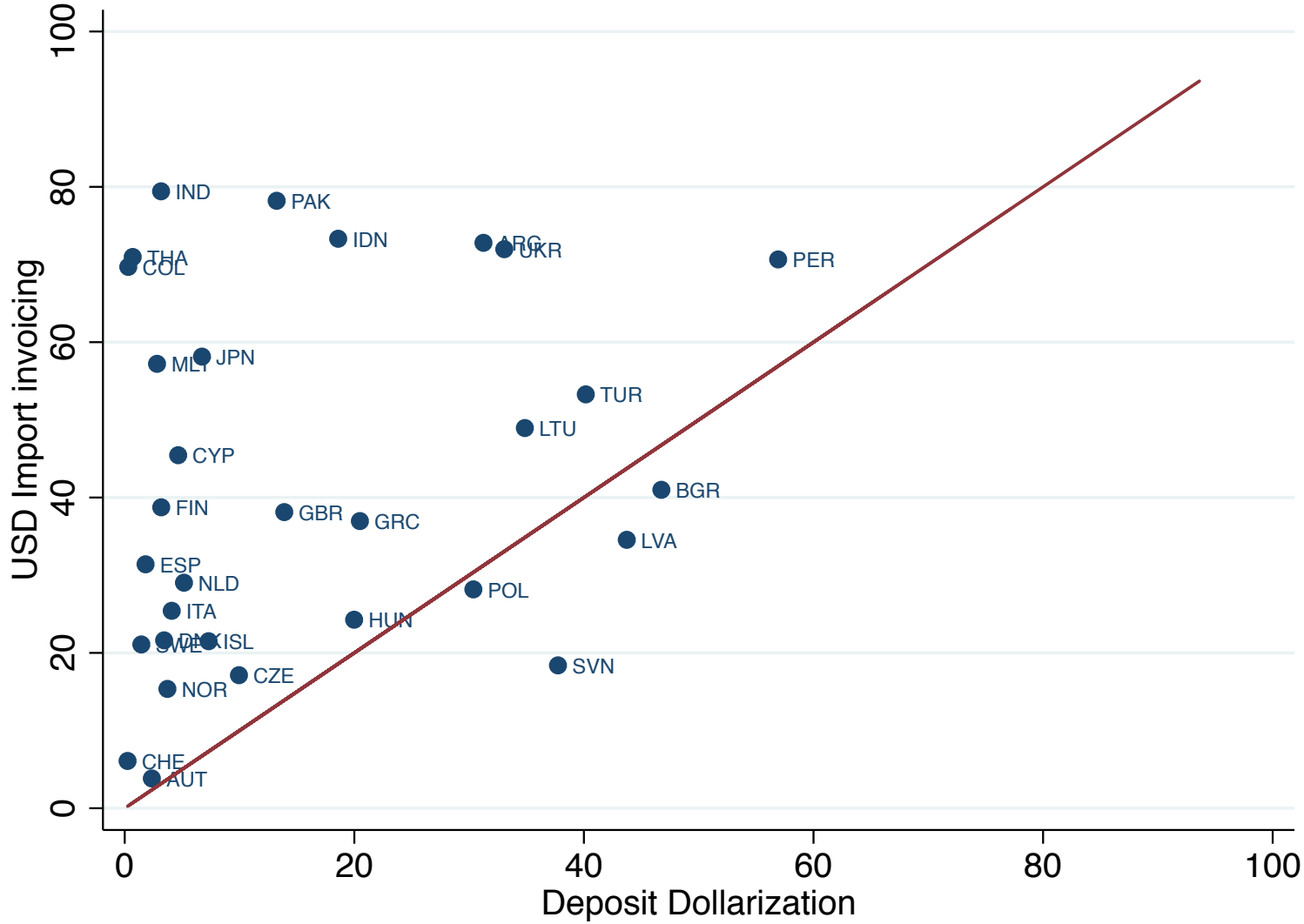
$$\theta_s = \begin{cases} 0 & \text{if } \chi < 1 \\ 1 & \text{if } \chi \geq 1 \end{cases} \quad \text{and} \quad \theta_b = \begin{cases} \chi & \text{if } \chi < 1 \\ 1 & \text{if } \chi \geq 1 \end{cases}$$

Proposition:
The baseline model with the above taste shocks is identical to the model with default in eq outcomes

Assumption 1': $\underbrace{\lambda \left(1 - F_\chi(1)\right)}_{\text{gains of trade}} > \underbrace{\mathbb{E}\left[\chi | \chi < 1\right] F_\chi(1)}_{\text{losses from default}}$

Additionally, if assumption above is satisfied, then the model also satisfies the original assumptions 1 and 2

Dollarization in International & Domestic Contracts



Sources: Gopinath (2015), Ize, Levy-Yeyati (2006)

▸ Back

Economy with International Contracts

- Economy with two symmetric countries: i, j
  - Continuum of buyers and sellers in each country
  - Buyers trade with sellers of other country
- Three available currencies: i, j, f
  - Assumption: both countries have same level of policy risk

$$\frac{\mathbb{E}\left[\phi_i^\dagger\right]}{\overline{\phi}_i^\dagger} = \frac{\mathbb{E}\left[\phi_j^\dagger\right]}{\overline{\phi}_j^\dagger}$$

- Focus on symmetric eq & region with full use of f as unique eq

Economy with International Contracts

- Optimal contract for buyer in country i and seller in country j solves

$$\max_{x_i, b_{ii} \geq 0, b_{ij} \geq 0, b_{if} \geq 0} (1+\lambda) x_i - \mathbb{E}\theta_{ib} \left(\phi_i b_{ii} + \phi_j b_{ij} + \phi_f b_{if} \right)$$

subject to

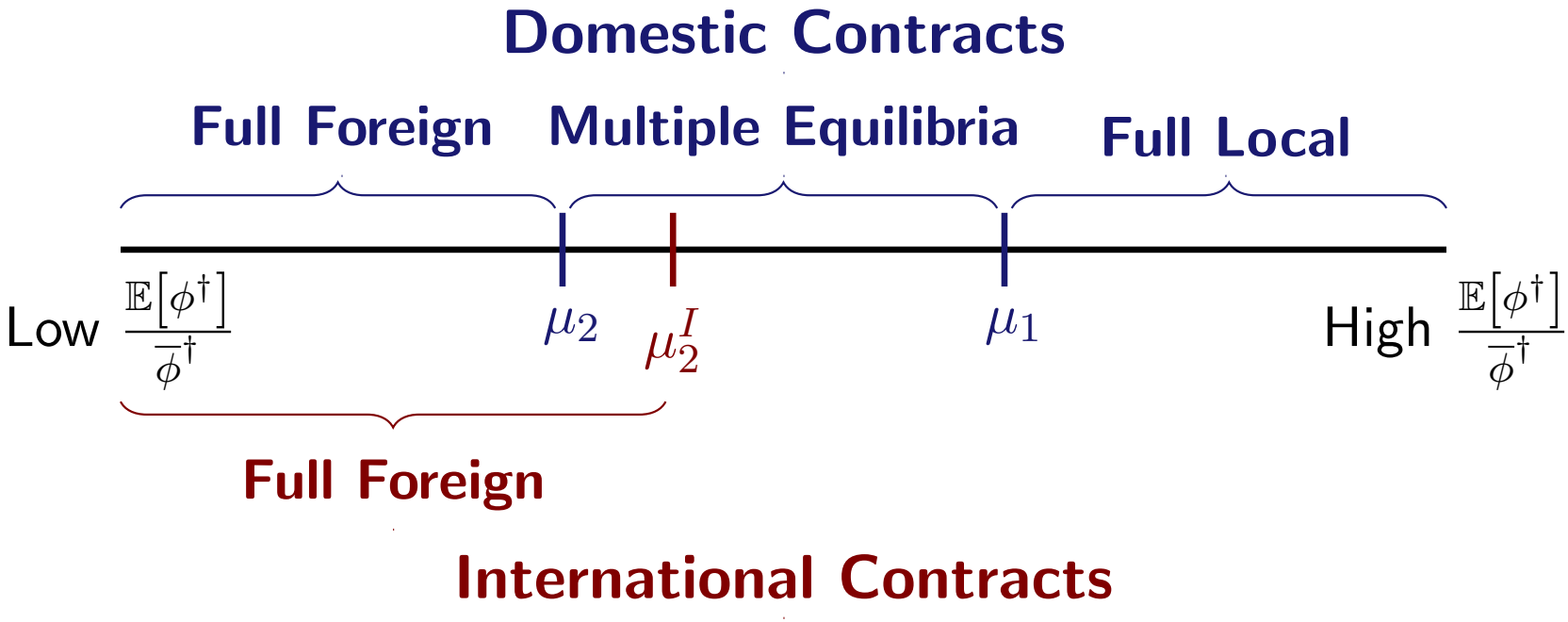
$$\text{Participation Const.:} \quad -x_i + \mathbb{E}\theta_{js} \left(\phi_i b_{ii} + \phi_j b_{ij} + \phi_f b_{if} \right) \geq 0$$

$$\text{Payments Feasibility:} \quad \phi_i b_{ii} + \phi_j b_{ij} + \phi_f b_{if} \leq y \quad \forall \phi_i, \phi_j, \phi_f$$

- Government of country i maximizes utility of its citizens only

$$\phi_i = \phi_i^\dagger + \frac{1}{\psi} \left(\theta_{is} B_{ji} - \theta_{ib} B_{ii} \right)$$

CE in Economy with International Contracts

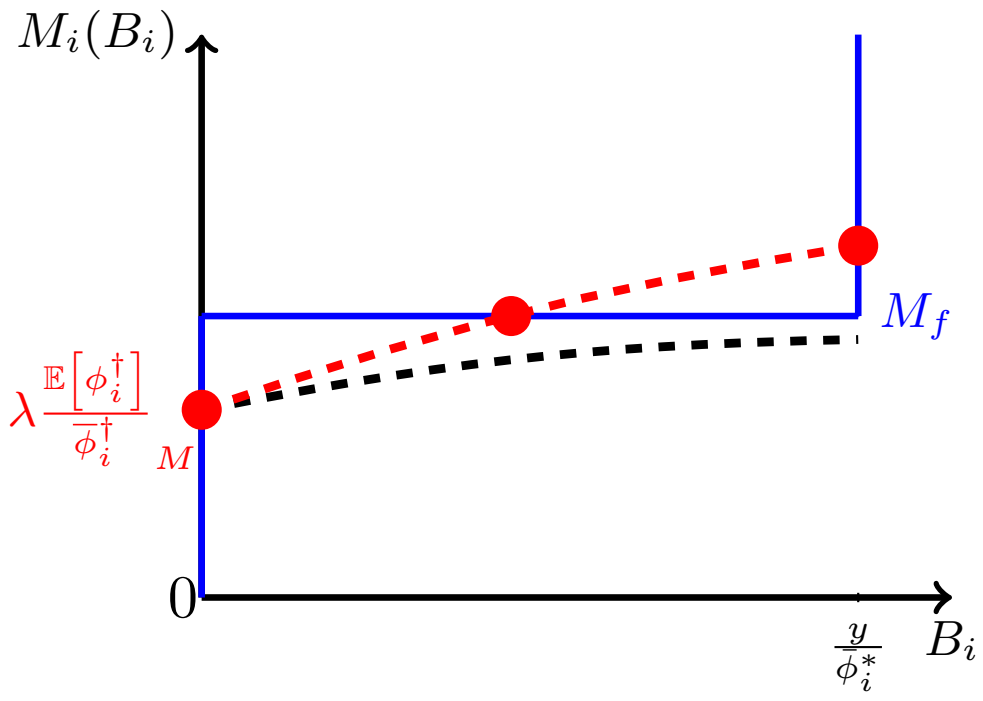


CE in Economy with International Contracts

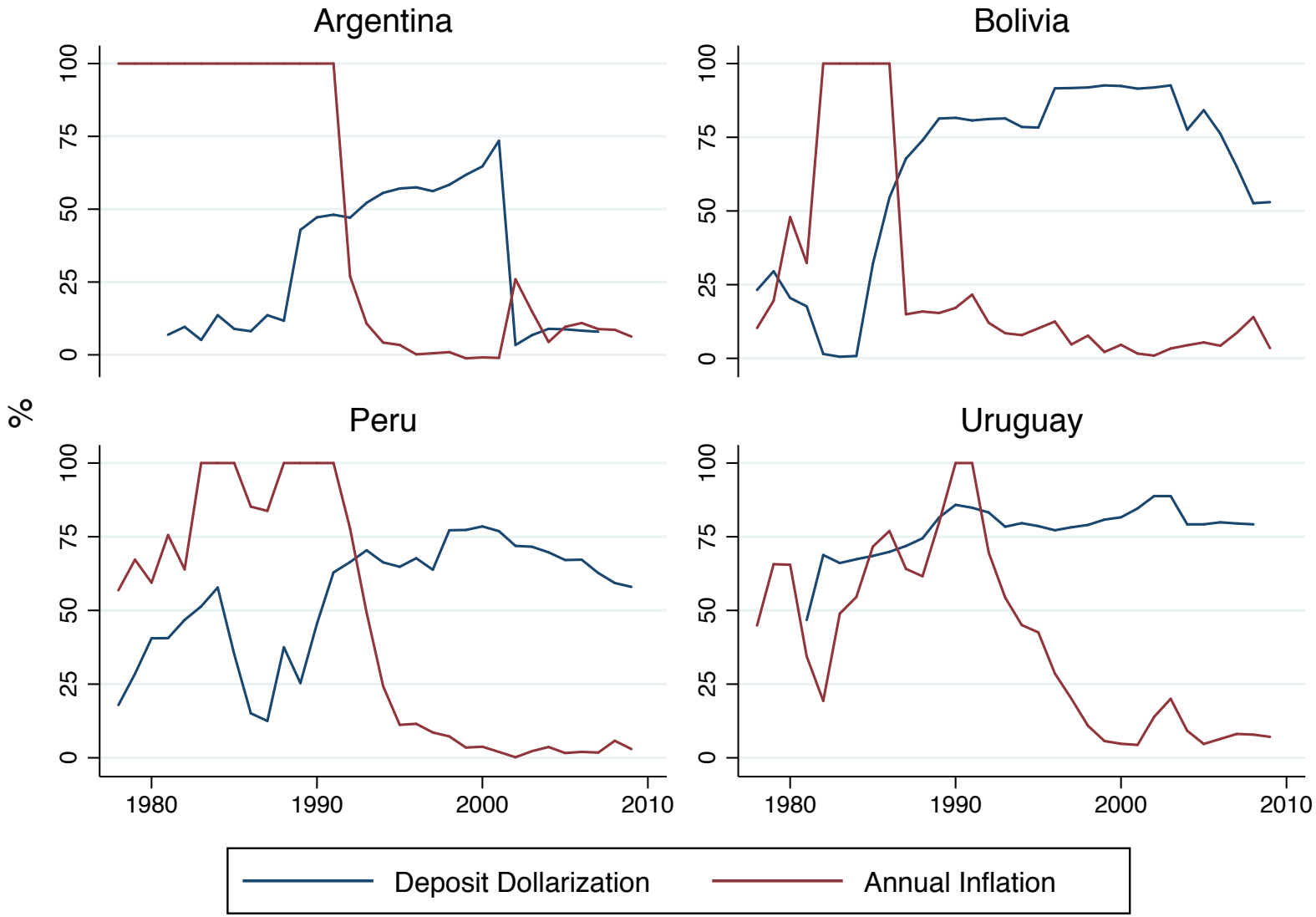
- Government's ability to provide insurance is undermined

$$\underbrace{\text{cov}\left(\left(\theta_{js}\left(1+\lambda\right)-\theta_{ib}\right),\frac{\phi_i}{\bar{\phi}_i}\right)}_{\textbf{International Contract}} < \underbrace{\text{cov}\left(\left(\theta_{is}\left(1+\lambda\right)-\theta_{ib}\right),\frac{\phi_i}{\bar{\phi}_i}\right)}_{\textbf{Domestic Contract}}$$

$$\phi_i = \phi_i^{\dagger} + \frac{1}{\psi}\left(\theta_{is}-\theta_{ib}\right)B_i \qquad \phi_i = \phi_i^{\dagger} + \frac{1}{\psi}\left(\theta_{is}-\theta_{ib}\right)B_i$$



Hysteresis in Dollarization



Back

Hysteresis in Model with Credit Chains

- Buyers endowed with y and claims $\hat{b}_l, \hat{b}_f$
  - Currency claims from prior contract in which buyer was seller
- Optimal contract for the buyer solves

$$\max_{x\geq 0, b_l \geq 0, b_f \geq 0} (1+\lambda)x + \mathbb{E}\left[\theta_b \left(y - (b_l - \hat{b}_l)\phi_l - (b_f - \hat{b}_f)\phi_f\right)\right]$$

subject to

Participation Const.: $x \leq \mathbb{E}\left[\theta_s (b_l \phi_l + b_f \phi_f)\right]$

Payments Feasibility: $y \geq (b_l - \hat{b}_l)\phi_l + (b_f - \hat{b}_f)\phi_f \quad \forall \phi_l, \phi_f$

- Government's problem remains the same
- Additional assumption: $var(\theta)$ not too large

Hysteresis in Model with Credit Chains

Proposition: Optimal contract is given by:

$$\text{if } M_l \geq M_f: \qquad b_l = \hat{b}_l + \frac{y}{\phi_l} \qquad b_f = \hat{b}_f$$

$$\text{if } M_l < M_f: \qquad b_l = \hat{b}_l \qquad b_f = \hat{b}_f + \frac{y}{\phi_f}$$

- Policy risk only determines currency of *new* borrowing flows
- Currency matching of stocks is optimal
  - Allows for more borrowing and provision of special good
  - Leads to path dependence

Model with Fixed Cost of Default

- Same model as before with different cost of default
  - If buyers choose to default, suffer cost $\chi \in \{\chi_L, \chi_H\}$
  - Implies buyers optimally repay when $\phi_l b_l + \phi_f b_f < \chi$
- No taste shocks ($\theta_i = 1$) nor policy risk ($\hat{\phi}_l = \phi_f = 1$)
- Government problem
  - If $\hat{\phi}_l b_l + \phi_f b_f < \chi$, set $\phi_l = \hat{\phi}_l$
  - If not, set ϕ_l to induce repayment as long as

$$\chi > \frac{\psi}{2}\left(\frac{\chi - \phi_f B_f}{B_l} - \hat{\phi}\right)^2$$

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Equilibrium Characterization

Proposition

There exists an eq with full use of FC & another with full use of LC.

If ψ is small enough, aggregate welfare is higher in the one with LC.

- Complementarities btw private and govt actions still in place
  - Higher use of LC makes govt use inflation to avoid default
  - State-contingent inflation makes LC more attractive

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