Optimal Exchange Rate Policy Under Collateral Constraints and Wage Rigidity

Pablo Ottonello

Columbia University

May 19, 2013

Motivation

- During external crises, XR policy in EMs seems to imply choosing "between a rock and a hard place"

  E.g. Policy debate East Asian/Latin American Crises 90s (Fischer (98), Calvo (01), Stiglitz (02)) or
  European Crisis 2008 (Krugman (10), Feldstein (11)) :

  - Fixing XR: unemployment and costly recessionary adjustment
  - Depreciating XR: sizable debt revaluation in terms of income, balance-sheet effects and financial destabilization

- Call this the "credit access – unemployment trade-off "

Motivation

- **Objective**: determine optimal XR policy under this trade-off, combining two branches of literature:

  1. Costs of fixing the XR during crises: unemployment
     Downward Wage Rigidity, as in Schmitt-Grohe-Uribe (11,12)

  2. Costs of Δ the XR during crises: consumption adjustment
     Collat Constraint in terms of tradable and nontradable income, as in Mendoza (02, 05), Arellano and Mendoza (03); Korninek, (11); Bianchi, (11); Benigno et al. (11, 12)

Contribution

- Provide a theoretical justification for credit access – unemployment trade-off
- Show large currency depreciations are in general optimal during financial crises:
  - Welfare gains: first moments (unemployment)
  - Welfare costs: second moments (consumption smoothing)
- Show optimal exchange rate policy is thus consistent with a "managed-floating" exchange rate regime

Outline

- Introduction
- **The Model Economy**
- Exchange Rate Regimes
- Quantitative Analysis
- Exchange Rate vs. Fiscal Devaluations
- Conclusions

Model Setup

- DSGE-SOE model
- Two sectors
  - Tradables: Endowment (y_t^T) / price determined by LOP
  - Nontradables: Production (y_t^N) / Price determined domestic demand and supply
  - Relative price: $p_t = \frac{P_t^N}{E_t}$
- Two departures from standard model
  - Downward nominal wage rigidity

$$W_t \geq \gamma W_{t-1}$$

  - A collateral constraint in the form of tradable and nontradable income

$$d_{t+1.} \leq \kappa \left(y_t^T + p_t y_t^N \right)$$

Households

- Household Problem:

$$Max_{\left\{c_t^T, c_t^N, d_{t+1}\right\}} E_0 \sum_{t=0}^{\infty} \beta^t U\left(A\left(c_t^T, c_t^N\right)\right) \tag{1}$$

$$s.t. \frac{d_{t+1.}}{R_t}\left(1-\tau_t^d\right) \geq d_t + c_t^T + p_t c_t^N - \left(y_t^T + w_t h_t + \Pi_t\right) - T_t$$

$$d_{t+1} \leq \kappa\left(y_t^T + w_t h_t + \Pi_t\right)$$

$$d_{t+1} \leq d^N$$

with $A\left(c^T, c^N\right) = \left[a\left(c^T\right)^{1-\frac{1}{\xi}} + (1-a)\left(c^N\right)^{1-\frac{1}{\xi}}\right]^{\frac{\xi}{\xi-1}}$

- Note: Assumes households supply $\overline{h}$ inelastically and take $h_t \leq \overline{h}$ as given.

Households

- First-order conditions:

$$U_c A_T\left(c_t^T, c_t^N\right) R_t^{-1}\left(1-\tau_t^d\right) = \beta \mathbb{E}_t U_c A_T\left(c_{t+1}^T, c_{t+1}^N\right) + \mu_t + \eta_t,$$

$$\left(\frac{1-a}{a}\right)\left(\frac{c_t^T}{c_t^N}\right)^{\frac{1}{\xi}} = p_t$$

- Complementary slackness conditions:

$$\mu_t \geq 0, \mu_t\left(\kappa\left(y_t^T + w_t h_t + \Pi_t\right) - d_{t+1}\right) = 0,$$

$$\eta_t \geq 0, \eta_t\left(d^N - d_{t+1}\right) = 0.$$

Nontradable Firms

- Nontradable Firms Problem:

$$Max_{\{h_t\}}\Pi_t = p_t F\left(h_t\right) - w_t h_t$$

- First-order condition:

$$p_t F'\left(h_t\right) = w_t.$$

Labor Market

- Labor Market:
  - Nominal Wage Rigidity:

$$\begin{aligned} W_t &\geq \gamma W_{t-1} \\ w_t &\geq \gamma \frac{w_{t-1}}{\in_t} \end{aligned}$$

  - Labor constraint

$$h_t \leq \overline{h}$$

  - Slackness condition

$$\left(w_t - \gamma \frac{w_{t-1}}{\in_t} \right) \left(\overline{h} - h_t \right) = 0$$

Government

- Balance budget each period:

$$\frac{d_{t+1.}}{R_t}\tau_t^d = T_t$$

- Policy instruments: $\left\{\tau_t^d, \in_t\right\}$

- Will characterize and compare exchange rate policy regimes (optimal, full-employment, peg) under optimal capital control tax policy

Market Clearing and Equilibrium

- Market clearing for nontradable goods:

$$c_t^N = F\left(h_t\right)$$

- Resource constraint:

$$\frac{d_{t+1.}}{R_t} = d_t + c_t^T - y_t^T$$

- Collateral Constraint:

$$d_{t+1.} \leq \kappa \left(y_t^T + \left(\frac{1-a}{a} \right) \left(c_t^T\right)^{\frac{1}{\xi}} F\left(h_t\right)^{\frac{\xi-1}{\xi}} \right) \equiv \overline{d}\left(h_t, c_t^T, y_t^T\right)$$

General Equilibrium Dynamics

Processes $c_t^T, d_{t+1}, h_t, p_t, w_t, \mu_t, \eta_t$ satisfying (GE):

$$d_{t+1.}R_t^{-1} = d_t + c_t^T - y_t^T,$$

$$U_c A_T\left(c_t^T, F(h_t)\right) R_t^{-1}\left(1-\tau_t^d\right) = \beta \mathbb{E}_t U_c A_T\left(c_{t+1}^T, F(h_{t+1})\right) + \mu_t + \eta_t,$$

$$p_t = \left(\frac{1-a}{a}\right)\left(\frac{c_t^T}{F(h_t)}\right)^{\frac{1}{\xi}},$$

$$d_{t+1.} \leq \kappa\left(y_t^T + p_t F\left(h_t\right)\right); d_{t+1} \leq d^N,$$

$$\mu_t \geq 0, \mu_t\left(\kappa\left(y_t^T + p_t F\left(h_t\right)\right) - d_{t+1.}\right) = 0, \eta_t \geq 0, \eta_t\left(d^N - d_{t+1.}\right) = 0,$$

$$w_t = p_t F'\left(h_t\right),$$

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t},\ h_t \leq \overline{h},\ \left(w_t - \gamma\frac{w_{t-1}}{\epsilon_t}\right)\left(\overline{h} - h_t\right) = 0$$

given the exogenous processes y_t^T and R_t, an exchange rate policy ϵ_t, a capital control policy τ_t^d and initial conditions w_{-1} and d_0.

Outline

- Introduction
- The Model Economy
- **Exchange Rate Regimes**
- Quantitative Analysis
- Exchange Rate vs. Fiscal Devaluations
- Conclusions

Optimal Exchange Rate Policy

- (OP) *Optimal exchange rate regime with optimal capital control tax:* Processes $\left\{\in_t, \tau_t^d\right\}$ that max HH lifetime utility (1) s.t. the set of equations describing the competitive dynamics (GE).

$$V\left(y_t^T, R_t, d_t\right) = \max_{d_t, c_t^T, h_t} \left[\begin{array}{c} U\left(A\left(c_t^T, F\left(h_t\right)\right)\right) + \\ \beta E_t V\left(y_{t+1}^T, R_{t+1}, d_{t+1}\right) \end{array} \right]$$

$$\begin{aligned} s.t. \frac{d_{t+1}}{R_t} &= d_t + c_t^T - y_t^T \\ h_t &\leq \overline{h} \\ d_{t+1} &\leq \kappa\left(y_t^T + \left(\frac{1-a}{a}\right)\left(c_t^T\right)^{\frac{1}{\xi}} F\left(h_t\right)^{\frac{\xi-1}{\xi}}\right) \\ d_{t+1} &\leq d^N \end{aligned}$$

Optimal Exchange Rate Policy, Unemployment and Credit Limit

Proposition

Under the optimal exchange rate policy with optimal capital control tax the following conditions hold at all dates and states:

- *if* $\xi < 1$, $\left(\overline{h} - h_t\right)\left(\overline{d}\left(h_t, c_t^T, y_t^T\right) - d_{t+1}\right) = 0$,
- *if* $\xi \geq 1$, $h_t = \overline{h}$.

The Credit Access - Unemployment Trade-off

XR policy in this economy may face a "credit access – unemployment trade-off:"

1. employment and credit market access are two independent welfare objectives

2. exchange rate policy might imply a tension between these two objectives:
   - nominal XR depreciation, under binding wage rigidity reduces unemployment.
   - real XR depreciation decreases the value of nontradable output in units of tradables.
   - if the price effect (real exchange rate depreciation) dominates the quantity effect (employment increase), an exchange rate depreciation can decrease the collateral value and make the credit limit tighter

The Credit Access - Unemployment Trade-off

Proposition

If $\xi < 1$, given an initial state $\left(y_t^T, R_t, d_t\right)$, for any debt level d_{t+1}^* with associated tradable consumption $c_t^{T*} = \left(d_{t+1}^* R_t^{-1} - d_t + y_t^T\right) > 0$ for which $d_{t+1}^* > \overline{d}\left(\overline{h}, c_t^{T*}, y_t^T\right)$, there exists a level of employment $h_t^* \in \left(0, \overline{h}\right)$ for which $d_{t+1}^* = \overline{d}\left(h_t, c_t^{T*}, y_t^T\right)$.

Evidence Intratemporal Elasticity of Substitution

- ξ key parameter: determines existence of trade-off
  - If $\xi < 1$: price effect (real XR depreciation) associated with increasing h_t dominates the quantity effect.
  - $\Longrightarrow$ XR depreciation decrease the collateral value
- Wide empirical support for $\xi < 1$
  - Stockman and Tesar (1995): $\widehat{\xi} = 0.44$.
  - Mendoza (1995): $\widehat{\xi} = 0.74$ in DC, $\widehat{\xi} = 0.43$ EMs.
  - EMs, Gonzalez-Rozada et al. (2004) $\widehat{\xi} \in [0.4, 0.48]$ for Argentina, Lorenzo et al. (2005), $\widehat{\xi} \in [0.46, 0.75]$ for Uruguay.
- All referenced studies that calibrate of a two sector SOE, use $\xi \in [0.44 - 0.83]$

The Credit Access - Unemployment Trade-off

Key difference with previous literature that studies exchange rate policy under nominal rigidities and financial frictions:

1. credit access is relevant only insofar as it affects output.
   discussion"exchange rate depreciations are expansionary or contractionary.
   Cespedes et al. (04), Aghion et al.(01), Braggion et al. (09)

2. 'divine coincidence': increase in employment does not affect or helps improve credit access
   Cespedes et al. (04), Fornaro (2012)

Exchange Rate Regimes

- (FE) *Full-employment exchange rate regime with optimal capital control tax:* Processes $\left\{\in_t, \tau_t^d\right\}$ that max HH lifetime utility (1) s.t. the set of equations describing the competitive dynamics (GE) and FE constraint:

$$h_t = \overline{h}$$

- (CP) *Fixed exchange rate regime with optimal capital control tax:* Processes $\left\{\in_t, \tau_t^d\right\}$ that max HH lifetime utility (1) s.t. the set of equations describing the competitive dynamics (GE) and currency peg constraint:

$$\epsilon_t = 0$$

Outline

- Introduction
- The Model Economy
- Exchange Rate Regimes
- **Quantitative Analysis**
- Exchange Rate vs. Fiscal Devaluations
- Conclusions

Calibration

- Functional forms

$$U(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

$$F(h) = h^{\alpha}$$

- Annual frequency, to match Argentinean data

Calibration

- Stochastic Process:
  - Assume $\begin{bmatrix} \ln\left(y_t^T\right) \\ \ln\left(\frac{R_t}{R}\right) \end{bmatrix} = \Phi \begin{bmatrix} \ln\left(y_{t-1}^T\right) \\ \ln\left(\frac{R_{t-1}}{R}\right) \end{bmatrix} + \varepsilon_t$
  - Estimation for Argentina 1983-2011

$$\widehat{\Phi} = \begin{bmatrix} 0.42 & -0.28 \\ 0.32 & 0.93 \end{bmatrix}; \ \widehat{\Omega} = \begin{bmatrix} 0.002 & -0.001 \\ -0.001 & 0.001 \end{bmatrix}; \ \widehat{R} = 1.113$$

  - Discretize process using 15 equally spaced points estimate the transition probability matrix with method proposed by Tauchen (1986).

Calibration

- Set of parameter values used:

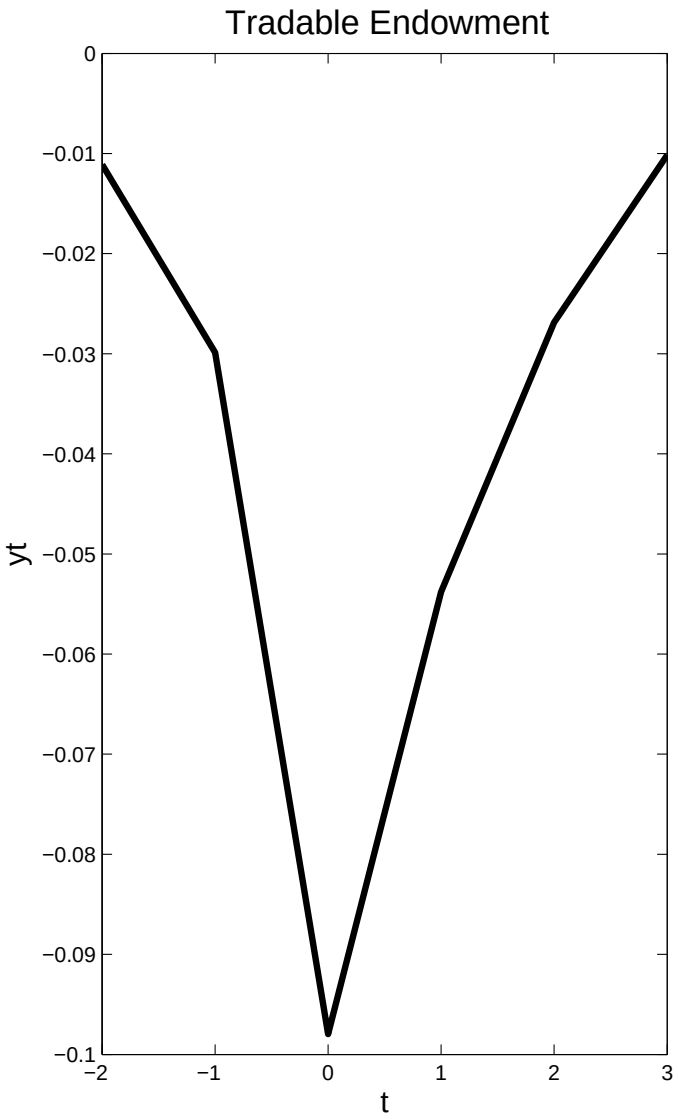
Parameter	Value	Description
σ	2	Inv intertemporal elasticity of subst
ξ	0.44	Intratemporal elasticity of substitution
a	0.28	Share of tradables
β	0.8	Annual subjective discount factor
κ	0.263	Share of income used as collateral
α	0.75	Labor share of the nontradable sector
γ	0.96	Degree of downward nominal rigidity

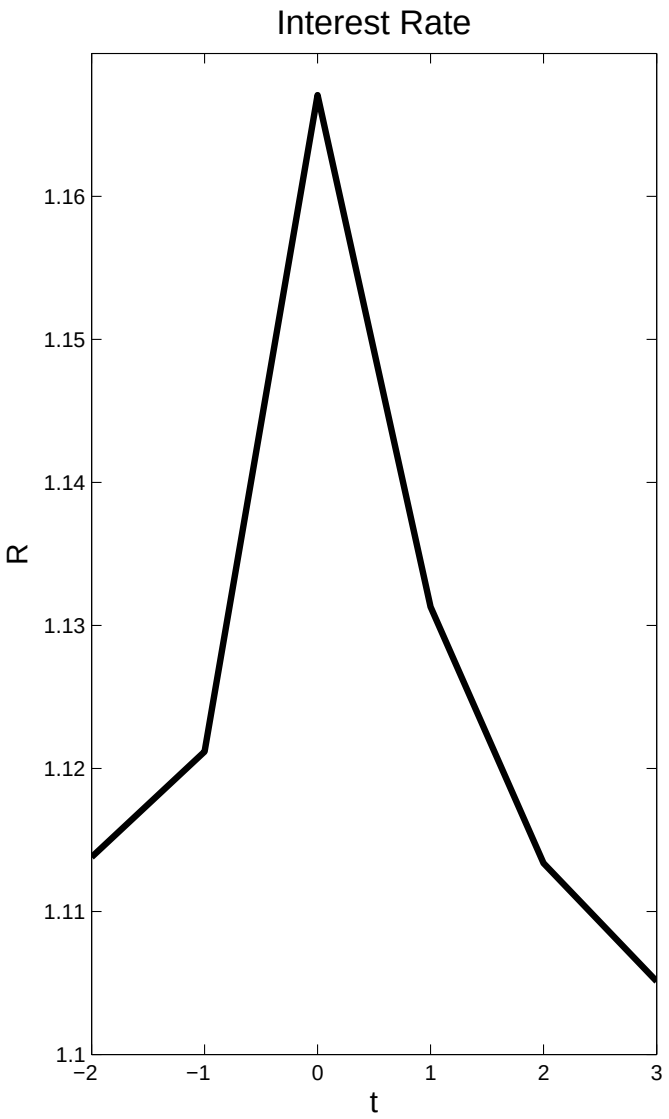
- Calibration strategy:
  - $\{\xi, \alpha, \gamma\}$: empirical evidence in previous literature for Argentina
  - $\{\beta, a, \kappa\}$: target historical averages 1975-2011 for Argentina (debt/GDP, share of tradables, and frequency of sudden stops)

Optimal Exchange Rate Policy: Financial Crises

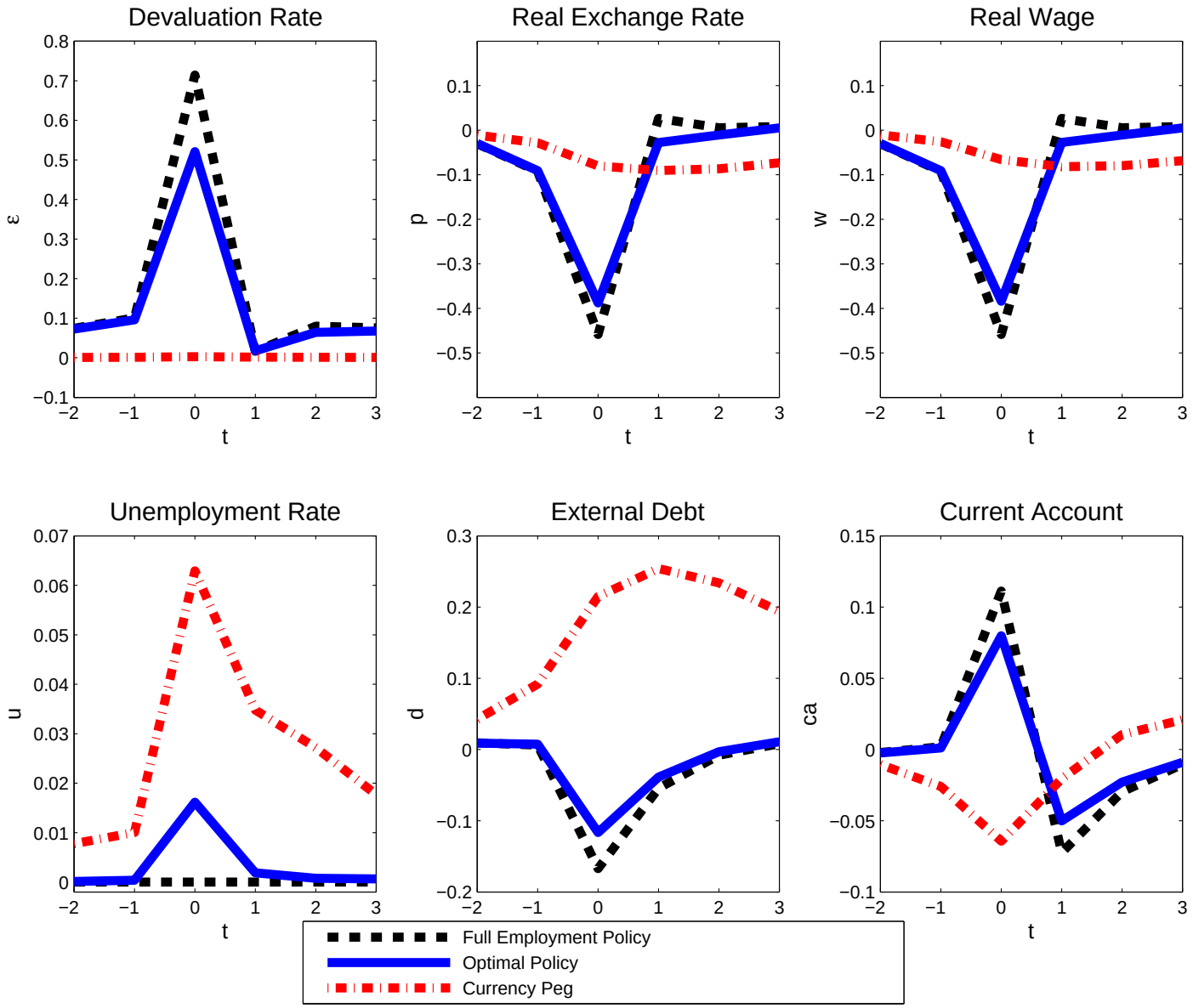
- Financial Crisis = episode in which collateral constraint binds for one or more consecutive periods
- Event study of Financial Crises:
  - Simulate model and identify periods in which the collateral constr is binding under the optimal XR policy.
  - Average the response of variables during all episodes .

Financial Crises: Exogenous Variables

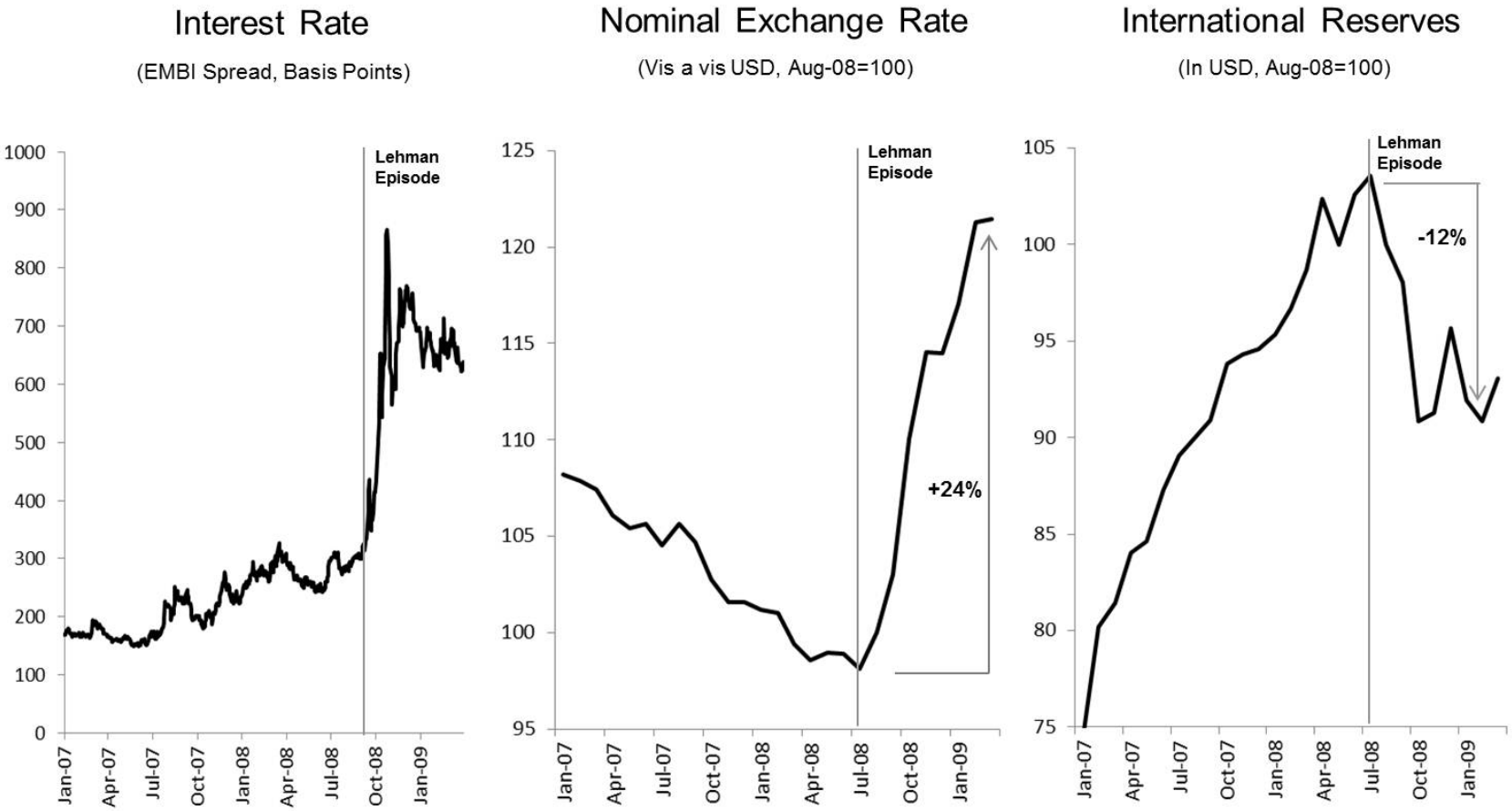




Financial Crises: Endogenous Variables



Exchange Rate Policy in EMs: Lehman Financial Turmoil



Welfare Costs by Exchange Rate Regime

Welfare Cost of:	FE	CP	CP
with respect to:	OP	OP	FE
Mean	0.006	0.833	0.827
Standard Deviation	0.024	0.694	0.695
Maximum	3.0	7.115	7.113
Minimum	0.001	0.001	−1.71

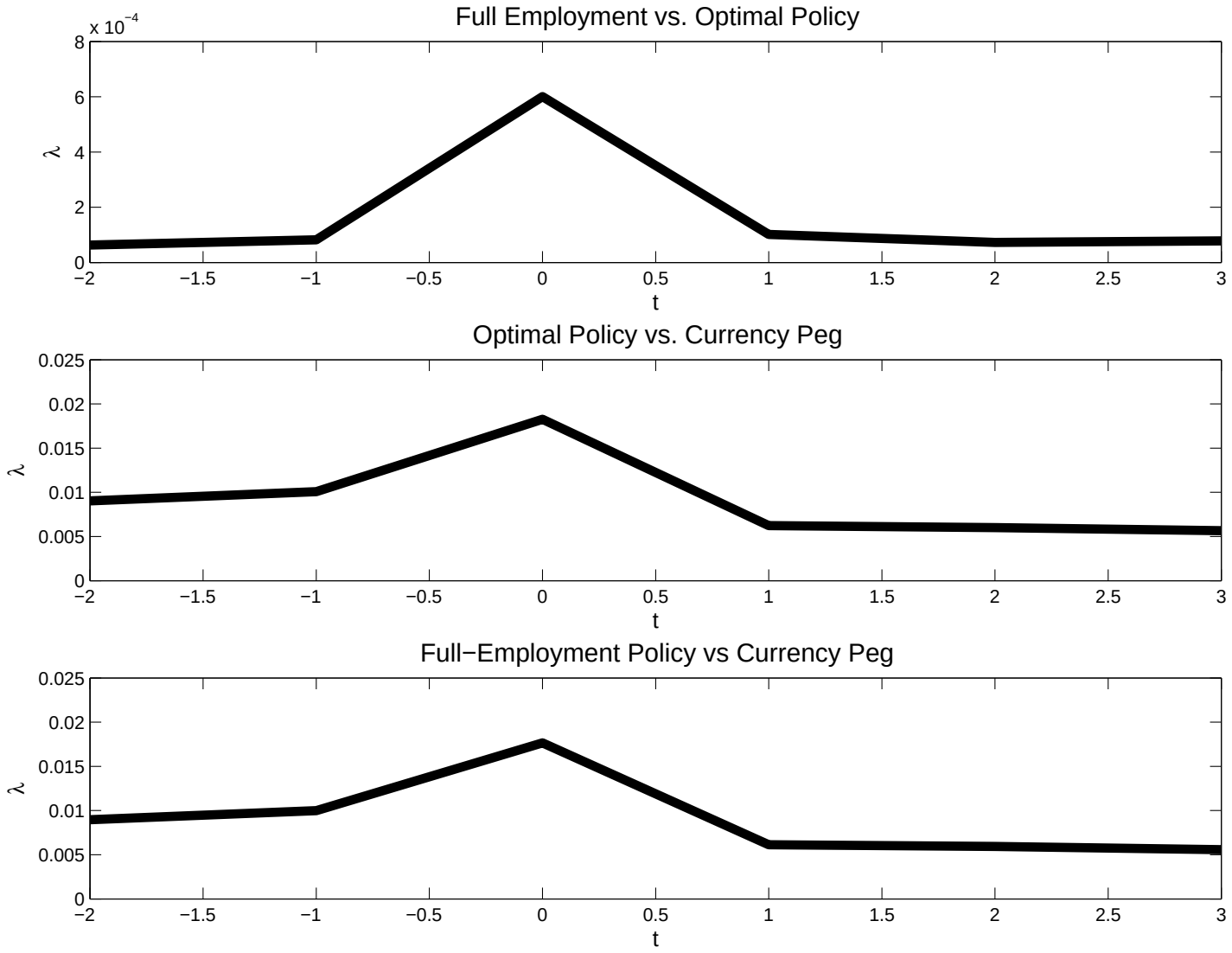
Note: Unconditional moments were computed in respective ergodic distributions. OP, FE and CP denote optimal exchange rate regime, full-employment exchange rate regime and currency peg respectively

First and Second Moments by Exchange Rate Regime

	Mean			Standard Deviation		
	OP	FE	CP	OP	FE	CP
c	0.98	0.98	0.98	0.0286	0.0289	0.030
c^T	0.94	0.94	0.95	0.083	0.084	0.058
c^T	1.00	1.00	0.99	0.004	0.000	0.023
p	2.09	2.09	2.16	0.407	0.414	0.253
$\overline{h} - h$ (%)	0.04	0.0	0.8	0.5	0.0	2.9
d	0.64	0.64	0.52	0.04	0.04	0.12

Note: Unconditional moments were computed in respective ergodic distributions. OP, FE and CP denote optimal exchange rate regime, full-employment exchange rate regime and currency peg respectively

Welfare Costs During Financial Crises



Outline

- Introduction
- The Model Economy
- Exchange Rate Regimes
- Quantitative Analysis
- **Exchange Rate vs. Fiscal Devaluations**
- Conclusions

Fiscal Devaluations

- Motivated by peripheral European debt crises part of the related literature has focused on fiscal alternatives to exchange rate devaluations (e.g. Farhi, Gopinah, Itskhoki (11), Schmitt-Grohe and Uribe (11)).

- Key result in this literature in the presence of collateral constraints is the form of tradable and nontradable income is obtained in Benigno et al (2012):
  using taxes on nontradable or tradable goods, the social planner can achieve the unconstrained first-best.

- Similar result can be obtained in this model economy, even under a currency peg

Fiscal Devaluations

- Assume that the social planner has access to a tax on nontradable goods, τ_t^N.
- Households' sequential budget constraint is now given by:

$$\frac{d_{t+1.}}{R_t}\left(1-\tau_t^d\right)=d_t+c_t^T+p_t\left(1+\tau_t^N\right)c_t^N-\left(y_t^T+w_t h_t+\Pi_t\right)-T_t$$

- From this, the equilibrium condition that is modified in the system of equations (GE) is:

$$p_t=\frac{1}{1+\tau_t^N}\left(\frac{1-a}{a}\right)$$

Fiscal Devaluations

Proposition

Define the unconstrained first-best solution as processes $\left\{d_{t+1}^{*}, c_t^{T*}, h_t^{*}\right\}$ that solve

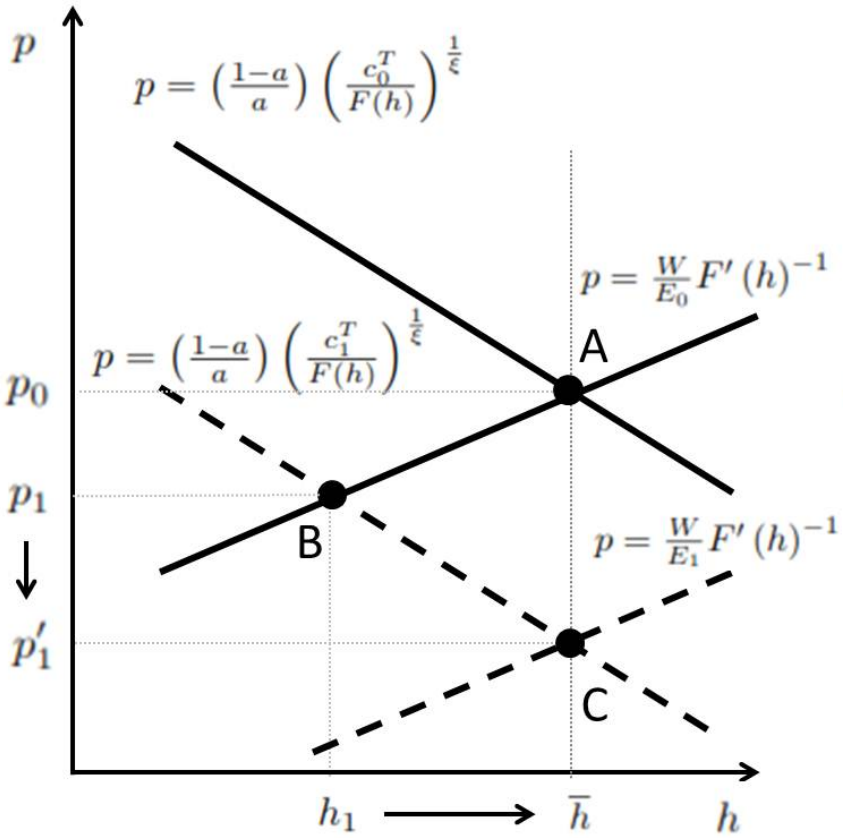
$$Max_{\left\{d_{t+1}, c_t^T, h_t\right\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(A\left(c_t^T, F\left(h_t\right)\right)\right)$$

$$\begin{aligned} s.t.\ \frac{d_{t+1}}{R_t} &= d_t + c_t^T - y_t^T, \\ h_t &\leq \overline{h}, \\ d_{t+1} &\leq d^N. \end{aligned}$$

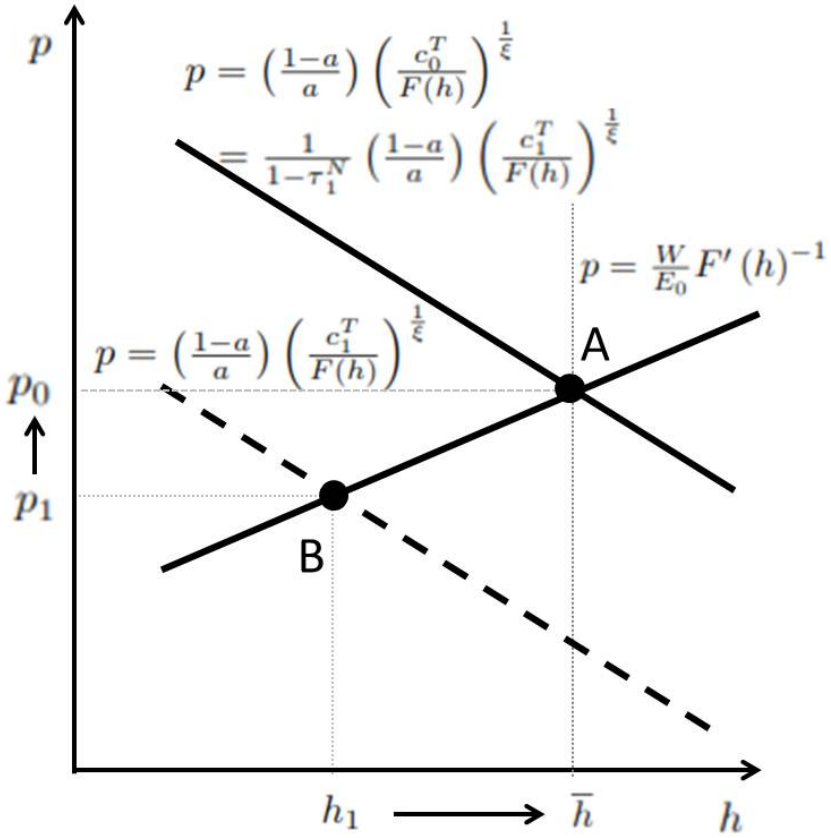
In an economy defined by (GE)' and (CP), there exists a tax policy $\left\{\tau_t^{N*}, \tau_t^{d*}\right\}$ that decentralizes the unconstrained first-best solution.

Exchange Rate vs. Fiscal Devaluations

i. Exchange Rate Devaluation



ii. Fiscal Devaluation



Outline

- Introduction
- The Model Economy
- Exchange Rate Regimes
- Quantitative Analysis
- Exchange Rate vs. Fiscal Devaluations
- **Conclusions**

Conclusions I

- This paper fills the gap in the literature between downward nominal wage rigidities and collateral constraints in the form of tradable and nontradable output
- Optimal exchange rate policy always allows for large real exchange rate depreciations.
  - welfare gains of resisting real exchange rate depreciation are related to second moments (a lower consumption volatility),
  - welfare costs of resisting real exchange rate are related to first moments (a higher average unemployment rate)
- "Sudden Stops" (i.e. large current account adjustments), are an optimal reaction of exchange rate policy to negative external shocks

Conclusions II

- During financial crises, while the optimal nominal exchange rate depreciation is large (52 percent on average), it is smaller than that which achieves full-employment (71 percent on average).
- This helps rationalize "managed-floating" exchange rate regimes, widely used by emerging economies in periods of Sudden Stops.
- During periods in which the collateral constraint does not bind, optimal exchange rate policy always achieves full-employment. This highlights the role of prudential policies.