Reserve Accumulation, Growth and Financial Crisis

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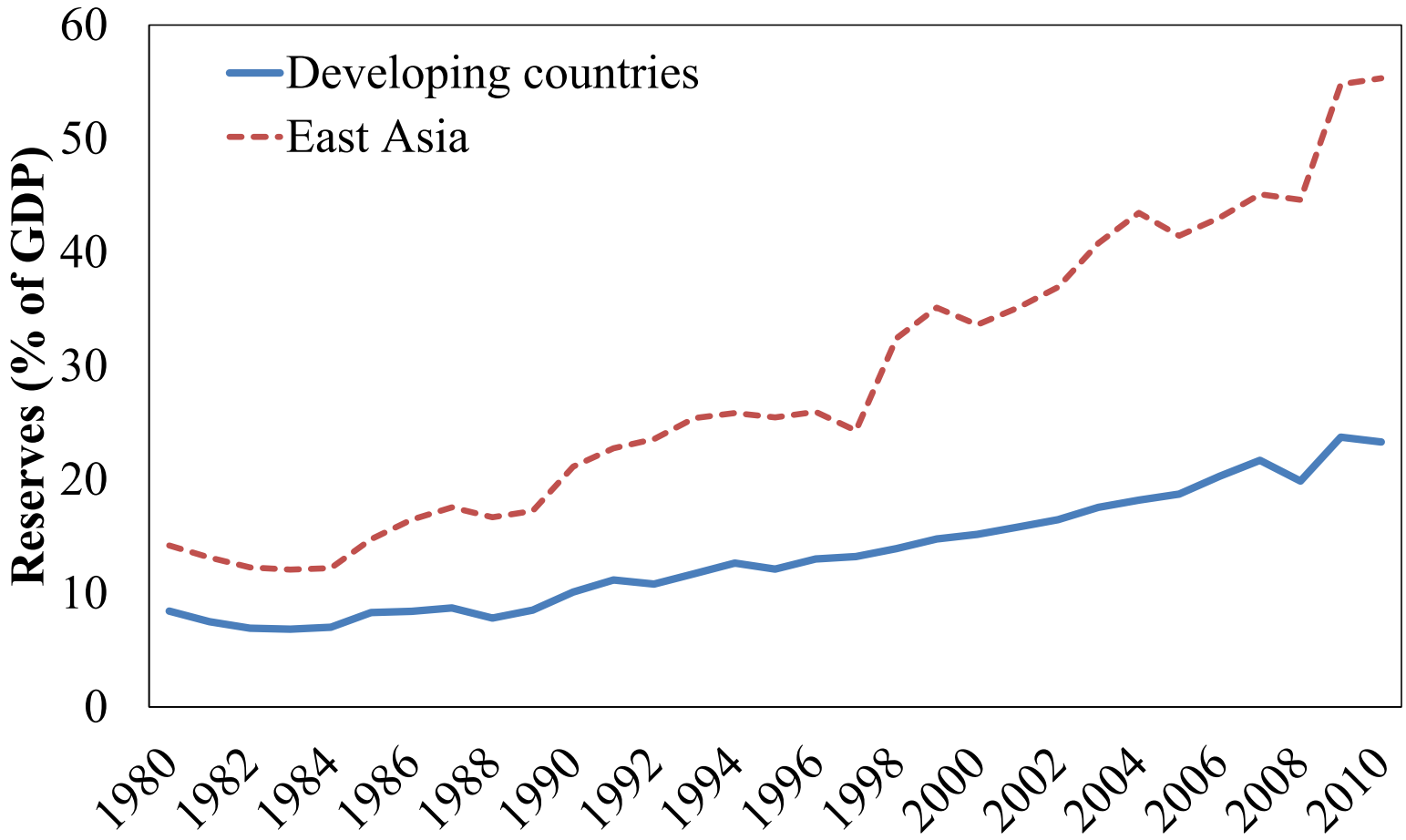
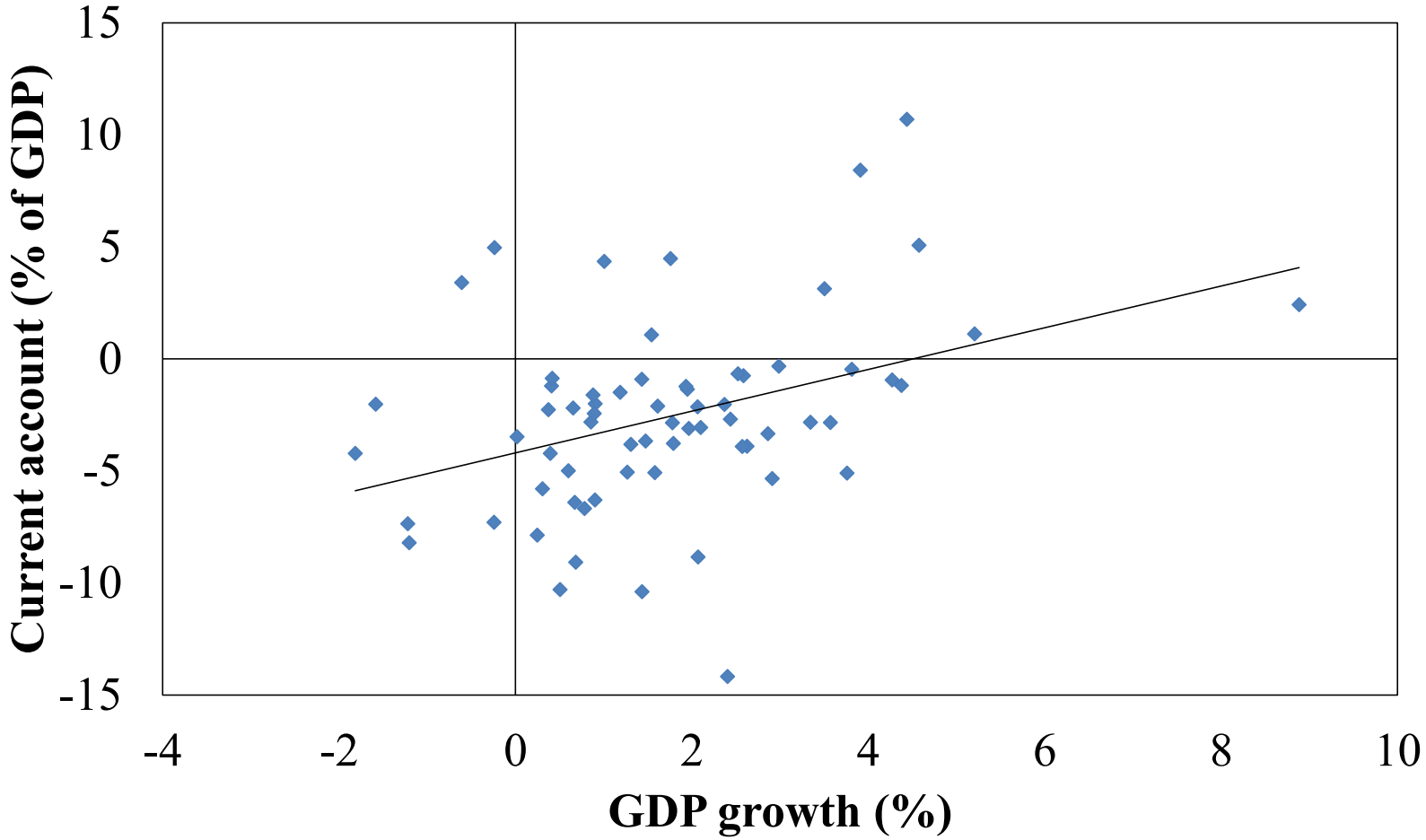
Motivation

- Spectacular accumulation of foreign exchange reserves by developing countries
- Fast growing developing countries tend to run current account surpluses

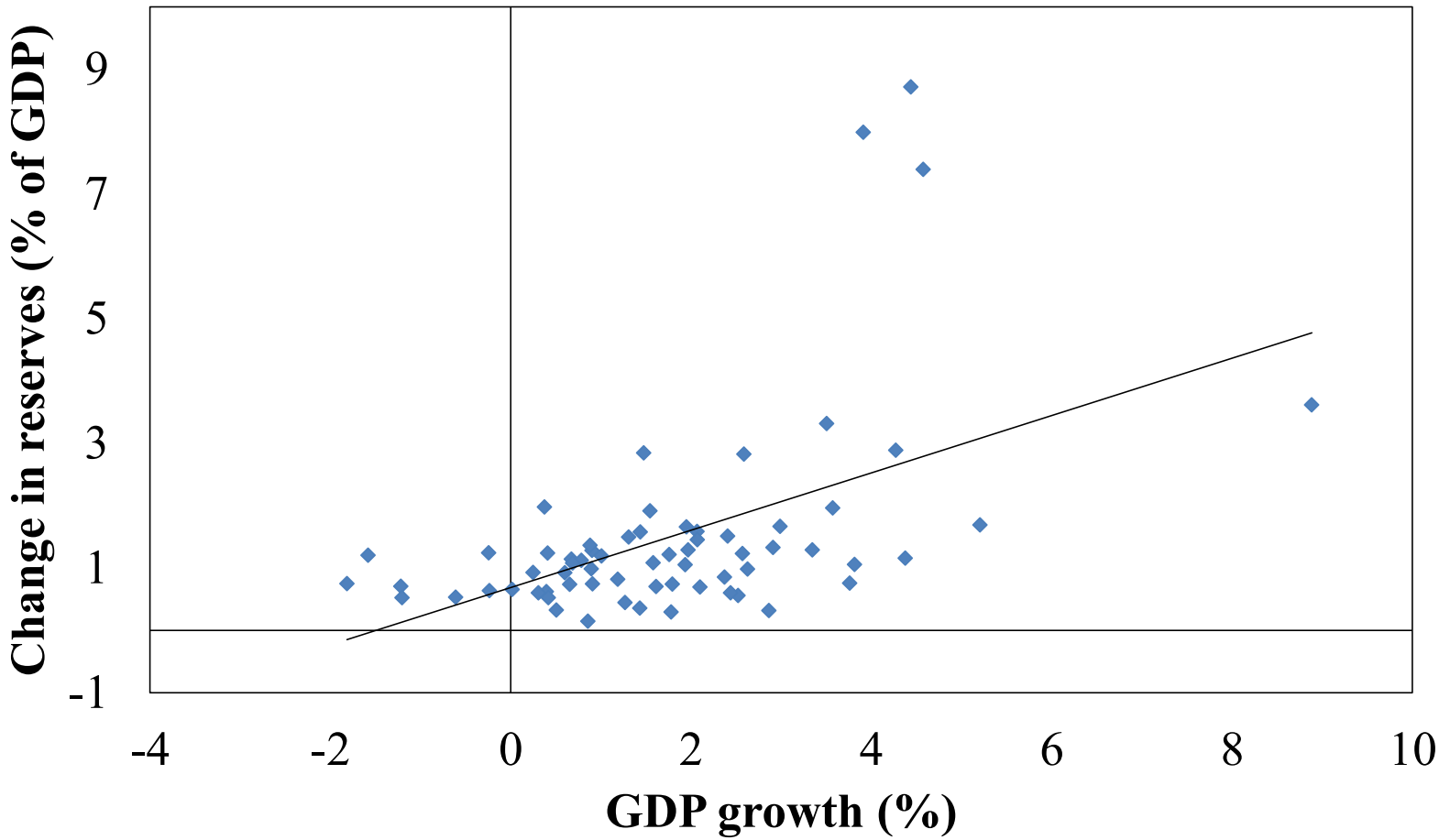
Reserve accumulation in developing countries



GDP growth and current account (1980-2010)



GDP growth and reserve accumulation (1980-2010)



The allocation puzzle

- These facts are hard to reconcile with the neoclassical growth model
- In the neoclassical growth model:
  - Faster growth is associated with higher capital inflows
  - The competitive equilibrium is efficient, hence no role for public intervention in capital flows
- Allocation puzzle, as dubbed by Gourinchas and Jeanne (2011)

Our contribution

- We build an open economy endogenous growth model that explains these facts
- Key elements:
  - Learning by importing externality in the tradable sector
  - Occasionally binding international borrowing constraint
- The combination of these two elements provides a powerful incentive for the government to accumulate reserves in order to stimulate growth

Our contribution (cont'd)

- Foreign technology discoveries spill over to the domestic economy through the imports of intermediate goods
- Knowledge is non-rival and non-excludable: inefficiently low imports of foreign intermediates by producers of tradable goods
- Reserve management can be used to overcome this inefficiency:
  - 1. Accumulation of reserves is associated with exchange rate undervaluation and higher production of tradables
  - 2. Reserves can be used to mitigate the impact of financial constraints on imports of intermediate goods

Key findings

- Reserve management is a second best policy
- Government intervention induces a positive correlation between reserve accumulation, current account surpluses and growth
- The welfare gains from an appropriate reserve policy are substantial (in the order of a 1 percent permanent increase in consumption in our baseline calibration)

Related literature on reserve accumulation

- **Insurance motive**: Durdu et al. (2010), Jeanne and Ranciere (2011)
- **Growth motive**: Dooley et al. (2003), Aizenman and Lee (2007), Rodrik (2009), Korinek and Serven (2010)

Plan of the talk

- Model
- Explanation of the mechanisms
- Reserve management in an economy opening to capital flows
- Welfare

Model

- Small open economy
- Two sectors: tradable and non-tradable
- Households, firms, foreign investors, government

Households

- Expected lifetime utility

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma}}{1-\gamma} \right] \tag{1}$$

- Consumption aggregator

$$C_t = \left(C_t^T\right)^{\omega} \left(C_t^N\right)^{1-\omega} \tag{2}$$

- Supply inelastically one unit of labor during each period
- Budget constraint

$$C_t^T + P_t^N C_t^N = W_t + \Pi_t^T + \Pi_t^N \tag{3}$$

Households (cont'd)

- Optimality conditions

$$\frac{\omega C_t^{1-\gamma}}{C_t^T} = \lambda_t \tag{4}$$

$$\frac{(1-\omega) C_t^{1-\gamma}}{C_t^N} = \lambda_t P_t^N \tag{5}$$

- Real exchange rate

$$P_t^N = \frac{1-\omega}{\omega} \frac{C_t^T}{C_t^N} \tag{6}$$

Firms: tradable sector

- Produce using labor L_t^T, imported inputs M_t and knowledge X_t

$$Y_t^T = \left(X_t L_t^T\right)^{\alpha_T} M_t^{1-\alpha_T} \tag{7}$$

- Dividends

$$\Pi_t^T = Y_t^T - W_t L_t^T - P^M M_t - B_{t+1} + RB_t - T_t \tag{8}$$

- Firms maximize

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \lambda_t \Pi_t^T\right] \tag{9}$$

Working capital

- Working capital requirement: a fraction ϕ of the imported inputs has to be paid before production takes place
- Government provides D_t intraperiod loans to finance working capital
- The rest has to be financed through intraperiod loans from foreign investors

$$\phi P^M M_t - D_t \tag{10}$$

- We assume a zero interest rate on intraperiod loans

Borrowing constraint

- At the end of the period each firm can default on its debts
- In case of default foreign investors recover $\hat{K}_t$
- To prevent defaults foreign investors impose the borrowing limit

$$\underbrace{-RB_t}_{\text{bonds at the start of period } t} + \underbrace{\phi P^M M_t - D_t}_{\text{intratemporal loan at time } t} \leq \hat{K}_t \qquad (11)$$

- Binding borrowing constraint interferes with:
  - Consumption smoothing
  - Import of intermediate goods

Borrowing constraint (cont'd)

- The borrowing limit depends on two components

$$\hat{K}_t = \kappa_t X_t \tag{12}$$

- κ_t is a stochastic component capturing shocks to the availability of foreign credit

- The term X_t ensures that the economy has a balanced growth path

Knowledge accumulation

- Knowledge evolves according to

$$X_{t+1} = \psi X_t + M_t^{\xi} X_t^{1-\xi} \tag{13}$$

- This is meant to capture spillovers of foreign knowledge through the imports of intermediate goods
- ξ determines the elasticity of the stock of knowledge with respect to M_t (we calibrate it using the estimates of Coe et al. 1997)
- ψ determines the average growth rate of the stock of knowledge
- Externality: since knowledge is non-excludable firms do not internalize the impact of their actions on the future stock of knowledge

Firms: non-tradable sector

- Produce using labor L_t^N

$$Y_t^N = \left(L_t^N\right)^{\alpha_N} \tag{14}$$

- Dividends

$$\Pi_t^N = P_t^N Y_t^N - W_t L_t^N \tag{15}$$

- Optimality condition

$$\alpha_N P_t^N L_t^{N\alpha_N - 1} = W_t \tag{16}$$

Government

- Collects taxes from firms in the tradable sector T_t, provides working capital loans D_t to firms and trades in foreign exchange reserves FX_t
- Loss from liquidity provision during crises: $D_t\theta/(1-\theta)$
- Budget constraint

$$FX_{t+1} = R^{FX} FX_t + T_t - D_t \frac{\theta}{1-\theta} \tag{17}$$

- Reserves cannot be negative ($FX_{t+1} \geq 0$) and pay an interest rate not greater than the one on private bonds ($R^{FX} \leq R$)
- Intervention during crises cannot exceed the start-of-period stock of reserves

$$\frac{D_t}{1-\theta} \leq R^{FX} FX_t \tag{18}$$

Market clearing

- Tradable good

$$C_t^T = Y_t^T - P^M M_t - B_{t+1} + RB_t - FX_{t+1} + R^{FX} FX_t - \frac{\theta}{1-\theta} D_t \quad (19)$$

- Non-tradable good

$$C_t^N = Y_t^N \quad (20)$$

- Labor

$$L_t^T + L_t^N = 1 \quad (21)$$

Intervention during tranquil times

- When firms are not financially constrained M_t is decreasing in the real exchange rate P_t^N

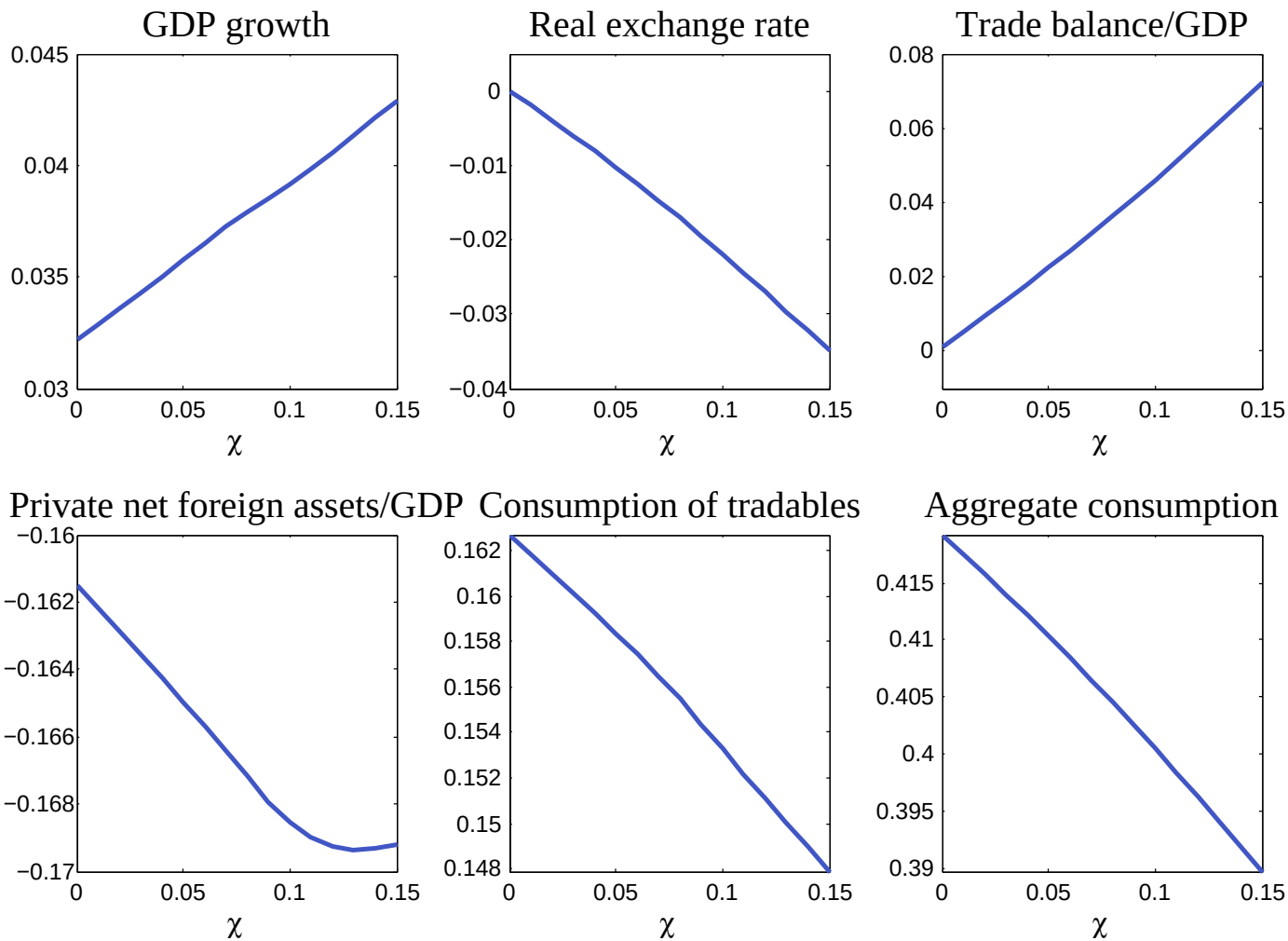
$$M_t = \left(\frac{1-\alpha_T}{P^M}\right)^{\frac{1}{\alpha_T}} X_t \left[1 - \left(\frac{\alpha_N}{\alpha_T}\frac{P_t^N}{X_t}\left(\frac{P^M}{1-\alpha_T}\right)^{\frac{1-\alpha_T}{\alpha_T}}\right)^{\frac{1}{1-\alpha_N}}\right]$$

- Increasing the stock of reserves leads to a real exchange rate depreciation and to an increase in M_t

$$P_t^N = \frac{1-\omega}{\omega}\frac{Y_t^T - P^M M_t - B_{t+1} + RB_t - FX_{t+1} + R^{FX} FX_t}{C_t^N}$$

- Focus on reserve accumulation rules of the form $T_t = \chi Y_t^T$

Intervention during tranquil times ($T_t = \chi Y_t^T$)



Intervention during crises

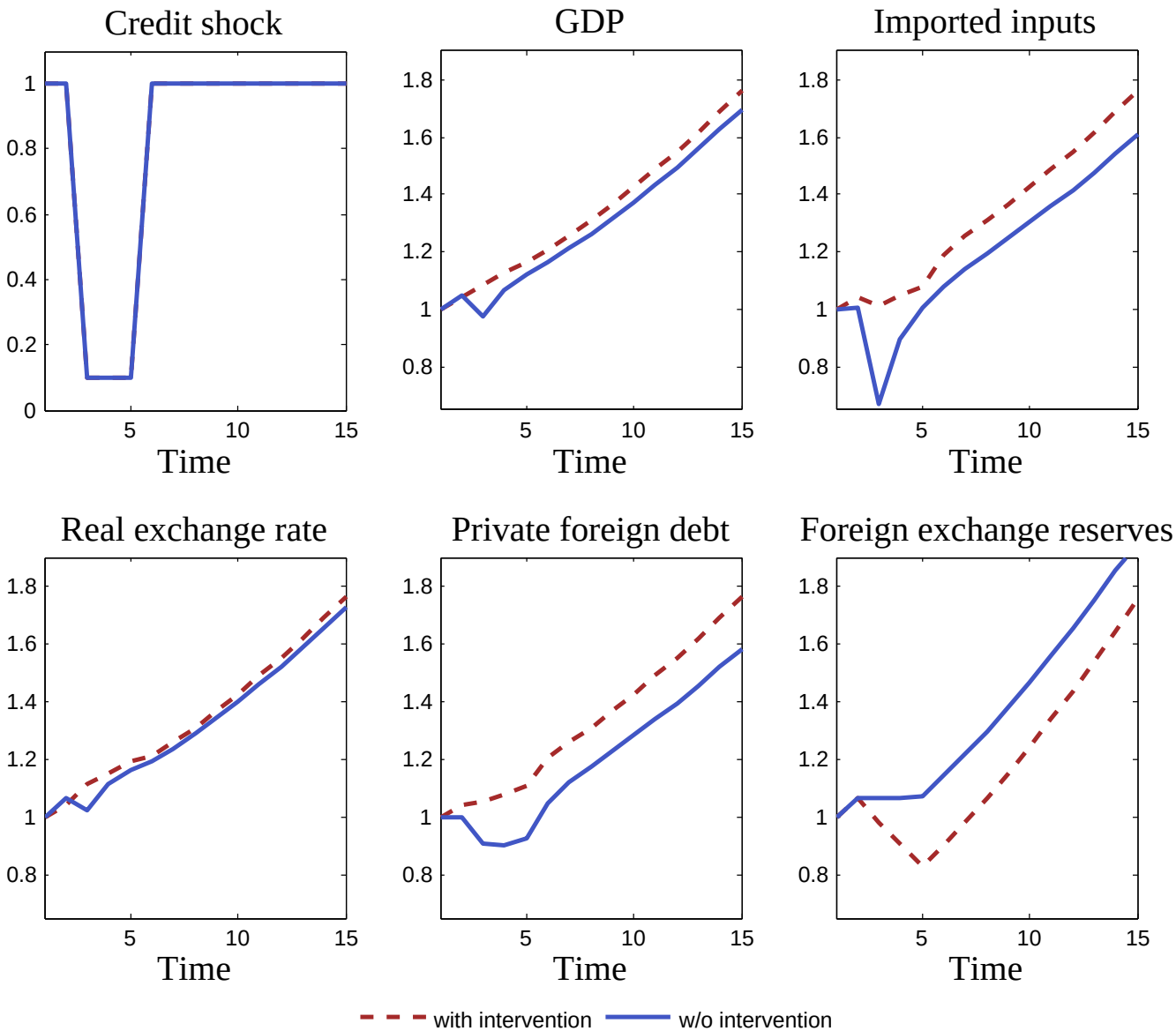
- When firms are financially constrained

$$M_t = \frac{X_t \kappa_L + RB_t + D_t}{\phi P^M}$$

- Government can increase the use of imported inputs by using foreign exchange reserves to finance working capital

- We assume that the government uses at most a fraction χ^{WK} of its stock of reserves to finance working capital

Intervention during crises (cont'd)



Policy intervention and financial liberalization

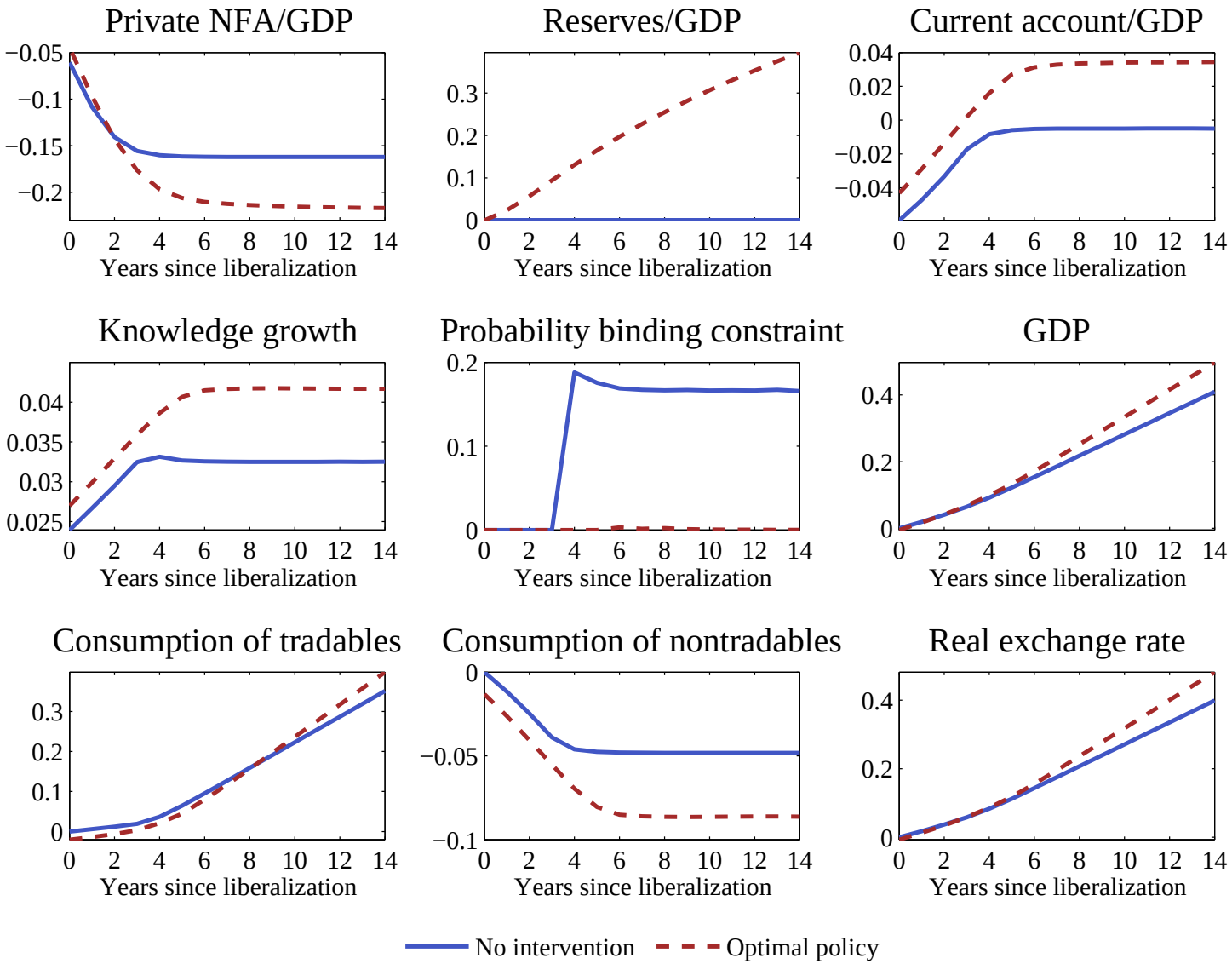
- To illustrate the properties of the model we look at the impact of policy on an economy that it is opening to capital flows (i.e. $B_0 = FX_0 = 0$)
- 1. We look at the effect on growth and capital flows by comparing an economy without intervention to one with the optimal policy rule ($\chi = 0.09$, $\chi^{WK} = 1$)
- 2. We compute the welfare gains from policy intervention
- We assume two possible realizations for the credit shock $k_H > k_L$

Calibration

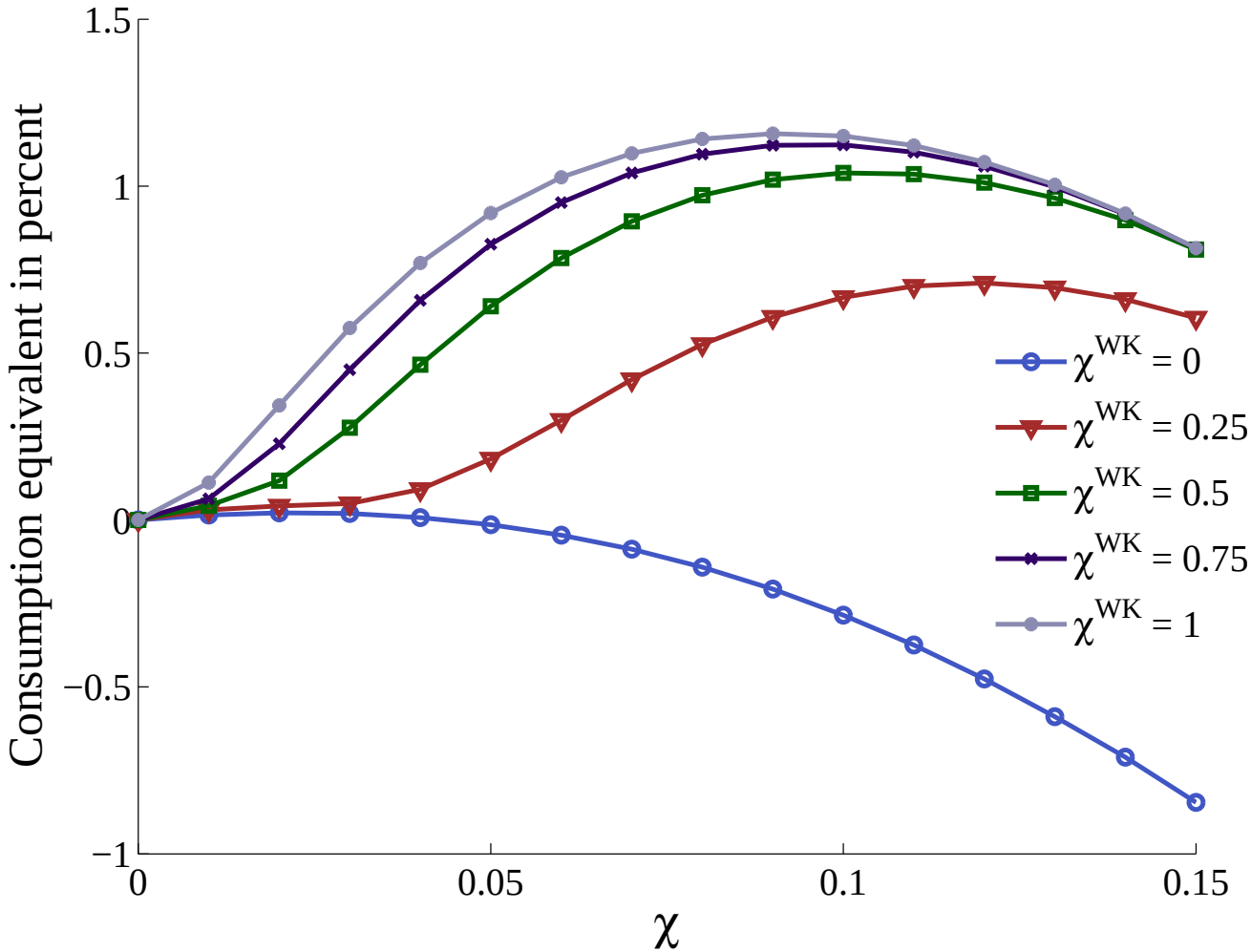
Table 1: Parameters

Parameter	Symbol	Value
Risk aversion	γ	2
Interest rate on private borrowing	R	1.04
Discount factor	β	$1/R$
Labor share in output in tradable sector	α_T	0.65
Labor share in output in non-tradable sector	α_N	0.65
Share of tradable goods in consumption	ω	0.341
Price of imported inputs	P^M	1
Borrowing limit	κ_L	0.1
Probability of bad credit shock	$1-\rho_H$	0.1
Probability of exiting bad credit shock	$1-\rho_L$	0.5
Working capital coefficient	ϕ	0.33
Elasticity of TFP w.r.t. imported inputs	ξ	0.15
Constant in knowledge accumulation process	ψ	0.34
Interest rate on reserves	R^{FX}	1
Efficiency of government intervention during crises	θ	0.5

Reserve management, growth and capital flows



Welfare


1.5
1
0.5
0
−0.5
−1
0
0.05
0.1
0.15
χ
Consumption equivalent in percent
χ^WK = 0
χ^WK = 0.25
χ^WK = 0.5
χ^WK = 0.75
χ^WK = 1

Conclusions

- We provide a novel framework able to reproduce the positive correlation between reserve accumulation, current account surplus and growth observed in the data

- Future research:
  - Interaction between reserve management and capital controls
  - Global imbalances and reserve accumulation