# Output Concerns and Precautionary Savings in Emerging Markets' Debt and Reserve Accumulation

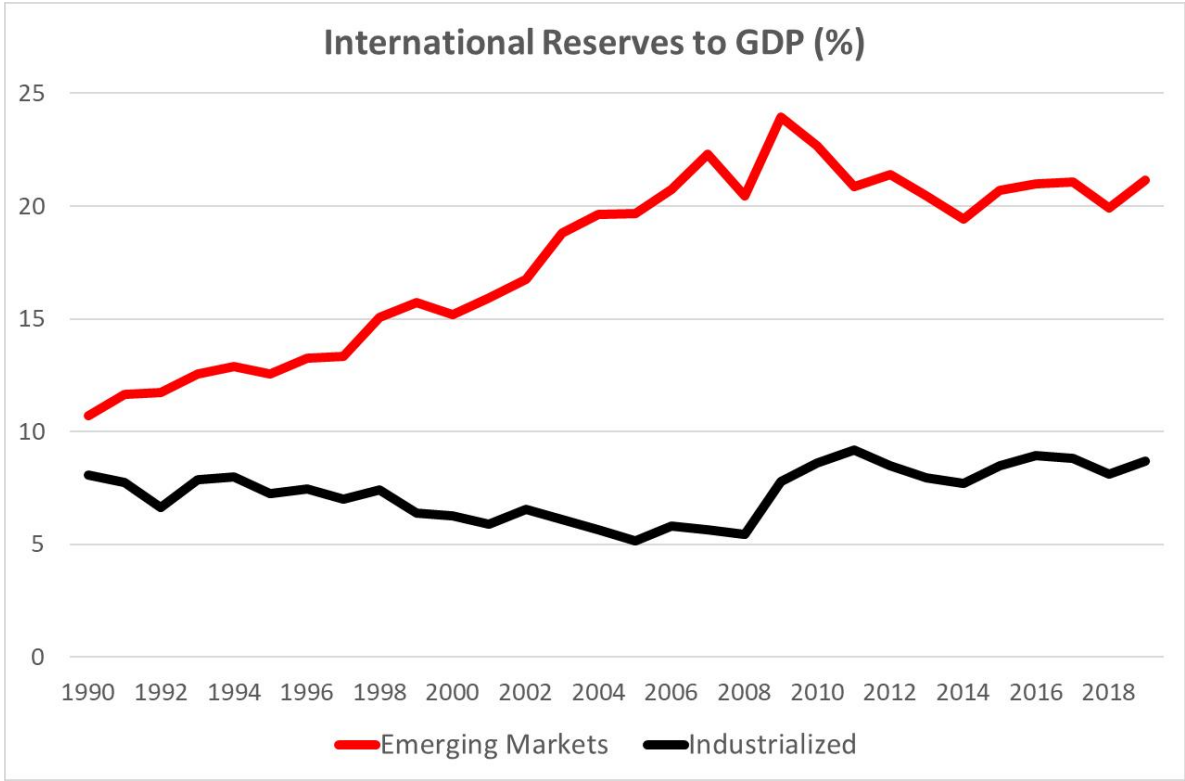
Sang Seok Lee

Bilkent University

November 28, 2022

# This paper

- With Refet Gürkaynak, Paul Luk[1] and Ju Hyun Pyun




- Governments of many emerging market countries have built up large international reserves in the past two decades. Why?
  - Output concerns such as mercantilism, export-led growth, etc.
  - Precautionary savings against sudden stops

[1] The usual disclaimer applies.

# This paper

- Both mercantilistic and self-insurance motives studied for 24 emerging market countries with a SOE-DSGE model
  - Both motives matter!
  - Important to model debt, international reserves, and the real interest rate jointly
- Outline:
  - Provide empirical evidence for the two motives
  - Propose a SOE model that includes these features and enables a joint analysis of debt, reserves, and the real interest rate
    - A bridge towards future fully microfounded models
  - Conduct various quantitative analyses based on the estimated models

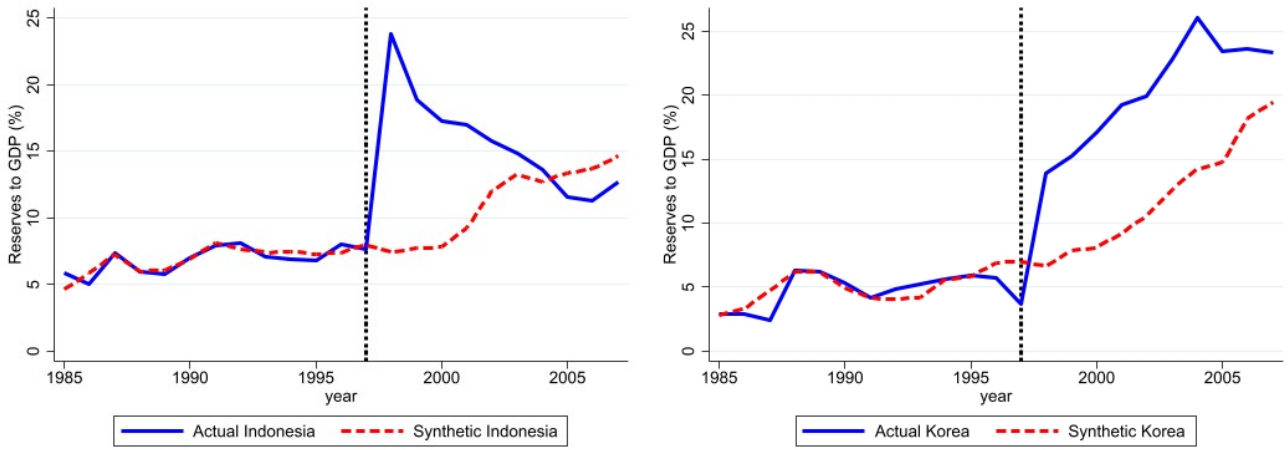
# A brief literature review

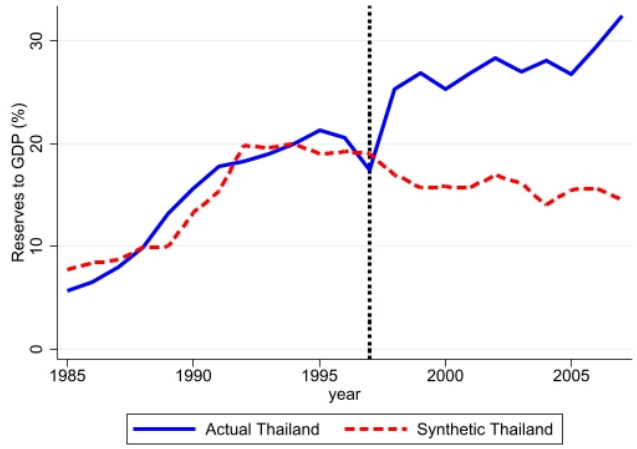
- Mercantilism: Dooley et al. (2003), Benigno and Fornaro (2012), Korinek and Serven (2016), Choi and Taylor (2017), Bergin et al. (2022)
- Self-insurance: Jeanne (2007), Durdu et al. (2009), Jeanne and Ranciere (2011), Calvo et al. (2012), Hur and Kondo (2016), Bianchi et al. (2018), Alfaro and Kanczuk (2019)
- Joint analysis: Aizenman and Lee (2007), Ghosh et al. (2017)
- Our model-based approach allows clearer separation of different channels of international reserve accumulation

# Evidence for precautionary motives

- Q: Is it an increase in (perceived) sudden stop risk that has led to significantly higher levels of international reserves?
- Need to identify an event that is clearly associated with a revision in the risk assessment which is challenging
  - Data limitations, the lack of clear timing for an event of interest, etc.
- The countries that experienced the AFC in 1997 can serve as a useful laboratory because no major crisis until the AFC
  - We focus on Indonesia, Korea, and Thailand which suffered heavily during the AFC
- We use the synthetic control method (Abadie and Gardeazabal, 2003) to estimate the counterfactuals

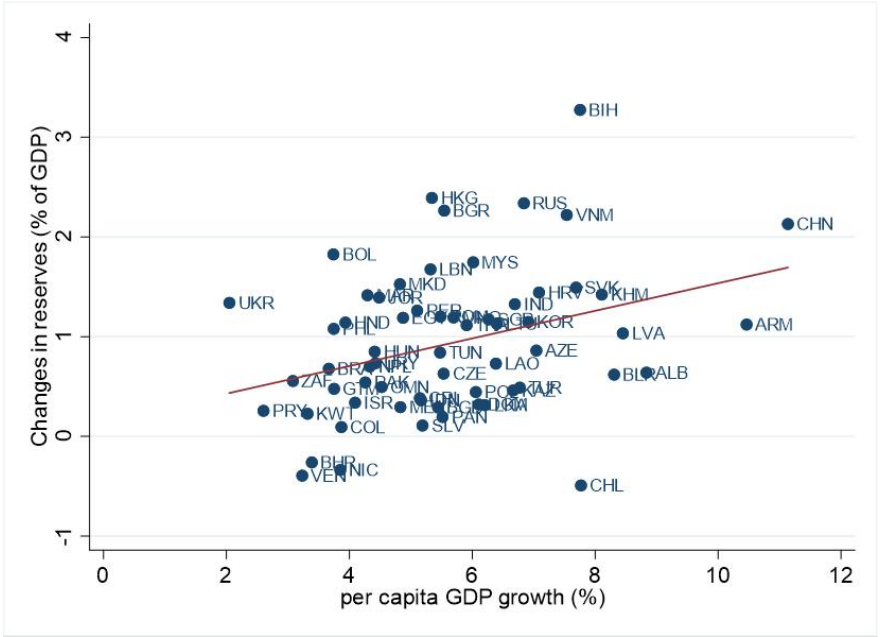
# Evidence for precautionary motives




- The AFC "caused" the persistent increase in international reserves thereafter (additional evidence in the paper)

# Evidence for output externalities




- Output externalities: a catch all for output effects of international reserves different from precautionary motives
- Reduced-form evidence (à la Benigno and Fornaro, 2012)
  - A positive and highly statistically significant relationship between economic growth and reserve accumulation
  - Faster-growing countries are net exporters of (public) capital (Gourinchas and Jeanne, 2011)

# Model: sudden stops

- A simple SOE-DSGE model whose key mechanisms are regime shifts, output externalities, and an interest rate premium
- In modeling crises, we recognize that
  1. potential crises are reflected in managing the economy during normal times and
  2. crises happen abruptly in emerging market countries
- Let $\Delta_t = 0$ denote a normal time and $\Delta_t = 1$ a crisis. The transition law for $\Delta_t$ is given by the Markov chain

$$\Pi = \begin{bmatrix} \pi_{00} & 1 - \pi_{00} \\ 1 - \pi_{11} & \pi_{11} \end{bmatrix}$$

  - Exogenous regime shifts
  - A crisis is a sudden stop where output is reduced and borrowing from international capital markets is hampered
  - A standard model: $\Delta_0 = 0$ and $\pi_{00} = 1$

# Model: total output

- Total output:

$$Y_t^{Tot} = Y_t + (1 - \Delta_t) v_t$$

where

$$\log Y_{t+1} = \Delta_t \theta^Y + \rho^Y \log Y_t + \sigma^Y \epsilon_{t+1}^Y$$

$$v_t = f(S_t)$$

  - With $\theta^Y < 0$, entering the crisis regime ($\Delta_t = 1$) reduces output endowment $Y_{t+1}$ (mean shift)
  - $v_t = f(S_t)$ stands for the output externalities from international reserves $S_t$
    - Present only during normal times ($\Delta_t = 0$)
    - We consider variety of functional forms that can accommodate curvature/sign shifts (more on this below)

# Model: real interest rate

- Domestic real interest rate:

$$r_t = r^* + rpre_t$$

where

$$rpre_t = \varphi_0 \left( e^{\varphi_D(\frac{D_t}{Y_t} - \bar{d}) - \varphi_S(\frac{S_t}{Y_t} - \bar{s}) + \varphi_{DS}(\frac{D_t}{Y_t} - \bar{d})(\frac{S_t}{Y_t} - \bar{s})\Delta_t} - 1 \right)$$

  - $r^*$ is the risk-free world real interest rate, $rpre_t$ is the interest rate premium, $D_t$ is debt, and $S_t$ is international reserves
    - Empirically grounded (Edwards, 1984; Gümüş, 2011)
  - $\varphi_0$ governs the overall degree of financial frictions (zero premium if $\varphi_0 = 0$) and $\varphi_D$, $\varphi_S$, and $\varphi_{DS}$ are elasticities
  - Setting $\varphi_D = Y_t = 1$ and $\varphi_S = \varphi_{DS} = 0$ gives Schmitt-Grohe and Uribe's (2003) premium function
- We provide the microfoundation for the premium function by modeling lenders in international capital markets

# Model: real interest rate

$$rpre_t = \varphi_0 \left( e^{\varphi_D(\frac{D_t}{Y_t} - \bar{d}) - \varphi_S(\frac{S_t}{Y_t} - \bar{s}) + \varphi_{DS}(\frac{D_t}{Y_t} - \bar{d})(\frac{S_t}{Y_t} - \bar{s})\Delta_t} - 1 \right)$$

- The relative sizes of $\varphi_D$ and $\varphi_S$ are crucial for the model behavior
  - The co-movement between debt and reserves
  - The determinacy properties (by limiting incentives to over-accumulate debt and reserves)
- A sudden stop enters the interest rate premium through the last term in the exponent
  - Triggered upon entering a crisis ($\Delta_t = 1$) and spikes the premium if $\varphi_{DS}(\frac{D_t}{Y_t} - \bar{d})(\frac{S_t}{Y_t} - \bar{s}) > 0$
    - Interest rates countercyclical in emerging markets (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Arellano, 2008)
  - Even though a sudden stop crisis is exogenous, its impact depends on debt-reserve portfolio through this term

# Model: the rest

- Incomplete asset markets (Schmitt-Grohe and Uribe, 2003; Garcia-Cicco et al., 2010), bonds only
- The representative household with CRRA preferences

$$U_t = E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \frac{C_{t+\tau}^{1-\gamma} - 1}{1-\gamma}$$

subject to the budget constraint

$$C_t + (1 + r_t) D_t + S_{t+1} = Y_t + (1 - \Delta_t) v_t + D_{t+1} + (1 + r^*) S_t$$

where $C_t$ is consumption

- Because the trade balance is $Y_t + (1 - \Delta_t) v_t - C_t$, output externalities can also be interpreted as trade externalities

# Model: equilibrium

$$\Delta_t \sim \Pi = \begin{bmatrix} \pi_{00} & 1-\pi_{00} \\ 1-\pi_{11} & \pi_{11} \end{bmatrix}$$

$$\log Y_{t+1} = \Delta_t \theta^Y + \rho^Y \log Y_t + \sigma^Y \epsilon^Y_{t+1}$$

$$r_t = r^* + rpre_t$$

$$rpre_t = \varphi_0 \left( e^{\varphi_D(\frac{D_t}{Y_t}-\bar{d}) - \varphi_S(\frac{S_t}{Y_t}-\bar{s}) + \varphi_{DS}(\frac{D_t}{Y_t}-\bar{d})(\frac{S_t}{Y_t}-\bar{s})\Delta_t} - 1 \right)$$

$$C_t + (1+r_t)D_t + S_{t+1} = Y_t + (1-\Delta_t)v_t + D_{t+1} + (1+r^*)S_t$$

$$C_t^{-\gamma} = \beta E_t \left[ \begin{pmatrix} 1 + r_{t+1} + \frac{D_{t+1}}{Y_{t+1}} \varphi_0 (\varphi_D + \varphi_{DS}(\frac{S_{t+1}}{Y_{t+1}} - \bar{s})\Delta_{t+1}) \\ \times e^{\varphi_D(\frac{D_{t+1}}{Y_{t+1}}-\bar{d}) - \varphi_S(\frac{S_{t+1}}{Y_{t+1}}-\bar{s}) + \varphi_{DS}(\frac{D_{t+1}}{Y_{t+1}}-\bar{d})(\frac{S_{t+1}}{Y_{t+1}}-\bar{s})\Delta_{t+1}} \end{pmatrix} C_{t+1}^{-\gamma} \right]$$

$$C_t^{-\gamma} = \beta E_t \left[ \begin{pmatrix} 1 + r^* + (1-\Delta_{t+1}) \frac{dv_{t+1}}{dS_{t+1}} + \frac{D_{t+1}}{Y_{t+1}} \varphi_0 (\varphi_S - \varphi_{DS}(\frac{D_{t+1}}{Y_{t+1}} - \bar{d})\Delta_{t+1}) \\ \times e^{\varphi_D(\frac{D_{t+1}}{Y_{t+1}}-\bar{d}) - \varphi_S(\frac{S_{t+1}}{Y_{t+1}}-\bar{s}) + \varphi_{DS}(\frac{D_{t+1}}{Y_{t+1}}-\bar{d})(\frac{S_{t+1}}{Y_{t+1}}-\bar{s})\Delta_{t+1}} \end{pmatrix} C_{t+1}^{-\gamma} \right]$$

- This is a simple model with only two shocks

# Output externalities

- No clear guidance on how to model output externalities
- We consider the following functional forms:

$$\text{Cobb-Douglas: } v_t = \phi_S \left(\frac{S_t}{Y_t} - s^*\right)^{\alpha_S}$$

$$\text{Exponential: } v_t = \phi_S e^{-\frac{\alpha_S}{2}\left(\frac{S_t}{Y_t} - s^*\right)^2}$$

$$\text{Logistic: } v_t = \frac{\phi_S}{1 + e^{-\alpha_S\left(\frac{S_t}{Y_t} - s^*\right)}}$$

$$\text{Gompertz: } v_t = \alpha_S \phi_S e^{\left(\phi_S + \alpha_S \frac{S_t}{Y_t} - \phi_S e^{\alpha_S \frac{S_t}{Y_t}}\right)}$$

- Flexible and cover many plausible shapes of the externalities
- Subsume some functional forms studied in the literature
- Related to Alfaro et al. (2022) who show that the effect of RER depreciation on innovation and growth is heterogeneous

# Sanity checks

Table 5: **Actual and simulated moments**

| Moments | Mexican Data | Bianchi et al. | Cobb-Douglas | Exponential | Logistic | Gompertz |
|---|---|---|---|---|---|---|
| SD of Consumption to SD of Total Output | 1 | 1 | 1 | 1 | 1 | 1 |
| Mean of Debt to Total Output | 43% | 43.5% | 42% | 42% | 42.5% | 43% |
| Mean of International Reserves to Total Output | 8.5% | 6% | 8.2% | 8.6% | 8.5% | 8.5% |
| Mean of Interest Rate Premium | 2.4% | 2.4% | 2.4% | 2.4% | 2.4% | 2.4% |
| SD of Interest Rate Premium | 0.9% | 2% | 0.6% | 0.9% | 0.8% | 0.8% |
| Corr of Interest Rate Premium and Total Output | -0.5 | -0.7 | -0.5 | -0.5 | -0.5 | -0.5 |
| Corr of Consumption and Total Output | 0.8 | 0.9 | 0.99 | 0.99 | 0.99 | 0.99 |

- Compare our model against the data and the baseline model
- Our model is simple yet empirically successful as far as these moments are concerned

# Solve and estimate the model

- Solution: the Taylor projection method of Levintal (2018)
  - Provides a good trade-off between accuracy and speed
- Estimation:
  - Data:
    - 24 emerging countries, at annual frequency from 1970 to 2017
    - For the AFC and the Russian crisis countries, only the post-crisis data
  - The regime probabilities: estimated using the ML based on Laeven and Valencia's (2020) coding of crises
  - Other estimated parameters: estimated using the SMM
    - 11 Target moments: (a) means and standard deviations of external debt to GDP, international reserves to GDP, trade balance to GDP, and interest rate spread, (b) correlations of spread with debt to GDP and reserves to GDP respectively, and (c) correlation of debt to GDP and reserves to GDP

# Overall assessments

- Overall assessments of our sample countries to establish broad empirical patterns
- From parameter estimates:
  - Reasonable values for the risk aversion coefficient $\gamma$ and the discount factor $\beta$
  - $\varphi_0$ is sufficiently larger than zero for all countries, indicating the presence of financial frictions
  - Except for one country, $\varphi_S > \varphi_D$ which corroborates the regression-based findings in the empirical literature
  - $\varphi_{DS} > 0$ for all countries, so a sudden stop impacts the interest rate premium
  - Except for four countries, $\phi_S > 0$ which indicates positive output externalities

# Overall assessments

- From simulated moments:
  - Actual data exhibit substantial variation across countries
  - Our simple model matches means and standard deviations of external debt to GDP, international reserves to GDP, and interest premium reasonably well
  - It also matches sign of the correlation between reserves to GDP and debt to GDP in almost all sample countries
  - The model underpredicts the reserve accumulation in Korea and Thailand
    - Not surprising given that the estimated crisis probabilities are likely to understate the perceived probabilities for these
    - An alternative model: aversion to Knightian uncertainty (Lee and Luk, 2018)

# South Africa

| Country | South Africa | |
|---|---|---|
| Moments | Actual | Model |
| mean(S/GDP) | 4.305 | 4.317 |
| mean(D/GDP) | 13.394 | 13.720 |
| mean(rpre) | 2.451 | 2.317 |
| mean(TB/GDP) | 1.993 | 1.999 |
| $\sigma$(S/GDP) | 4.536 | 5.766 |
| $\sigma$(D/GDP) | 15.460 | 3.240 |
| $\sigma$(rpre) | 0.961 | 1.012 |
| $\sigma$(TB/GDP) | 3.445 | 2.724 |
| *corr*(S/GDP,D/GDP) | 0.921 | 0.934 |
| *corr*(rpre,S/GDP) | -0.093 | -0.093 |
| *corr*(rpre,D/GDP) | 0.109 | 0.110 |

# Quantitative exercises

- We conduct various quantitative exercises
- Example: Argentina
  - If output externalities are turned off, both reserves to GDP and debt to GDP hardly change in Argentina
  - When regime-switching is turned off, both reserves to GDP and debt to GDP increase substantially in Argentina
  - For Argentina, the precautionary motive dominates output externalities
- In general, the effect of output externalities on the reserve accumulation is heterogeneous due to relative magnitudes of the income and substitution effects
  - This may be why some authors have not found economically significant effects of mercantilistic variables for explaining reserve dynamics (Aizenman and Lee, 2007)

# Key takeaways

- Different countries have different reasons for holding international reserves
- We provide a more complete understanding by modeling the interaction among debt, reserves, and the real interest rate