

# Financial Crises, Bailout and Optimal Monetary Policy in Open Economies\* (Job Market Paper)

Yang Jiao<sup>†</sup>

Columbia University

[Please click here for the latest version](#)

December 18, 2017

## Abstract

This paper studies jointly optimal bailout policy and monetary policy in open economies. I document that countries with larger foreign currency liability/GDP ratio before financial crises underwent larger currency devaluation, inflation and bailout in crises. I build a quantitative open economy model with both nominal rigidities and financial frictions. Using the model, I show that in a world without bailout while currency mismatch effect is present, larger foreign currency liability before crises calls for smaller currency devaluation in crises, embracing the notion of “fear of floating”. The incorporation of optimal government bailout, whose cost needs to be financed by inflation tax, can overturn the above negative relationship between foreign currency liability and currency devaluation, delivering results consistent with the empirical findings. Finally, I use firm level data to show that whether firms suffer from currency mismatch effect or not during crises hinges on their chance of obtaining bailout.

---

\*I am deeply indebted to my thesis advisors Stephanie Schmitt-Grohé, Shang-Jin Wei, Patrick Bolton, Martín Uribe and Jesse Schreger for their constant guidance, support and encouragement. I am grateful to Yan Bai, Andres Drenik, Zhen Huo for detailed and extremely helpful discussions and suggestions. I thank Sakai Ando, Luigi Bocola, Tuo Chen, Feng Dong, David Dorn, Jonathan Eaton, Xiang Fang, Simon Gilchrist, Juan Carlos Hatchondo, Harrison Hong, Yoon Joo Jo, Réka Juhász, Ryan Kim, Rishabh Kirpalani, Dirk Krueger, Jennifer La’O, Benjamin Moll, Frederic Mishkin, Seunghoon Na, Emi Nakamura, Serena Ng, Pablo Ottonello, B. Ravikumar, Bernard Salanié, Juan Sanchez, José Scheinkman, Jón Steinsson, Neng Wang, Pengfei Wang, Yicheng Wang, David Weinstein, Yi Wen, Mike Woodford, Peifan Wu, Pierre Yared, Jing Zhou and seminar participants in Columbia University and Federal Reserve Bank of St. Louis for their invaluable comments. Part of this paper was written at the Federal Reserve Bank of St. Louis while I was a dissertation intern. I am very grateful for their hospitality. All errors are mine.

<sup>†</sup>Department of Economics, 420 W. 118th St., New York, NY 10027. Email: yang.jiao@columbia.edu.

# 1 Introduction

A prevailing view about the balance sheet effect of exchange rate devaluation is based on the currency mismatch argument (sometimes called “liability dollarization”), e.g., Krugman (1999), Eichengreen, Hausmann and Panizza (2003) and Frankel (2005). When external liability denominated in foreign currency is substantial, domestic currency devaluation effectively increases liability burden in terms of domestic currency, hurting the balance sheets of domestic firms or banks and thus tightening their financial constraints. Foreign currency liability exposure has been regarded as one explanation for the “fear of floating” phenomenon of exchange rate documented in Calvo and Reinhart (2002). This currency mismatch view predicts that, when financial constraints matter, larger foreign currency liability exposure calls for smaller currency devaluation when designing monetary policy.<sup>1</sup>

My empirical investigations of financial crisis episodes across countries, however, reveal a different picture from what the currency mismatch argument alone would favor. I zoom in to financial crisis episodes because they are considered as periods when financial constraints matter a great deal. My empirical finding is that larger foreign currency liability/GDP before crises instead is associated with larger devaluation during crises. This relationship still holds after controlling for the severity of crises, institutional quality, which is argued to affect monetary policy credibility in the literature, and a set of other relevant control variables.

An important aspect during financial crises is the large scale bailout to firms or banks. I argue that the difference between my empirical findings and the theoretical predictions of the existing literature can be explained by considering bailouts. Based on the IMF database on banking crises in Laeven and Valencia (2012), the average fiscal cost of restructuring the financial sector is around 12% GDP, far from negligible. A natural question is how to finance the bailout package, especially in the emergency need within crisis windows. I argue that bailout, at least partially, needs to be monetized<sup>2</sup> via inflation tax.<sup>3</sup> Data shows that, during financial crises, larger foreign currency liability exposure is indeed associated with larger inflation and larger bailout.

---

<sup>1</sup>See e.g., Du and Schreger (2016). While Du and Schreger (2016) look at year 2005-2014, this paper focuses on financial crisis episodes. The mechanism I will highlight is closely connected with financial crisis episodes, but not necessarily with normal times.

<sup>2</sup>Jácome, Saadi-Sedik and Townsend (2011) provide evidence on the monetization of bailout in Latin America countries during 1995-2007. Aslund (2015) describes that in its most recent crisis around 2014 if the Ukraine government recapitalizes banks, they have to monetize the cost and its currency hryvnia devalues with every announcement of bank recapitalization. They both verbally describe the policy tradeoffs of bailout and currency mismatch faced by these countries as I formally model in this paper.

<sup>3</sup>For this paper’s purpose, inflation tax includes at least 3 main components: 1) printing money collects seigniorage revenues; 2) inflating away existing government local currency debt brings additional resources for the government to do bailout; 3) inflating away financially distressed banks’ or firms’ local currency debt also improves their balance sheet. The third one is the redistribution effect of inflation, which can be viewed as a broader definition of inflation tax to “bailout”.

I propose a theoretical framework that discusses the optimal size of bailout and nests the currency mismatch effect at the same time. In the framework, bailout needs to be funded by an inflation tax. In crises, a benevolent government trades off the benefit of using an inflation tax to bailout and the cost of the currency mismatch effect when choosing monetary policy. A currency devaluation hammers corporate balance sheets but bailout, funded by inflation tax, leads to improvement of the corporate balance sheet. The latter incentive can be strong enough to dominate the former incentive. Then a larger foreign currency liability before crises requires a larger bailout and thus more inflation tax, featuring a larger devaluation during crises. In contrast, due to the more severe currency mismatch problem, if one shuts down the bailout option, larger foreign currency liability calls for a smaller devaluation, featuring “fear of floating”.

My model builds on both the open economy sudden stop literature with financial frictions and New Keynesian literature with nominal rigidities. In the model, the small open economy is subject to sudden stop shocks in debt inflows along with tradable sector endowment and borrowing cost shocks. The non-tradable sector is a production sector, which is subject to both nominal rigidities and financial frictions. Nominal rigidities and financial frictions are necessary to produce currency mismatch effect. The capital structure of the non-tradable sector’s firms is composed of domestic equity and external debt (foreign currency debt) so as to finance firms’ investment. The financial frictions between domestic households and firms provides a scope for bailouts.

In the absence of domestic financial frictions, nominal rigidities are the sources of inefficiencies in the domestic economy. Inflation stabilization in the non-tradable sector fully undoes the inefficiencies caused by price adjustment cost and serves as the optimal monetary policy. The policy is characterized by a currency devaluation in crises as in the literature.

When domestic financial frictions matter, however, the optimal monetary policy is not inflation stabilization. If no bailout option is available, nominal rigidities coupled with financial frictions and foreign currency denominated debt create another problem for the non-tradable sector firms: the currency mismatch effect. Devaluation increases the nominal debt burden of non-tradable sector firms, reducing real value of retained earnings and tightening financial constraints, and firms have to reduce investment further. In this case, a benevolent government would choose to lower exchange rate devaluation compared to that under the inflation stabilization policy. They do so more if the foreign currency liability before crises is larger as the financial constraints also bind more tightly. This gives us a negative relationship between foreign currency liability before crises and exchange rate devaluation during crises. This prediction is at odds with what the empirical evidence on financial crisis episodes suggests that there is a positive relationship between foreign currency liability/GDP and currency devaluation.

If bailout policy is taken into account, another constraint on monetary policy shows up. The binding domestic financial frictions in sudden stop episodes offer an incentive for the government to conduct bailout. This is because, from the domestic economy's point of view, resource flows from non-productive sector to productive sector are hindered by financial frictions. Bailout effectively facilitates the flow of funds from households to productive sector and thereby loosens the financial constraint. Secondly, inflation tax can be one source of bailout funds. I document that effective tax rate (i.e., tax revenue/GDP) on average doesn't show much change and even declines in the trough of crises. The cost of inflation in my model is endogenous, coming from nominal rigidities. Inflation leads to an inefficient wedge for firms' labor choice, and the accompanied devaluation also leads to currency mismatch cost. Whether the benevolent government chooses less or more devaluation beyond inflation stabilization policy in crises depends on their weighing on the marginal benefit of employing inflation tax to finance bailout versus the marginal cost of currency mismatch effect. I calibrate the model to an emerging country Philippines<sup>4</sup> to illustrate the former incentive can be stronger. Therefore, allowing inflation tax to finance a bailout calls for larger devaluation compared to the inflation stabilization policy, in contrast with the case without bailout. Furthermore, as larger foreign currency debt needs more bailout in crises, consistent with the empirical evidence on financial crisis episodes, the model implies a positive relationship between foreign currency debt exposure and exchange devaluation.

The effect of anticipation of bailout is also significant. In expectation of government interventions when bad shocks arrive, firms build up higher leverage ex-ante, which could make things worse during crises, and calls for a large bailout and thus leads to a large currency devaluation and inflation. In other words, the expectation-of-bailout driven credit boom and investment boom make the economy more vulnerable. Despite this moral hazard effect ex-ante, my quantitative results show that there are in general still welfare gains from bailout policy.

Computationally, in the private sector, as my model has occasionally binding constraints, I use global method (I employ policy function iteration method) to solve an open economy model with three endogenous state variables and two occasionally binding financial constraints, in debt market and equity market respectively. This process takes the government policy as given. This problem then requires a second layer of iteration as the optimal monetary policy also takes into account private sector's response. In this paper, I provide solutions of time-consistent optimal policies without and with bailout options and compare their predictions about exchange rate movement.

---

<sup>4</sup>I have in mind a financial crisis originated in the private sector but don't aim to address sovereign debt crisis in this paper. Philippines experiences current account reversal in the Asian financial crises and their government debt is not regarded as a serious problem at that time. Their government intervenes in the crises with fiscal cost of restructuring financial sector equivalent to 13.2% GDP. Their inflation hikes and monetary base increases substantially before the crisis ends.

Finally, two key implications of my theory to an individual firm is that if a firm does not obtain bailout, it will suffer from currency mismatch effect when there is currency devaluation, while if a firm can receive bailout or other subsidies in crises, then currency mismatch effect on it can be mitigated or even offset (depending on the size of bailout to an individual firm). Using firm level data from Southeast Asian countries around the Asian Financial Crises, I assign firms into two groups: one is a politically-unconnected group that is less likely to get bailout or other subsidies in crises, argued in the existing literature e.g., Faccio, Masulis and McConnell (2006), and the other group contains only politically-connected firms who are more likely to get bailout or other subsidies. Focusing on the politically-unconnected group, I find evidence of the currency mismatch effect: sales growths during crises are lower for firms who have higher foreign currency liability exposure before crises. However, there is indeed no evidence of the negative effect of foreign currency liability exposure on the politically connected firms' sales growth.

Related Literature This paper builds on the literature on monetary policy in open economies as well as literature on financial frictions and financial policies. It is related to the theoretical and quantitative New Keynesian open economy with financial frictions.

The monetary policy literature in open economies has extensively studied monetary policy with nominal price rigidity, e.g., Obstfeld and Rogoff (1995), Clarida, Gali and Gertler (2001) and Gali and Monacelli (2005) among others. The key role of monetary policy is to stabilize price. When I shut down domestic financial frictions and keep nominal rigidities in my model, I show that the optimal policy is exactly inflation stabilization in the non-tradable sector. When domestic financial frictions matter, however, the optimal policy deviates from inflation stabilization.

A burgeoning recent literature on open economy models introduces financial frictions by exploring collateral constraints for external borrowing including Mendoza (2010), Bianchi (2011), Schmitt-Grohé and Uribe (2016b) and Korinek and Sandri (2016). My model also features collateral constraint on external borrowing and uses shocks to the borrowing capacity to trigger crises. My model in addition introduces domestic financial frictions to generate scope of bailout as in Bianchi (2016) and Jiao (2016).

The macro level empirics in the paper is related to Calvo and Reinhart (2002) and Du and Schreger (2016). Calvo and Reinhart (2002) document the phenomenon that even if a country claims their exchange regime is floating, the country still actively restricts the volatility of exchange rate. They point out that one reason of the fear of floating phenomenon can be attributed to the currency mismatch concerns. Du and Schreger (2016) connect private sector's foreign currency exposure with local currency sovereign risk. Their intermediate mechanism is the currency mismatch argument. Larger private sector's foreign currency liability exposure should predict higher sovereign

risk and lower inflation. While their paper looks at year 2005-2012, the current paper specifically focuses on financial crisis episodes and highlights the importance of bailout in crisis episodes.

This paper closely relates to the theoretical currency mismatch literature. Ottonello (2014) builds on downward nominal wage rigidity as in Schmitt-Grohé and Uribe (2016a) and incorporates currency mismatch as a counter-force of currency devaluation, where he models that households can use labor income as collateral to borrow, thus devaluation hurts their borrowing capacity by reducing real labor income. My paper studies the productive corporate sector's financial constraints instead. Cook (2004), Céspedes et al. (2004) and Du and Schreger (2016) introduce financial frictions along with nominal price rigidity to highlight currency mismatch effect of monetary policy. The key insight of these papers is that currency devaluation can generate negative balance sheet effect when the corporate sector is exposed to foreign currency liability but their revenues or assets are in local currency. I provide an explicitly-modeled currency mismatch channel in a canonical sticky-price New Keynesian model with optimal monetary policy analysis under financial frictions. In my model, currency devaluation lowers the real revenues of firms and makes their financial constraints bind more tightly, constraining firm investment further. Moreover, by incorporating bailout option, I jointly study optimal monetary and financial policies and its implications on the extent of currency devaluation.

Aoki, Benigno and Kiyotaki (2016) emphasize jointly monetary policy and macroprudential policy in an open economy context with production sector's nominal rigidities and banks' financial frictions as in Gertler and Kiyotaki (2010) and Gertler, Kiyotaki and Queralto (2012). By imposing macro-prudential policies on the financial sector, Van der Ghote (2016) derives large deviations from price stability, in a closed economy model. I depart by considering ex-post bailout policies, as another constraint on monetary policy as bailout cost needs to be monetized in my framework. My model produces deviations from price stability due to currency mismatch concerns or bailout incentives, in the opposite directions.

This paper contributes to the ex-post government intervention and bailout policy literature. Gertler and Kiyotaki (2010) evaluate how various credit market interventions might mitigate the severity of crises in a closed economy. In their paper, credit policies are given by exogenous rules instead of optimally derived. Bianchi (2016) studies efficient bailout with distortionary tax instruments and quantitatively compare the welfare effect of systemic bailout and idiosyncratic bailout. Jiao (2016) studies bailout policy financed by government spending cut to generate divergent external debt dynamics for public and private sector in crises. Chari and Kehoe (2016) emphasize regulating leverage and taxing size help restore constrained efficiency coupled with ex-post bailout. Bailout authorities finance bailout by tax on firms. In my paper, the government finances bailout

with inflation tax effectively imposed on the household sector and I focus on the bailout policy's implications on currency devaluation in crises. Bocola and Lorenzoni (2017) explore the role of domestic authorities as a lender of last resort to eliminate the dollarized crisis equilibrium. In their paper, monetary policy is exogenously given as inflation targeting, while in my paper, I emphasize optimal monetary policy choice.

My firm level empirical studies on currency mismatch is linked to several firm level investigations on the balance sheet effect of exchange rate depreciation. Aguiar (2005) finds evidence of currency mismatch effect when exploring Mexico 1994 peso crisis. While Bleakley and Cowan (2008) do not find support of currency mismatch using firms in five Latin America countries in the 1990s. Kim, Tesar and Zhang (2015) use Korean firm level data around the Asian Financial Crisis and find that only among small firms can one detect this balance sheet effect of exchange rate depreciation. I contribute to this literature by sorting firms into firms who are more likely to get bailout, i.e., politically connected, and firms who are less likely to get bailout. This is an important consideration because bailout or subsidies to firms in crises can potentially mitigate currency mismatch effect on these firms.

Layout The remainder of the paper is organized as follows. Section 2 presents evidence on cross country-crisis relationship between foreign currency liability exposure before crises, and bailout and currency devaluation during crises. Section 3 presents the model. Section 4 analyzes currency mismatch incentives and bailout incentives for a benevolent government. Section 5 conducts quantitative analysis and compares optimal monetary policies without and with bailout option. Section 6 presents firm level empirical studies on the role of bailout in mitigating currency mismatch effect. Finally, Section 7 provides a conclusion.

## 2 Foreign Currency Liability, Bailout and Currency Devaluation

In this section, I empirically explore the relationship between foreign currency liability before financial crises and exchange devaluation during crises. Based on the currency mismatch effect argument, higher foreign currency liability will provide disincentives to policy makers to devalue its currency when designing policies. I focus on financial crisis episodes because the currency mismatch effect argument relies on financial constraints. The crisis dating is from Laeven and Valencia (2012).<sup>5</sup> I shall use letter “ $T$ ” to denote crisis start year.<sup>6</sup>

---

<sup>5</sup>They identify 147 banking crises from year 1970 to 2011 across 162 countries (some countries record 0 banking crisis). The banking crises are defined based on two conditions 1) significant losses in the banking system, bank runs and/or bank liquidations; 2) significant banking policy intervention measures. The first year when both conditions are met is identified as banking crisis start year.

<sup>6</sup>I will drop United States crises because I use local currency exchange rate relative to US dollars, so that the United States herself exchange rate is mechanically always fixed. In the case of the Eurozone when crises happen I

To have an idea of in general what happens in these crises, Figure 1 plots the median dynamics around financial crises. Not surprisingly, GDP growth rate slows down in these episodes. The trade balance improvement in crises is consistent with Mendoza (2010), which also motivates the consideration of a sudden stop shock to external borrowing of an economy (interest rate rise and tightening of borrowing constraint). Finally, the large currency devaluation is usually present in these crises.

I next present benchmark regression results on the relationship between foreign currency liability/GDP and currency devaluation. I then link foreign currency liability/GDP with inflation and bailout. Various robustness checks are performed in the Appendix.

## 2.1 Foreign Currency Liability and Currency Devaluation

My first empirical setting across crises is

$$devaluation\ rate_i = \beta_0 + \beta_1 * FC\ liability/GDP_i + \beta_2 * LC\ liability/GDP_i + \delta_e * X_i' + \epsilon_i, \quad (1)$$

where  $i$  denotes a crisis observation. The left hand side *devaluation rate* is the devaluation rate during the crisis from  $[T-2, T+2]$ <sup>7</sup>, defined as  $devalue\ rate_i = \ln(er_{i, T+2}) - \ln(er_{i, T-2})$ , where  $er_{i, T}$  denotes the period average of exchange rate in crisis  $i$  when the crisis starts, available in the WDI database. The currency composition of external liability is taken from Bénétrix, Lane and Shambaugh (2015), which is an updated dataset of Lane and Shambaugh (2010). They provide the currency denomination of external wealth of nations starting from year 1990. *FC liability/GDP* is the foreign currency liability/GDP in the end of year  $T - 2$  to mitigate the concern that GDP may start to decline in year  $T-1$  already.<sup>8</sup> *LC liability/GDP* is the corresponding local currency liability/GDP.  $X$  denotes a set of control variables.

One concern is that the lack of monetary policy credibility leads to foreign investors becoming unwilling to lend in domestic currency. Du, Pflueger and Schreger (2016) model the portfolio choice of local currency and foreign currency debt under exogenous monetary credibility. Lack of monetary policy credibility leads to both a larger foreign currency share in debt and a larger inflation (devaluation). To partially address this concern, I control for factors that can possibly

---

always exclude that crisis observation because an individual country in the Eurozone doesn't have its independent monetary policy. Finally, I drop crisis observations if the crisis happens within 10 years of the birth of the country, e.g., the Czech Republic had a financial crisis in 1996 and its birth was in 1993 after breaking up with Slovakia. The division of countries can have significant economic impact and it may involve the conversion of old currencies to new currencies for transactions and debt, which are beyond the scope of this paper.

<sup>7</sup>I also try  $[T-1, T+2]$ , the results indicate our empirical studies are robust.

<sup>8</sup>To minimize sample size reduction, if  $T-2$  FC liability/GDP is not available, I use  $T-1$  value to substitute. This includes Nigeria1991, Norway1991, Sweden1991, Tunisia1991, Hungary1991, Finland1991 crises. My empirical results are robust if I all use end of  $T - 1$  values.

affect monetary policy credibility. Huang and Wei (2006) endogenize monetary policy credibility using institutional quality, e.g., corruption.<sup>9</sup> Therefore, I control for institutional quality by using the control of corruption index (a larger value implies better institutional quality) provided by World Governance Indicators.<sup>10</sup>

I then try to control for the severity of crises because more severe crises can imply that demand for money falls thus the exchange rate devalues. The variable *GDP loss* attempts to capture the severity of a crisis. It is defined as the cumulative GDP loss in period  $[T, T+2]$  from quadratic or Hodrick-Prescott trend. I perform empirical studies with both measures. For each crisis, I compute the pre-crisis trend using 20 years' natural logarithm of real GDP between  $[T - 20, T - 1]$ .<sup>11</sup> I then use the estimated trend to predict GDP in  $[T, T + 2]$ . Figure 14 in the Appendix gives a graphic example (Thailand 1997 crisis) on how *GDP loss* is constructed.

The first three columns of Table 1 report the regression results. We can see that robustly higher foreign currency liability/GDP before crises is associated with larger devaluations during crises. The point estimate is around 0.2, which means a 50% increase in levels of foreign currency liability/GDP is associated with 10 percent more currency devaluation. Control of corruption is significant and better institutional quality implies less currency devaluation.

In Columns (4) and (5), I add more control variables. First, I distinguish between developed countries and developing countries using the OECD dummy. It takes the value 1 if the country has OECD membership in the year 2017. Secondly, I control for export/GDP before crises (period T-2 value<sup>12</sup>). If a country's firms' large fraction of revenues are also in U.S. dollars from export, then even if they are exposed to large foreign currency liability, they will not suffer from currency mismatch problem. Finally, I also control for broad money/reserves before crises to capture the idea that foreign reserve adequacy could be used to intervene in the exchange rate market. Adding these controls don't alter my conclusions on the relationship between foreign currency liability/GDP and currency devaluation. The point estimates are still significant and in fact, there is little change in the values of point estimates.

[Table 1 here]

Table 2 restricts the sample to non-OECD countries only. I find that FC liability/GDP is always statistically significant and the point estimates are much larger and increase to about 0.4.

<sup>9</sup>Bai and Wei (2000) model how corruption translates into reduced ability of the government to collect tax revenue. See also Acemoglu et al. (2003) for the connection between institutions and macro policies.

<sup>10</sup>I use year 2006-2015 ten years' average of the control of corruption index.

<sup>11</sup>It is possible that not all  $[T - 20, T - 1]$  data on real GDP are available in WDI. In this case, I require at least 15 years' available data to estimate the quadratic trend. Otherwise, the GDP loss of this crisis is considered to be missing.

<sup>12</sup>For the Zambia1995 crisis, there is no 1993 export/GDP ratio in WDI, so I use its 1994 export/GDP instead.

LC liability/GDP is no longer statistically significant and institutions also cease to be significant. Figure 2 displays the raw data of devaluation rate during crises and FC liability/GDP before crises for the non-OECD group. There is in fact visually a strong positive relationship between these two variables.

[Table 2 here]

[Figure 2 here]

In summary, my empirical finding shows a positive relationship between before crises foreign currency liability exposure and during crises currency devaluation rate. This is in contrast with the currency mismatch perspective alone that higher foreign currency liability calls for less devaluation during financial crises.

## 2.2 Foreign Currency Liability, Inflation and Bailout

To reconcile the above empirical finding, I propose that another important aspect during these financial crises is significant government interventions including bailout policy. Based on the Laeven and Valencia (2012) database, the average cost of restructuring the financial sector is above 12% for governments. This is likely an underestimate of the size of government intervention's fiscal cost because it only includes financial sector information but in reality the government also directly bails out non-financial firms. I argue that bailout needs to be monetized at least partially, leading to inflation and devaluation, i.e., the government uses inflation tax to fund the bailout. For this paper's purpose, inflation tax is a broad concept in my mind. It includes printing money to collect seigniorage. Inflating away government nominal debt also brings additional resources for the government to use in the bailout. Moreover, inflating away financially distressed banks' or firms' local currency debt also improves their balance sheet.

I now explore the following two empirical settings by substituting the left hand side variable devaluation rate by inflation rate (I use  $\frac{\pi}{1+\pi}$  where  $\pi$  is inflation. This measure is not only noise reducing but also sometimes can be mapped to the size of inflation tax.<sup>13</sup>) and bailout

$$inflation_i = \gamma_0 + \beta_1 * FC\ liability/GDP_i + \gamma_2 * LC\ liability/GDP_i + \delta_\pi * X_i' + \varepsilon_i, \quad (2)$$

$$bailout_i = \zeta_0 + \zeta_1 * FC\ liability/GDP_i + \zeta_2 * LC\ liability/GDP_i + \delta_b * X_i' + u_i, \quad (3)$$

---

<sup>13</sup>For example, a 100% ( $\pi$ ) inflation rate makes nominal debt reduce to half of the original debt ( $\frac{\pi}{1+\pi}$ ). The literature sometimes treats it as an approximation of inflation tax, e.g., Vegh and Vuletin (2015). I have also used inflation  $\pi$  directly, and my empirical results are robust.

where inflation is measured as log difference of CPI between [T-2,T+2] and bailout is log of cost to restructure the financial sector/financial sector asset.

Table 3 and 4 report regression results corresponding to CPI inflation and bailout, respectively. I find that larger foreign currency liability/GDP is also associated with higher inflation and more bailout. 50% increase in levels of foreign currency liability/GDP is associated with about 3.5% level increase in inflation and 20 percent more bailout. Institutional quality also matters. Better control of corruption implies less inflation and less bailout. Table 5 show results for non-OECD group. The point estimates are much larger. 50% increase in levels of foreign currency liability/GDP is associated with about 5% level increase in inflation and 80 percent more bailout.

[Table 3 here]

[Table 4 here]

[Table 5 here]

To sum up, I present evidence that larger foreign currency liability/GDP before crises is related to more bailout and higher inflation during crises. These findings lead me to consider financial policy, in particular bailout policy which needs to be monetized, in addition to the currency mismatch concerns of monetary policy in crises.

I conduct a series of robustness checks in the Appendix. These robustness checks include 1) excluding the sovereign default sample; 2) using external debt instead of external liability; 3) using BIS-Locational Banking Statistics external debt held by foreign banks; 4) using BIS-Locational Banking Statistics banks' external debt held by foreign banks. Our checks indicate that the positive relationship between before crises FC liability/GDP and during crises currency devaluation rate, inflation and the size of bailout is robust.

In the following section, I introduce a model that will feature both bailout and currency mismatch and use it to investigate the relationship between foreign currency liability and currency devaluation, inflation and bailout.

### 3 The Model

Motivated by the empirical findings in the previous section, I now set up the model. The model economy is a small open economy. There are households who are endowed with tradable goods, non-tradable sector firms (or bank and firms combined<sup>14</sup>) who produce non-tradable goods, a government

---

<sup>14</sup>In reality, we observe external borrowing and government bailout of both banks and firms. I don't model banks and firms separately. This setup could be thought of as abstracting from frictions between banks and firms as in Gertler

and foreign lenders. The non-tradable sector firms finance their investment by retained earnings, domestic equity and borrowing from abroad in foreign currency. They are the only borrowers in the economy. I describe the optimization problems faced by different private agents without bailout first, and then turn to government policy analysis without and with bailout option.

### 3.1 Money Demand

I assume that households are endowed with  $y_t^T$  tradable good and the money demand of households is

$$M_t = \theta P_t^T y_t^T, \quad (4)$$

where  $M_t$  is money supply and  $P_t^T$  is tradable good's price in local currency. In the appendix, I provide a micro-foundation of this money demand by adding tradable good firms (owned by households) who face cash in advance constraint when purchasing inputs. The only reason for us to introduce money is to generate inflation tax on households. I make the money demand function only related to tradable good. The first reason is for simplicity such that the size of inflation tax is increasing in currency devaluation and the second reason is that the non-tradable sector firms will be the agents that receive bailout, therefore, using inflation tax on them to bailout them will not generate real effect. Fluctuations in  $y_t^T$  can be viewed as terms of trade shocks or capture weather shocks to agricultural products etc.

### 3.2 Households

There is a continuum of identical households who maximize her lifetime utility

$$\max_{\{c_t^T, c_t^N, h_t, x_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t - v(h_t)), \quad (5)$$

where  $c_t = \Omega(c_t^T, c_t^N)$  is the consumption bundle of tradable good consumption  $c_t^T$  and nontradable good consumption  $c_t^N$ ,  $h_t$  is labor supply,  $x_{t+1}$  is her holding of the equity share of firms and  $\beta$  is the subjective discount factor.

Function  $\Omega(c^T, c^N)$  defined over positive values of its arguments is assumed to be homogeneous

---

and Kiyotaki (2015). One justification is in financial crises a government may set up corporate debt restructuring process favoring firms between firms and their creditors (including banks) and at the same time bail out banks, which is equivalent to bail out firms, see e.g., Malaysia established the Corporate Debt Restructuring Committee in Asian Financial Crises. Another reason is that since my theory also embraces the idea of inflating away local currency domestic debt as "bailout", devaluation will reduce end-borrowers' debt burden, which are indebted firms. Banks are both borrowers and lenders in local currency who will be less affected, see some narrative discussions in a New York Times article in 2001 "Who Pays If Argentina Devalues Its Currency?" right before Argentina devalues in the beginning of 2002.

of degree one, increasing, concave and it also satisfies the Inada conditions. I adopt the following CES form

$$\Omega(c_T, c_N) = [ac^{T^{1-\frac{1}{\xi}}} + (1-a)c^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{1-\frac{1}{\xi}}}. \quad (6)$$

I assume that the utility function  $u(\cdot)$  has the constant relative risk aversion form with risk aversion parameter  $\sigma > 0$ . The labor supply disutility is

$$v(h) = \psi_h \frac{h^{1+\chi}}{1+\chi}. \quad (7)$$

The parameter  $\chi$  is the inverse of the labor supply elasticity.

Households can trade equity shares of firms. At the beginning of period  $t$ , the households inherits  $x_t$  fraction of all shares from the previous period, and then chooses to hold  $x_{t+1}$ . The budget constraint is

$$P_t^T c_t^T + P_t^N c_t^N + x_{t+1} P_t^T (e_t - div_t) = [P_t^T y_t^T - M_t + M_{t-1}] + W_t h_t + x_t P_t^T e_t, \quad (8)$$

where  $P_t^N$  is non-tradable good's price,  $P_t^T e_t$  is the nominal equity price before paying dividend  $P_t^T div_t$ . Dividing both sides by tradable good's domestic currency price (tradable good serves as the numeraire), I have

$$c_t^T + p_t^N c_t^N + x_{t+1}(e_t - div_t) = y_t^T - \frac{M_t - M_{t-1}}{P_t^T} + w_t h_t + x_t e_t, \quad (9)$$

with  $p_t^N$  the price of nontradable good and  $w_t$  the wage, both in terms of tradable good.

Denoting  $\lambda_t$  the Lagrange multiplier of the above budget constraint, I obtain the following first order conditions for  $c_t^T, c_t^N, h_t$  and  $x_{t+1}$ :

$$[c_t - \psi_h(1+\chi)^{-1}h_t^{1+\chi}]^{-\sigma} [ac_t^{T^{1-\frac{1}{\xi}}} + (1-a)c_t^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}} a(c_t^T)^{-\frac{1}{\xi}} = \lambda_t \quad (10)$$

$$[c_t - \psi_h(1+\chi)^{-1}h_t^{1+\chi}]^{-\sigma} [ac_t^{T^{1-\frac{1}{\xi}}} + (1-a)c_t^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}} (1-a)(c_t^N)^{-\frac{1}{\xi}} = \lambda_t p_t^N \quad (11)$$

$$[c_t - \psi_h(1+\chi)^{-1}h_t^{1+\chi}]^{-\sigma} \psi_h h_t^\chi = \lambda_t w_t \quad (12)$$

$$e_t = div_t + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} e_{t+1} \quad (13)$$

Equation (10) and (11) pin down the relative price of nontradable good

$$p_t^N = \frac{1-a}{a} \left( \frac{c_t^N}{c_t^T} \right)^{-\frac{1}{\xi}}. \quad (14)$$

As we will see, onset of a crisis, tradable consumption drop will generate a decrease in  $p_t^N$ : a depreciation in real exchange rate. Iterate forward equation (13) and rule out bubbles to arrive at

$$e_t = E_t \sum_{s=0}^{\infty} \beta^s \frac{\lambda_{t+s}}{\lambda_t} div_{t+s}. \quad (15)$$

It says that the stock price is the discounted value of future dividend payments.

### 3.3 Non-tradable Sector Firms

From above, a non-tradable sector firm  $j$ 's objective is to maximize its equity value

$$e_{j0} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} div_{jt}, \quad (16)$$

where  $div_{jt}$  is the dividend payment of firm  $j$  at time  $t$ .

Firms in the non-tradable sector produce non-tradable good with the following technology

$$y^N = k^{\alpha_k} (zh)^{\alpha_h}, \quad (17)$$

where  $k$  is capital good which is tradable good such as equipments and machines,  $h$  is labor employed and  $z$  is a scale parameter. One can easily add a third domestic input land  $L$  in the production function, and the economy supplies at fixed amount, held by firms. It will not change my analysis. I set  $\alpha_k + \alpha_h < 1$ , so the land share can be viewed as  $1 - \alpha_k - \alpha_h$ .

I assume that each firm  $j \in [0, 1]$  provides a specific variety  $j$ . The non-tradable final good is in the Dixit-Stiglitz aggregation form

$$y_t^N = \left[ \int_0^1 (y_{jt}^N)^{\frac{\gamma-1}{\gamma}} dj \right]^{\frac{\gamma}{\gamma-1}} \quad (18)$$

with elasticity of substitution  $\gamma > 1$ . The price index in the non-tradable sector is

$$P_t^N = \left[ \int_0^1 P_{jt}^N 1-\sigma dj \right]^{\frac{1}{1-\sigma}}. \quad (19)$$

Therefore, the demand function for variety  $j$  is

$$y_{jt}^N = \left( \frac{P_{jt}^N}{P_t^N} \right)^{-\gamma} y_t^N. \quad (20)$$

In order to correct the monopolistic distortion, I follow the extensive New Keynesian literature,

e.g., Rotemberg and Woodford (1997), Rotemberg and Woodford (1999) and impose a technical assumption that there is proportional output subsidy  $\tau_y = \frac{1}{\gamma-1}$  to the production, financed by a lump sum tax  $T_t$  on non-tradable sector firms.<sup>15</sup>

Each period  $t$ , firms pay back debt  $b_{jt}$  and issue new debt  $b_{j,t+1}$  to foreign lenders, given exogenous interest rate  $r_t$ . All debt is denominated in foreign currency. After existing capital  $k_{jt}$  depreciates at a rate  $\delta$ , firms choose new capital stock  $k_{j,t+1}$  and additionally pay capital adjustment cost  $\frac{\phi}{2}(\frac{k_{j,t+1}}{k_{jt}} - 1)^2 k_{jt}$  which adopts the quadratic form. The purpose of introducing capital adjustment cost is to dampen investment volatility. Firms also face price adjustment cost a la Rotemberg (1982). The adjustment cost takes the quadratic form  $\frac{\psi}{2}(\frac{P_{jt}^N}{P_{j,t-1}^N} - 1)^2 P_t^T$  in nominal term.<sup>16</sup> The purpose of introducing price adjustment cost is to generate price stickiness and thus cost of inflation including the currency mismatch effect.

Firm  $j$ 's budget constraint is written as

$$\begin{aligned} P_t^T div_{jt} &= P_{jt}^N y_{jt}^N (1 + \tau_y) - W_t h_{jt} \\ &+ P_t^T \left( -k_{j,t+1} + (1 - \delta)k_{jt} - \frac{\phi}{2} \left( \frac{k_{j,t+1}}{k_{jt}} - 1 \right)^2 k_{jt} - b_{jt} + \frac{b_{j,t+1}}{1 + r_t} - \frac{\psi}{2} \left( \frac{P_{jt}^N}{P_{j,t-1}^N} - 1 \right)^2 \right) - T_t. \end{aligned} \quad (21)$$

$T_t$  is equal to the subsidy to output

$$T_t = \tau_y P_t^N y_t^N. \quad (22)$$

I have allowed interest rate  $r_t$  to be time-varying. This is motivated by the existing literature on open economy business cycles where interest rate shocks are found to play a significant role (see e.g., Neumeyer and Perri (2005) and Uribe and Yue (2006)). I then express the budget constraint in terms of tradables to arrive at

$$div_{jt} = \frac{P_{jt}^N}{P_t^T} y_{jt}^N (1 + \tau_y) - w_t h_{jt} - k_{j,t+1} + (1 - \delta)k_{jt} - \frac{\phi}{2} \left( \frac{k_{j,t+1}}{k_{jt}} - 1 \right)^2 k_{jt} - b_{jt} + \frac{b_{j,t+1}}{1 + r_t} - \frac{\psi}{2} \left( \frac{P_{jt}^N}{P_{j,t-1}^N} - 1 \right)^2 - t_t. \quad (23)$$

In the international debt market, I assume that firms are subject to a collateral constraint

$$\frac{b_{j,t+1}}{1 + r_t} \leq \kappa_t k_{jt}, \quad (24)$$

where they can pledge their own capital's book value as collateral for international borrowing. I take

<sup>15</sup>See more discussions on subsidies in Woodford (2002) in a monopolistic competitive environment.

<sup>16</sup>For notational simplicity, I normalize the reference point of inflation rate to be 0. I could have used  $\frac{\psi}{2} \left( \frac{P_{jt}^N}{P_{j,t-1}^N} - \pi^* \right)^2 P_t^T$  so that the reference point of inflation rate is  $\pi^* - 1$ . The analysis is not materially changed.

$\kappa_t$  as sudden stop shocks.<sup>17</sup> By omitting capital price in the collateral value, I implicitly assume that after foreign lenders seize capital, they can only liquidate capital good into consumption good at a discount.<sup>18</sup> The debt constraint attempts to capture that firms' borrowing is rationed, especially in crises. That is, I think in crises firms not only face higher interest rate but also find it hard to borrow to the amount they prefer, suffering from liquidity problem.

I turn to the key domestic financial frictions now. I assume that when paying dividends, firms commit to paying at least a certain level of dividend,

$$P_t^T \text{div}_{jt} \geq P_t^T \underline{d}, \quad (25)$$

where  $\underline{d}$  measures the extent of equity market friction, possibly originating from some agency or informational frictions between equity holders and managers from a theoretical perspective. For instance, Myers and Majluf (1984) model asymmetric information between firms and outside investors as a reason why firms may not issue equity even if there is positive NPV (net present value) project. Empirically, Brav et al. (2005) find managers have a particularly strong desire to avoid dividend cuts. A special setting  $\underline{d} = 0$  means firms cannot raise new funds from equity owners, which is a restriction widespread imposed in the existing literature, e.g., Brunnermeier and Sannikov (2014). When  $\underline{d} < 0$ , the friction restricts the amount of funds that firms are able to frictionlessly raise from equity market to a certain extent. The no equity market friction scenario corresponds to  $\underline{d} = -\infty$ . Again, I write the constraint in terms of tradable good

$$\text{div}_{jt} \geq \underline{d}. \quad (26)$$

Using the demand function and production function to substitute  $h_{jt}$  by  $P_{jt}^N$  and  $k_{jt}$ , firms choose  $P_{jt}^N, b_{j,t+1}, k_{j,t+1}$  subject to budget constraint, borrowing constraint and equity market friction to maximize stock market value. Write the corresponding first order conditions and factor in symmetric equilibrium assumption to obtain (denote  $\nu_t$  and  $\mu_t$  as the Lagrange multipliers associated with debt market and equity market constraint respectively):

$$(1 + \mu_t) \left( (\gamma - 1) y_t^N p_t^N (1 + \tau_y) - w_t h_t \frac{\gamma}{\alpha_h} + \psi(\pi_t^N - 1) \pi_t^N \right) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \psi(\pi_{t+1}^N - 1) \pi_{t+1}^N (1 + \mu_{t+1}). \quad (27)$$

$$(1 + \mu_t) \frac{1}{1 + r_t} - \frac{\nu_t}{1 + r_t} = \beta E_t \left( \frac{\lambda_{t+1}}{\lambda_t} (1 + \mu_{t+1}) \right), \quad (28)$$

<sup>17</sup>See also Eggertsson and Krugman (2012) for deleveraging shocks in a closed economy.

<sup>18</sup>In the literature with collateral constraint, people have used either book value (e.g., Bianchi (2016), Wang and Wen (2012)) or market value (e.g., Mendoza (2010)) for their own purpose. The current paper doesn't focus on the pecuniary externality mechanism, so I take book value of collateral for simplicity.

$$(1 + \mu_t) \left( 1 + \phi \left( \frac{k_{t+1}}{k_t} - 1 \right) \right) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left\{ \left[ \left( 1 - \delta + \frac{\phi}{2} \left[ \left( \frac{k_{t+2}}{k_{t+1}} \right)^2 - 1 \right] \right) + \frac{\alpha_k}{\alpha_h} \frac{w_{t+1} h_{t+1}}{k_{t+1}} \right] (1 + \mu_{t+1}) + \kappa_{t+1} \nu_{t+1} \right\}, \quad (29)$$

where  $\pi_t^N = \frac{P_t^N}{P_{t-1}^N}$  which is 1 plus inflation rate in the non-tradable sector.

Equation (27) shows how the subsidy rate  $\tau_y = \frac{1}{\gamma-1}$  corrects the monopolistic inefficiency and the cost of inflation. First, shut down nominal rigidities such that  $\psi = 0$ .  $\frac{\gamma-1}{\gamma} \alpha_h p_t^N \frac{y_t^N}{h_t}$  is the marginal value of using one more unit of labor while  $w_t$  is the marginal cost of labor in the absence of subsidies. In a competitive market ( $\gamma = +\infty$ ),  $\alpha_h p_t^N \frac{y_t^N}{h_t}$  is the marginal value, therefore, set  $\tau_y$  such that  $\frac{\gamma-1}{\gamma} (1 + \tau_y) = 1$  shall correct the inefficiency coming from the monopolistic competition. If  $\psi \neq 0$  and  $\pi_t^N \neq 1$ , however, a wedge between  $w_t h_t$  and  $\alpha_h y_t^N p_t^N$  will appear. This is the inflation cost in conventional models without currency mismatch effect. Equation (28) is the Euler equation for debt. The appearance of  $\nu_t$  reflects the shadow cost of borrowing due to the borrowing constraint.  $\mu_t$  reflects borrowing one more unit today relaxes equity market constraint while  $\mu_{t+1}$  reflects borrowing one more unit today in expectation tightens next period's equity market constraint as next period firms have a higher debt burden to repay. Equation (29) is the Euler equation for capital.  $\mu_t$  on the left hand side captures that increasing capital stock for next period (chosen at current period) tightens equity market constraint today while  $\mu_{t+1}$  on the right hand side captures that it relaxes next period's equity market constraint. Finally,  $\nu_{t+1}$  is the marginal benefit a higher capital stock ushers in to relax debt market constraint next period as borrowing is limited by firms' capital stock.

The complementary slackness conditions of the borrowing constraint and equity market friction are

$$\frac{b_{t+1}}{1 + r_t} \leq \kappa_t k_t, \quad (30)$$

$$\left( \kappa_t k_t - \frac{b_{t+1}}{1 + r_t} \right) \nu_t \geq 0, \quad (31)$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta) k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 \geq \underline{d}, \quad (32)$$

$$\mu_t \left( p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta) k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \underline{d} - \frac{\psi}{2} (\pi_t^N - 1)^2 \right) \geq 0. \quad (33)$$

Whenever  $\mu_t \neq 0$ , there is inefficiency from the whole small open economy's point of view. The domestic frictions are the source where bailout transfer will potentially improve welfare. More precisely, as firms have to pay a minimum  $\underline{d}$  to households, the choice of capital stock  $k_{t+1}$  is below the socially desirable level. This under-investment caused by equity market friction captures Myers and Majluf (1984) idea that profitable investment may be foregone due to equity market frictions,

despite that I take a shortcut to model the friction in order to carve it in a dynamic quantitative framework. Using Korean firm-level data to structurally estimate their model, Gilchrist and Sim (2007) find that financial frictions account for 50%-80% of the overall drop in investment during the Asian Financial Crises.

When a bad  $\kappa$  shock arrives, firms would like to cut down dividend payments or even turn to raising new equity to finance investment. However, the presence of equity market friction prevents them from doing so freely, depressing their investment further. This also explains why a binding equity market constraint is usually associated with the “sudden stop” shock in my simulation of the economy.

### 3.4 Government

The government picks up exchange rate policy (devaluation rate+1),

$$\epsilon_t = \frac{\Xi_t}{\Xi_{t-1}} = \frac{P_t^T}{P_{t-1}^T}, \quad (34)$$

where  $\Xi_t$  is exchange rate and foreign currency price of a tradable good is normalized to  $P_t^{T*} = 1$  so that  $P_t^T = \Xi_t^T P_t^{T*} = \Xi_t^T$ . The inflation tax is

$$it_t = \frac{M_t - M_{t-1}}{P_t^T} = \theta(y_t^T - \frac{y_{t-1}^T}{\epsilon_t}). \quad (35)$$

Without the bailout option, all the inflation tax is assumed to be rebated to households. Finally, the following equality also holds by definition

$$\frac{p_t^N}{p_{t-1}^N} = \frac{P_t^N / \Xi_t}{P_{t-1}^N / \Xi_{t-1}} = \frac{\pi_t^N}{\epsilon_t}. \quad (36)$$

### 3.5 General Equilibrium

The market clearing conditions for tradables and nontradables are

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2, \quad (37)$$

$$y_t^N = c_t^N. \quad (38)$$

The nontradable sector production function is

$$y_t^N = k_t^{\alpha_k} (zh_t)^{\alpha_h}. \quad (39)$$

Investment is

$$i_t = k_{t+1} - (1 - \delta)k_t + \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t. \quad (40)$$

I am now ready to define the competitive equilibrium given exchange rate policy (without bailout). In the Appendix I list all the equilibrium conditions from equation (60) to equation (74). I notice that if nominal rigidities are non-existent ( $\psi = 0$ ), then money is neutral. Prices just move with the exchange rate, and real allocations remain unaltered. They are summarized below:

**Proposition 1** *When nominal friction is absent, i.e.  $\psi = 0$ , exchange rate policy is irrelevant for the real allocation.*

**Proof.** If  $\psi = 0$ , then  $\pi_t^N$  is not relevant from equation (60) to equation (74), therefore, I can solve the equilibrium allocation without looking at exchange rate policy  $\epsilon_t$  in equation (75). After obtaining  $p_t^N$ , inflation  $\pi_t^N$  just moves with  $\epsilon_t$  according to equation (75). ■

**Proposition 2** *The allocation under inflation stabilization policy (such that  $\pi_t^N = 1$ ), is equivalent to the allocation with  $\psi = 0$ .*

**Proof.** From equation (60) to equation (74), set  $\pi_t^N - 1 = 0$  then I obtain the same equilibrium conditions as when  $\psi = 0$ . ■

When  $\psi = 0$  or under inflation stabilization policy, in order to solve the model,  $p_{t-1}^N$  is no longer a state variable. The allocation is equivalent to a real economy setting. Note that the maximum level of debt the current economy can support is limited, similar to the natural debt limit concept in a simple endowment economy. Intuitively, a higher level of capital stock should support higher level of debt as firms can repay by liquidating their capital stock. In the Appendix, I discuss and design an algorithm to numerically nail down the maximum level of debt for each capital stock  $k$  in the real economy. This is important as when I conduct quantitative analysis, I need to work on solving policy functions for each grid, where feasibility for each grid has to be satisfied.

### 3.6 Social Planner Problem

To facilitate policy analysis, I first investigate the social planner problem below so as to highlight the inefficiency problem in the competitive equilibrium. I define a domestic social planner (where domestic frictions between households and non-tradable sector firms are left out) problem as

$$\max_{\{c_t^T, c_t^N, h_t, b_{t+1}, k_{t+1}, \pi_t^N\}} E_0 \sum_{t=0}^{+\infty} \beta^t u(\Omega(c_t^T, c_t^N) - v(h_t)), \quad (41)$$

subject to the tradable good resource constraint, the non-tradable good production function, and collateral constraint

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}\left(\frac{k_{t+1}}{k_t} - 1\right)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2, \quad (42)$$

$$c_t^N = k_t^{\alpha_k} (zh_t)^{\alpha_h}, \quad (43)$$

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t. \quad (44)$$

I provide the optimal exchange rate policy without domestic financial frictions below.

**Proposition 3** *In the competitive equilibrium under inflation stabilization policy (such that  $\pi_t^N = 1$ ), when  $\underline{d} = -\infty$ , it coincides with social planner allocation.*

**Proof.** See Appendix. ■

In order to obtain the exchange rate under the inflation stabilization policy, one can solve the real economy first. Equation (36) then provides solution to exchange rate by setting  $\pi_t^N = 1$ :

$$\epsilon_t(b_t, k_t, p_{t-1}^N, ES_t) = \frac{p_{t-1}^N}{p_t^N}, \quad (45)$$

where  $ES_t$  means “exogenous shock” ( $y_t^T, r_t, \kappa_t$ ). After a “sudden stop” shock ( $\kappa$  falls), tradable goods consumption falls in the economy, generating a fall in  $p_t^N$  as well. Therefore, inflation stabilization means an increase in  $\epsilon_t$  (devaluation of domestic currency) in the crisis. In the absence of equity market friction, the optimal exchange rate policy is to stabilize non-tradable sector price and requires a devaluation. This conclusion is also derived by Uribe and Schmitt-Grohé (2017) Chapter 9 with Calvo-type sticky price setup in the non-tradable sector. However, with domestic financial frictions, the optimal monetary policy will deviate from inflation stabilization. Moreover, the direction of exchange rate deviation from inflation stabilization policy will depend on whether I take bailout into account or not.

When domestic frictions disappear ( $\underline{d} = -\infty$ ), the competitive equilibrium coincides with social planner solution as there are no other domestic inefficiency source. Since the domestic financial friction is crucial and it impedes fund flows from households, a direct policy implication is:

**Proposition 4** *The social planner solution can be replicated by imposing a lump sum transfer  $LT_t \geq \underline{d} - \{p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}\left(\frac{k_{t+1}}{k_t} - 1\right)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t}\}^{SP}$  from households to banks in the competitive equilibrium under inflation stabilization policy.  $SP$  denotes social planner allocation.*

**Proof.** See Appendix. ■

The lump sum transfer  $LT_t$  effectively fully undoes the domestic equity frictions. I can replicate social planner solution with the lump sum transfer. Despite the fact that this policy fully resolves the inefficiency, I take a position that it is hardly feasible or it is very costly in reality for a government to implement a lump sum tax on households to bailout firms during crises. When I average across financial crises, I rarely observe significant tax policy change. The effective tax rate even declines in the trough of crises (period T+1) if any. See Figure 3 on the effective tax rate around crises. I conjecture the drop in effective tax rate is because tax code is very hard to change in the short run and the tax system usually features progressivity so that in recessions, lower income often leads to lower effective tax rate. I will assume when bailout is allowed, only inflation tax can be used to finance it.

[Figure 3 here]

## 4 Currency Mismatch and Bailout: Optimal Monetary Policy

I now turn to optimal monetary policy analysis with both equity market friction and nominal rigidities. On the one hand, when a government conducts monetary policy, if the non-tradable sector's nominal price is sticky, the real value of revenue of firms goes down after a devaluation, tightening financial constraints. It constitutes a rationale why optimal monetary policy should be less devaluation relative to the inflation stabilization policy. On the other hand, if the government ignites a bailout financed by inflation tax, devaluation (inflation) helps improve corporate balance sheet. This is the “financial” tradeoff that a government faces. The latter force can be strong enough to overturn the model's prediction with only the currency mismatch effect, so that a larger devaluation relative to the inflation stabilization policy might be preferred. I proceed to explore the model prediction without bailout option (only currency mismatch effect) first and then take into account using inflation tax to bailout in “sudden stop” episodes.

### 4.1 Currency Mismatch Effect (No Bailout)

I ignore bailout options in this section. For currency mismatch effect to work, financial constraints have to matter. When a “sudden stop” shock leads to both binding collateral constraint and dividend constraint at time  $t$ , I have

$$\frac{b_{t+1}}{1+r_t} = \kappa_t k_t, \quad (46)$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 = \underline{d}. \quad (47)$$

We already know the inefficiency comes from the binding dividend constraint and there is too little investment. Investment is financed by new borrowing, new equity issuance and retained earnings. When there is sticky price for  $P_t^N$ , devaluation will decrease  $p_t^N$ , making the real earnings of firms less. As firms are constrained in external financing, currency devaluation lowers the real value of retained earnings and thus decreases investment further. This is the intuitive reason in my model why less devaluation (relative to the inflation stabilization policy) is desirable to mitigate this currency mismatch effect.

To elaborate this point more formally, I do the following local analysis. Suppose the government always commits to inflation stabilization policy in the future from  $t + 1$  on but firms are facing binding borrowing and dividend constraints at time  $t$ . The government is only allowed to optimally choose her monetary policy in time  $t$ . I denote  $\hat{x}_t$  as the percentage deviation from time  $t$  solution under the inflation stabilization policy. I summarize the theoretical result below.

**Proposition 5** *If*

$$\frac{p_t^N c_t^N}{c_t^T} \chi < 1, \quad (48)$$

*then a devaluation leads to currency mismatch problem: if  $\hat{\epsilon}_t > 0$  then  $\hat{p}_t^N < 0$ ,  $\hat{\pi}_t^N > 0$  and  $\hat{i}_t < 0$ . Here  $p_t^N$ ,  $c_t^N$  and  $c_t^T$  are solutions under inflation stabilization policy at time  $t$ .*

**Proof.** See Appendix. ■

This proposition implies that if the government chooses to decrease devaluation rate locally, then investment will go up. I notice that  $\frac{p_t^N c_t^N}{c_t^T} \chi < 1$  is a sufficient condition that is not hard to be satisfied empirically. On the one hand,  $\chi$  is the inverse of elasticity of labor supply, the macro estimate of  $\frac{1}{\chi}$  is usually large. For example, in Chetty et al. (2011), this number can be as high as 2.85. The ratio of nontradable consumption expenditure and tradable consumption expenditure, for instance, in the Philippines is  $0.58/0.42 = 1.38$ . Therefore, the sufficient condition is easily satisfied. The economics here is that if labor response is very small (very high  $\chi$ ) and since capital stock is pre-determined, non-tradable output will hardly change. The relative price  $p_t^N$  is pinned down by the demand function  $p_t^N = \frac{1-a}{a} \left( \frac{c_t^N}{c_t^T} \right)^{-\frac{1}{\xi}}$ . Therefore, exchange rate policy can hardly alter the real value of revenues when  $\chi$  is too large.

As a summary, the cost of devaluation includes the cost of inflation: inefficient wedge when choosing labor input and the price adjustment cost itself (it is second order in local analysis), which are conventional in models with that include a price adjustment cost. Moreover, with dollar debt and financial frictions, a currency mismatch cost shows up. The currency mismatch effect is the reason why government will prefer less devaluation (when no bailout is allowed) compared to the devaluation rate under the inflation stabilization policy.

I now move to global analysis and focus on time-consistent optimal monetary policy, i.e., discretionary optimal policy.

**Definition 1 (*Optimal Time-Consistent Monetary Policy: Currency Mismatch Effect*)**

*Given the future exchange rate policy, and implied future private sector policy functions, the government solves the Bellman problem at each time:*

$$V^{cm}(b, k, p_{-1}^N, ES) = \max_{\{\epsilon, c, c^T, c^N, y^N, \lambda, h, i, k', b', \nu, \mu, p^N, w, \pi^N\}} u(c - v(h)) + \beta EV^{cm}(b', k', p^N, ES') \quad (49)$$

*subject to the equilibrium conditions from equation (60) to (75). Time consistency requires current policy coincides with future policy.*

In the quantitative analysis section, I will numerically solve the above policy.

## 4.2 Bailout

Suppose that now the government is entitled to choose to implement a bailout financed by inflation tax in crises. Denote  $\omega^b \geq 0$  as the bailout transfer from the government to firms. The budget constraint of non-tradable sector firms will be changed to include bailout term  $\omega_t^b$

$$div_t = p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 + \omega_t^b. \quad (50)$$

The bailout fund is financed by the inflation tax:

$$\omega_t^b \leq it_t - \frac{\phi^b}{2} it_t^2,$$

where  $\phi^b \geq 0$  reflects the inefficiency problem when government implements bailout policy. It could come from that due to information problem, the government is not 100% certain who are the right objects to do bailout transfer. When  $\phi^b = 0$ , there is no inefficiency problem. The efficiency loss when government does financial policies is introduced in e.g., Gertler, Kiyotaki and Queralto (2012). The existence of  $\phi^b \geq 0$  in fact decreases bailout incentives and thus devaluation rate.

When nominal rigidities are minuscule, using more inflation tax to bailout means having more transfer to firms in crises, relaxing their financial constraints without cost. Therefore, larger devaluation should be preferred. Another polar case is that when inflation tax is minuscule, i.e.,  $\theta = 0$ , the solution returns to the case without bailout. Therefore, the extent of nominal rigidities and the amount of inflation tax shall affect whether bailout incentives dominate currency mismatch or not.

I move to formally establish the time-consistent optimal policy with bailout. I assume that the government can only have the option to bailout when tighter borrowing constraint  $\kappa_L$  happens. One rationale is that in normal times, it is politically infeasible or the political obstacle is too high to carry out a bailout. When the government initiates a bailout, she also needs to incur a fixed utility loss  $f_e$ . The utility loss  $f_e$  can be interpreted as political cost or captures other fixed costs to implement a bailout.

**Definition 2 (Optimal Time-Consistent Monetary Policy: Bailout)** *Given future exchange rate policy  $\epsilon$  and bailout policy  $\omega^b$ , and implied future private sector policy functions, the government solves the Bellman problem at each time:*

$$V^{bt}(b, k, p_{-1}^N, ES_{-1}, ES) = \max_{\{\epsilon, it, \omega^b, c, c^T, c^N, y^N, \lambda, h, i, k', b', \nu, \mu, p^N, w, \pi^N\}} u(c-v(h)) - f_e 1_{\omega^b > 0} + \beta EV^{bt}(b', k', p^N, ES, ES') \quad (51)$$

subject to

$$\omega_t^b \leq it_t - \frac{\phi_b}{2} it_t^2, \quad (52)$$

$$it_t = \theta \left( y_t^T - \frac{y_{t-1}^T}{\epsilon_t} \right), \quad (53)$$

and equilibrium conditions from equation (60) to (75), except equation (68) and (69) are replaced by

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 + \omega_t^b \geq \underline{d},$$

$$\mu_t \left( p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 + \omega_t^b - \underline{d} \right) \geq 0.$$

Time consistency requires current policy coincides with future policy.

In the quantitative analysis section, I will numerically solve the above policy as well.

## 5 Quantitative Analysis of Financial Crises and Optimal Monetary Policy

In the following section, I hope to quantitatively analyze the model's performance and characterize optimal policy. I have in mind a financial crisis in a country who is exposed to foreign currency external debt and the government actively implements bailout during the crisis, for instance, Thailand, Indonesia, Malaysia and the Philippines in the Asian financial crises in 1998. As the interest

rate data (EMBI spread) is available for the Philippines for a relatively long period, I use the Philippines data to calibrate the model. As my model features occasionally binding constraints, I solve my model using global methods. The computational algorithm is detailed in the Appendix.

## 5.1 Calibration

### 5.1.1 Exogenous Processes

The model has exogenous shocks of a triplet  $(y_t^T, r_t, \kappa_t)$ .  $(y_t^T, r_t)$  are directly observable in the data. The law of motion of  $(y_t^T, r_t)$  is assumed to be a joint process

$$\begin{bmatrix} \log y_t^T \\ \log\left(\frac{1+r_t}{1+r}\right) \end{bmatrix} = A \begin{bmatrix} \log y_{t-1}^T \\ \log\left(\frac{1+r_{t-1}}{1+r}\right) \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \quad (54)$$

where the last term is white noise distributed by  $N(0, \Sigma)$  and  $r$  is the mean of real interest rate.

The available quarterly data spans over 1998Q1:2016Q4. The tradable sector is the summation of Agriculture, Hunting, Forestry, Fishing, Mining, Quarrying and Manufacturing. The cyclical component of tradable output  $\log y_t^T$  is obtained by removing the log-quadratic trend.<sup>19</sup> The real interest rate is the sum of the EMBI global spread for Philippines and 3-month US T-bill rate, deflated by the expected dollar inflation.<sup>20</sup>

The estimates of coefficient matrix  $A$ , covariance matrix  $\Sigma$  and mean real interest rate are

$$A = \begin{bmatrix} 0.9593 & -0.0001 \\ 0.0341 & 0.8037 \end{bmatrix}; \Sigma = \begin{bmatrix} 0.000023 & -0.000005 \\ -0.000005 & 0.000286 \end{bmatrix}; r = 0.0048 \quad (55)$$

The result implies that both tradable output and real interest rate are very persistent. The shock components are negatively correlated. The steady state annualized real interest rate is 1.934 percent.

I discretize  $(\ln(y_t^T), r_t)$  with five states. Denote  $\ln(y_t^T)^a$  and  $r^a$  as the mean of  $\ln(y_t^T)$  and  $r_t$ ;  $\ln(y_t^T)^l$  and  $r^l$  as one standard deviation below mean;  $\ln(y_t^T)^h$  and  $r^h$  as one standard deviation above mean.<sup>21</sup> The first state is the ‘‘average state’’  $(\ln(y_t^T)^a, r^a)$ . The other four states are  $(\ln(y_t^T)^h, r^l)$ ,  $(\ln(y_t^T)^h, r^h)$ ,  $(\ln(y_t^T)^l, r^l)$ ,  $(\ln(y_t^T)^l, r^h)$ . Similar to Schmitt-Grohé and Uribe (2016a), I construct the transition probability matrix by simulating equation (54) 1 million times. I associate

<sup>19</sup>I implement seasonal adjustment to the raw data before removing the trend component using X13-ARIMA.

<sup>20</sup>I construct real interest rate  $r_t$  from  $1 + r_t = (1 + i_t)E_t \frac{1}{1+\pi_{t+1}}$ , where  $i_t$  is the sum of the EMBI global spread and US 3-month T-bill rate. I follow Schmitt-Grohé and Uribe (2016a) to obtain  $E_t \frac{1}{1+\pi_{t+1}}$  by using the predicted value of  $\frac{1}{1+\pi_{t+1}}$  with an AR(2) model augmenting data from 1960Q1 to 2016Q4.

<sup>21</sup>This strategy of using one standard deviation above mean and below mean to represent high and low states are also used in e.g., Mendoza (2010), Bianchi (2016). The difference is that I additionally have an ‘‘average state’’, corresponding to states of neither boom nor bust.

each observation in the time series with one of the 5 possible discrete states by euclidean distance minimization. Therefore, I obtain a  $5 \times 5$  transition matrix  $\Pi^0$  for  $(\ln(y^T), r)$ .

I further insert  $\kappa_t$  shock. I pick up two values  $\kappa^H$  and  $\kappa^L$ . As will be clearer in the calibration,  $\kappa^H$  is chosen to be large enough so that debt constraint will never bind in that state. But  $\kappa^L$  is the state where it is possible that debt constraint becomes binding. I assume that  $\kappa^L$  only possibly appears when  $(\ln(y^T)^l, r^h)$  happens. This assumption is in order as usually during a current account reversal, both borrowing cost is high and tradable output is low. Therefore, the previous state  $(\ln(y^T)^l, r^h)$  breaks into two states  $(\ln(y^T)^l, r^h, \kappa^H)$  and  $(\ln(y^T)^l, r^h, \kappa^L)$ . In the Appendix, I explain in detail about how to construct the updated transition matrix with  $\kappa_t$ , which is a  $6 \times 6$  dimension matrix  $\Pi$ .

### 5.1.2 Parameter Values

Table 6 summarizes parameter values. Risk aversion  $\sigma$  is set to a standard value in macro literature as 2. The elasticity of substitution  $\xi$  between tradables and non-tradables follows Rozada et al. (2004) estimation for Argentina 0.44. I don't have an available estimate for the Philippines on  $\xi$ , so I take a practical route to use the value for Argentina, which is also an emerging country. Stockman and Tesar (1995) estimates the elasticity between tradables and nontradables for developed countries and returns a value of 0.44 as well. Elasticity of substitution between non-tradable varieties  $\gamma$  is set to 3, which falls into range in the literature. The labor supply elasticity  $\frac{1}{\chi}$  is set to 1.5, which falls into the range of literature on the macro estimate. Capital depreciation rate  $\delta$  is set to 0.05. Neumeyer and Perri (2005) uses  $\delta = 0.044$  when studying a group of emerging countries' business cycles, where the Philippines is one of their sample countries. Using firm level data, Bu (2006) find that in the Philippines, aggregate capital stock annual depreciation rate is 20.3% in 1996-1999.

The labor share  $\alpha_h$  is calibrated to be 0.42 after I average Philippines' labor share from 1970-2014 provided in the Penn World Table. The land share 0.05 is taken from Bianchi and Mendoza (2013). The capital share is computed as  $\alpha_k = 1 - \alpha_h - \alpha_l = 0.53$ . The consumption share of tradable goods is 0.42 based on the information in Philippines input-output table. When the external imbalance is not large, parameter  $a$  should be near to consumption share, so I directly set  $a = 0.42$ .

Parameters  $(\psi_h, z, \beta, \phi, \kappa_L, \kappa_H, \underline{d}, f_e, \phi^b, \psi, \theta)$  are set to target various objects. Labor disutility coefficient  $\psi_h$  and labor productivity scale parameter  $z$  are calibrated to normalize average hours to 1 and average non-tradable output  $y^N$  to 1. The subjective discount factor  $\beta$  is chosen to be 0.985 such that the average capital/value of output in the non-tradable sector is 8.7. The value 8.7 is from the economy wide capital stock/GDP ratio in the Penn World Table. The capital adjustment cost parameter  $\phi = 9$  is to match the standard deviation of investment  $i$ /standard deviation of

non-tradable output to be 2.3 as in the Philippines economy wide data. I choose  $\kappa_H = 0.52$  which is high enough so that debt constraint will never be binding. I set  $\kappa_L = 0.42$  to match the average net foreign asset position/GDP to be -0.4 as in Philippines data, which is averaged between 1970 and 2011 from Lane and Milesi-Ferretti (2007). The equity market friction parameter  $\underline{d}$  is set to be -0.01. In reality, it is not easy to tell what is the exact correspondence to  $\underline{d}$ . I take a stand that equity market binding is less frequent than capital flow reversal. Notice in my model, the inefficiency comes from the equity market friction, I would like to think these severe episodes are rarer than capital flow reversal itself.  $\underline{d} = -0.01$  is chosen so that the probability of equity market binding to be roughly half of the probability of debt market binding. This strategy also captures the pecking order theory of corporate financing, where firms first exhaust their borrowing capacity then seek for equity financing. Note the equity market frictions are very important for us to generate scope of bailout. In reality, it is rare that firms issue equity during crises. I have indeed set it below 0 such that firms are allowed to issue a bit equity. The values for  $f_e$  and  $\phi^b$  are set to roughly match 0.01% of consumption and bailout inefficient loss of about 10% of total bailout. It is not easy to directly observe these targets. One can reduce  $f_e$  or  $\phi^b$ , then I get more bailout and larger currency devaluation. Since my paper's key is that there is substantial bailout in crises(as in the data), I don't attempt to set too high values for  $f_e$  or  $\phi^b$  to shut down bailout. Parameter  $\theta$  is to match the M1/GDP of Philippines around Asian Financial Crises.<sup>22</sup> Finally, the price adjustment cost  $\psi = 0.4$  is to match standard deviation of  $\pi_t^N = 0.007$  as in Philippines data.<sup>23</sup>

After calibration, I turn to characterizing the dynamics of the model. I first focus on the inflation stabilization policy (equivalent to the real economy). It serves as the benchmark policy to help understand private agents' behavior. Then I turn to optimal time-consistent monetary policy without bailout and with bailout. I will explore the role of existing debt in determining the magnitude of devaluation rate.

## 5.2 Inflation Stabilization Policy

The inflation stabilization policy is my benchmark policy because 1) it replicates allocation of the economy without nominal rigidities ( $\psi = 0$ ) and 2) if domestic equity friction has been non-existent, it achieves the social planner allocation. I will use this policy to inspect the basic model mechanism in the private sector.

---

<sup>22</sup>In the end of 1999, Philippines nominal annual GDP is 3.24e+12 pesos and M1 stock is 3.94e+11 pesos. In quarterly unit, M1/GDP=0.49.

<sup>23</sup>I have quarterly CPI information from year 1994 on from Bangko Sentral ng Pilipinas (central bank of Philippines). They provide price index for different consumption categories. I take the following categories as non-tradable consumption: 1) housing, water, electricity, gas and other fuels 2) furnishing, household equipment and routine maintenance of the house 3). health 4) transport 5) communication 6)recreation and culture 7) education 8) restaurants and miscellaneous goods and services. The weight for each category is also given in the dataset.

Figure 5 displays the policy functions of dividend payment with and without equity friction. I have the following observations. First of all, dividend is strictly decreasing in the current debt burden until it hits the dividend constraint. Secondly, when debt is very low, policy functions look very near to each other. The reason is that when debt is low, firms are far away from binding financial constraints thus financial frictions don't matter much. Thirdly, under  $\kappa_H$ , as current debt increases, with equity friction, firms exhibit precautionary behavior by paying less dividend and select more conservative next period debt. When current debt is too high, however, dividend constraint starts to bind. Fourthly, the binding dividend constraint also shows up with equity friction under  $\kappa_L$  when existing debt is too high. Finally, the existence of tighter borrowing constraint ( $\kappa_L$  compares with  $\kappa_H$ ) makes dividend constraint bind at a lower current debt threshold.

[Figure 5 here]

Figure 6 compares policy functions of debt and capital with equity friction and without equity friction. Panel (a) is debt policy. The first observation is due to domestic financial frictions, there is precautionary motive: under  $\kappa_H$ , the debt choice is more conservative with equity friction compared to the without equity friction case. This precautionary motive is more pronounced when current debt is already high. While under  $\kappa_L$ , when current debt is high, the debt constraint becomes binding. Panel (b) is capital stock policy. The above-mentioned precautionary motive makes capital choice smaller with equity friction compared to without equity friction both under  $\kappa_H$ , especially when current debt is high. On the contrary, under  $\kappa_L$  when current debt is high, debt constraints become binding both with and without equity friction, capital is smaller with equity friction. The reason is that when equity constraint also becomes binding, there is inefficiently more investment drop. The divergent point between these two lines is the point where equity constraint becomes binding. Overall, I find next period capital is decreasing with current debt and firms do more so when current debt is high: firms are paying down debt by not investing too much or are forced to do so.

[Figure 6 here]

Figure 7 turns to the limiting distributions of the two endogenous state variables: debt and capital. I simulate the economy 1 million times and plot the density function of debt and capital after throwing away sufficient long burning periods. In panel (a), I can see that with equity friction, the debt distribution is on the left of that without equity friction. It reflects the precautionary motive associated with domestic equity friction. Firms are willing to shy away from the binding equity constraint by borrowing less so that a "sudden stop" shock brings less pain to them. Another observation is each distribution has fat tail on the left. This skewness reflects the precautionary motive associated with debt constraint. Even without equity friction, firms are unwilling to hit or

hit too hard the collateral constraint on the debt market. In panel (b), the capital distributions are much similar. The reason is I have capital adjustment cost but no debt adjustment cost, so firms reduce debt instead of increasing capital stock too much, when equity friction is present. I still see, however, slightly higher capital under equity friction.

[Figure 7 here]

Lastly, I turn to sudden stop dynamics. Figure 8 shows the results. After I simulate the economy, I take non-overlapping windows where the first 4 quarters are with  $\kappa_H$  (no bad financial shock) and the following 4 quarters are with  $\kappa_L$  ("sudden stop" shock arrives in period 0 in the figure). I average each variable across these windows. Each variable is expressed as percentage change to the mean of that variable except exchange rate at period -4 is normalized to 1 and I use average devaluation rate to plot exchange rate from period -3 to period +4.

The sudden stop dynamics conforms to what I expect. Tradable output and interest rate are exogenous in my model. Since by construction I have related  $\kappa_L$  to  $(y^L, r^H)$ , the drop in tradable endowment and rise in interest rate are in order. The decline in external debt is driven by the  $\kappa$  shock where firms can not roll over its debt as they desire. The shock forces the economy to improve its trade balance and tradable consumption drops.

A key feature of this open economy model is the spillover from tradable sector to non-tradable sector. Since tradable consumption drops, the demand for non-tradable good also falls because tradable consumption and non-tradable consumption are complementary. Therefore, the relative price of non-tradable good (real exchange rate) falls. Capital stock drops due to several reasons. The decline in demand for non-tradable consumption is one. Another reason is the lack of financing source. Sometimes when firms would like to issue equity to finance its investment but they find them unable to do so due to the equity market frictions. The collapse in non-tradable good demand also pushes down labor demand thus hours worked also falls. Finally, inflation stabilization requires exchange devaluation because real exchange rate depreciates in sudden stop episodes.

[Figure 8 here]

### 5.3 Optimal Monetary Policy

In this section, I compare optimal time-consistent monetary policy with and without bailout policy. The inflation stabilization policy tells us there is already currency devaluation under sudden stop shock. Recall that when there is no bailout policy, the benevolent government still needs to take care of the currency mismatch cost. While with bailout policy, the government also needs to monetize its chosen bailout size.

### 5.3.1 Foreign Currency Liability and Currency Devaluation

To convey the key insight of the difference between with or without bailout policy, I begin by directly comparing policy functions of exchange rate under different policies. For illustrative purpose, I fix endogenous state variables  $(k_t, p_{t-1}^N)$  at their mean values under inflation stabilization policy's simulations conducted above and set previous period's exogenous state as  $(y^L, r^H, \kappa^H)$ . The current period is hit by the sudden stop shock  $(y^L, r^H, \kappa^L)$ . I vary the existing debt levels and compare the exchange rate policy functions under different policies.

Figure 9 displays the results. When existing debt is low, inflation stabilization policy, optimal policy without bailout and with bailout track each other closely. This is because domestic financial constraints don't matter in this region yet even if the economy is hit by a sudden stop shock. When existing debt becomes higher, however, domestic financial constraints become relevant. Exchange rate policy functions also diverge. For inflation stabilization policy, I can see that devaluation rate ceases to increase in the high current debt region. The reason is that when domestic financial frictions bind, there is inefficiently too little investment, and by market clearing, there is inefficiently too much tradable consumption.<sup>24</sup> Therefore, the demand of non-tradable good ceases to fall as well.

If bailout policy is not considered but currency mismatch effect is present, under optimal policy, exchange rate devaluation becomes more conservative compared to the inflation stabilization policy. Moreover, larger current debt calls for less devaluation. The reason is that larger existing debt makes financial frictions bind more severely and the government needs to be more concerned about the currency mismatch effect. This corresponds to the currency mismatch view that large foreign currency liability makes the government reluctant to devalue.

On contrary, with bailout which needs to be monetized, under optimal policy, exchange rate devaluations become more aggressive compared to the inflation stabilization policy. In addition, larger current debt calls for more devaluation. The reason is that larger existing debt demands more bailout and thus more inflation tax. The prediction of exchange rate devaluation is not consistent with the conventional "fear of floating" but embraces the empirical relationship in the data.

[Figure 9 here]

In my earlier empirical studies, I use foreign currency liability/GDP ratio before crises as the key explanatory variable. One concern is that it could be that lower pre-crisis debt also coincides with lower GDP. If high liability/GDP ratio doesn't reflect high liability level but just coincides with low liability and even lower GDP, then only looking at the relationship between debt level and exchange

---

<sup>24</sup>This doesn't mean there is consumption boom. In general, consumption still falls compared to pre-shock period.

rate devaluation above is not direct. So I simulate the economy under optimal policy with bailout, and take out all the incidences when bailout happens.<sup>25</sup> I compute the before bailout debt/GDP (1 year before) and run simple regressions of devaluation rate ( $\log \frac{E_t}{E_{t-1}}$ ), inflation ( $\pi_t/(1 + \pi_t)$ ) and bailout  $\log(\frac{\omega_t^b}{k_{t+1}})$ <sup>26</sup> when bailout is implemented, on the pre-bailout debt/GDP (1 year before):

$$\text{devaluation rate}_i = \beta_0 + \beta_1 \cdot \text{debt/GDP}_i + \epsilon_i, \quad (56)$$

$$\text{inflation}_i = \gamma_0 + \gamma_1 \cdot \text{debt/GDP}_i + \varepsilon_i, \quad (57)$$

$$\text{bailout}_i = \zeta_0 + \zeta_1 \cdot \text{debt/GDP}_i + u_i. \quad (58)$$

I further feed in the corresponding exchange rate and inflation policy function without bailout option for the same incidences and run similar regressions. Regression results are reported in Table 7. I find that with bailout, all the above 3 point estimates  $\hat{\beta}_1$ ,  $\hat{\gamma}_1$  and  $\hat{\zeta}_1$  are all positive and statistically significant, all consistent with the empirical counterpart. Specifically, when compared with the non-OECD sample's empirical results, I match the size of bailout relatively well. The point estimates of inflation is higher than the empirical part. The point estimates of devaluation is slightly higher than the empirical part. This could reflect the fact that in reality government also employs other financing options for the bailout, in addition to the inflation tax, e.g., seeking for IMF bailout or government spending cut. When I consider optimal policy without bailout, however, the point estimates of  $\hat{\beta}_1$ ,  $\hat{\gamma}_1$  are negative and significant, which are opposite to my empirical findings. Moreover, by construction, policy designed under no bailout option doesn't have any prediction on bailout.

[Table 7 here]

### 5.3.2 Ex-ante Risk Taking

Having studied the ex-post policy responses, I now turn attention to ex-ante firm decisions. The anticipation of bailouts can possibly induce more risk-taking, making the economy more vulnerable when bad shocks hit.

I use the simulated series under inflation stabilization policy and take out the sudden stop windows defined as before. I start with the same period -4 state variables and then feed in the policy functions under optimal monetary policy with and without bailout from period -4. I construct the average dynamics across these windows under optimal policy without and with bailout. In this

<sup>25</sup>In the dataset I use from Laeven and Valencia (2012), one necessary criterion of a crisis is significant government interventions.

<sup>26</sup>Using market value of firm asset instead of book value will not change the sign of my estimation.

experiment, by controlling for the initial endogenous state variables and the same sequence of exogenous shocks, I can conduct meaningful counterfactual analysis with different policies.

The exchange rate dynamics is in Figure 10. I see that when sudden stop shock arrives the devaluation rate under optimal policy without bailout is indeed more conservative than the case under inflation stabilization, reflecting the currency mismatch channel. While the devaluation rate under optimal policy with bailout is much larger than the case under inflation stabilization due to the bailout incentives.

[Figure 10 here ]

There is also exchange rate appreciation from period -4 to -1 under optimal policy with bailout. The reason is that with bailout, firms understand that they can get bailout had bad things happen in the future. Therefore, they are willing to build up higher leverage and build up more capital stock by investing more (to a lesser extent and this implies the high leverage is used to pay dividend mostly), see Figure 11. Therefore, my model generates a expectation-of-bailout driven credit boom. This finding shares the feature with Krugman (1998) and Corsetti, Pesenti and Roubini (1999) where implicit guarantees from the government lead to credit and investment booms. Moreover, not surprisingly, inflation on average rises when sudden stop shock hits if inflation tax to bailout is allowed. But when there is no bailout option, inflation decreases when sudden stop shock hits. The consumption and employment boom from period -4 to -1 are in order as well due to the credit boom. The high leverage reflects the moral hazard problem and makes the economy more vulnerable ex-post because of the higher leverage ( $b/k$ ) of non-tradable sector firms.

[Figure 11 here ]

### 5.3.3 Welfare Analysis

The ex-ante moral hazard problem and the resulting substantial inflation in crises makes us interested in the welfare implications of bailout policy. I conduct the following analysis. I compute the percentage increase in consumption after imposing bailout option. Formally, for each state, I calculate  $g_0$  as follows

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^* - v(h_t^*)) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t(1 + g_0) - v(h_t)), \quad (59)$$

where subscript \* denotes optimal policy with bailout option while  $c_t$  and  $h_t$  are consumption and labor supply under optimal policy without bailout option. I can compute the welfare gains for each given state.

[Figure 12 here]

Figure 12 shows the welfare gains results by an example.<sup>27</sup> For exogenous state variables, the economy transits from last period  $((y^T)^H, r^H, \kappa^H)$  to current period  $((y^T)^L, r^H, \kappa^L)$ . For endogenous state variables, I fix state capital stock  $(k)$  and non-tradable good relative price  $(p^N)$  at their respective mean values under inflation stabilization policy, and vary current debt  $b$ . When current debt is low, the welfare gains are very small and varying current debt doesn't change the welfare gains much. When debt increases further, however, the welfare gains increase dramatically. The reason is that when current debt is high enough, financial constraints start to matter. The bailout policy takes effect. My results on welfare gains from bailout policy is of similar magnitude with Bianchi (2016) where he explores bailout policy in a real economy.<sup>28</sup> In my model, bailout needs to be monetized and leads to inflation cost as well ex-post. In conclusion, in spite of the moral hazard effect ex-ante, there are still welfare gains from bailout policy.

## 6 Foreign Currency Debt, Bailout and Firm Performance

In this section, I provide cross-firm empirics to support my theory's implications on firm level performance. My emphasis on bailout and currency mismatch implies that if an individual firm does not receive bailout or other subsidies in crises, it will suffer from currency mismatch problem while if a firm gets bailout or other subsidies, currency mismatch effect on it can be mitigated or even offset (depending on the amount of bailout they obtain). Unfortunately, it is not easy to get a dataset containing information on government subsidies directly and indirectly to firms. A compromise is in order. I will assign firms into two groups: one is a politically-connected group who are more likely to get bailout or other subsidies in crises, argued in the existing literature, and another group contains only politically-unconnected firms who are less likely to get bailout or other subsidies.<sup>29</sup> In other words, I use political connection to proxy the chance of getting bailout or subsidies in crises.

Faccio (2006) provides names of political connected firms around year 1997 in 35 countries. She defines a company as politically connected firm if one of the company's large shareholders is: (a) a member of parliament, (b) a minister or the head of state, or (c) closely related to a top official. The period her dataset covers coincides with the Asian Financial Crises. I need a non-trivial number of political connected firms to conduct meaningful empirical studies. The existing empirical literature

---

<sup>27</sup>I also check every point on the grid, optimal policy with bailout gives higher welfare than that under optimal policy without bailout.

<sup>28</sup>See also Bolton and Rosenthal (2002) for ex-ante welfare analysis in a model with ex-post state-contingent moratoria.

<sup>29</sup>See e.g., Faccio, Masulis and McConnell (2006), Acemoglu et al. (2016), and Johnson and Mitton (2003).

has investigated political connection does affect Indonesia and Malaysia stock return (see Fisman (2001), Johnson and Mitton (2003)). I will use these two countries' firms as my benchmark sample. The Faccio (2006) dataset identifies substantial number of political connected firms in Indonesia (68 firms) and Malaysia (176 firms)<sup>30</sup>, and both countries suffer from the Asian Financial Crises. I thus create a dummy variable *connected* = 1 for politically connected firms, and the variable takes value 0 otherwise.

I collect firm balance sheet information from the Thomson Reuters Worldscope database. Worldscope data is available via WRDS (Wharton Research Data Services). *Sales growth* in the crises (year 1997-1999) is the dependent variable I am interested in. Firm *size* is measured by  $\ln(\text{asset})$  before crises break out after 1997 July. Since I have annual information, I take end of year 1996 information. Firm total *leverage* is firm debt stock divided by its asset in year 1996.

The last dataset I use is Thomson One loan and bond where currency denomination information of debt is provided. I gather foreign currency debt and calculate *FC leverage* as foreign currency debt (issued before 1997 July but matured after 1997 July) divided by firm asset in year 1996.

I hand-match the above 3 data sources. Many firms have changed their names through years, in the matching process, I seek for the help of Orbis database, where their website offers previous names of firms if firms change their names. Table 8 report the empirical results with which I always control for country-industry dummies, size and access to foreign currency debt.<sup>31</sup> All columns show that high leverage before crises does harm to sales growth in crises. In column (1), I directly exclude politically connected firms and find evidence of currency mismatch effect, that is, higher foreign currency debt before crises is related to slower sales growth during crises. In column (2), when mixing both politically connected and unconnected firms, the role of foreign currency debt is weakened and turns insignificant. In column (3), I find that the summation of coefficients before FC leverage and the interaction between FC leverage and political connection is even positive though not statistically significant, meaning that politically connected firms don't suffer from currency mismatch effect. Overall, these findings echo my theory's implications on individual firms that whether firms suffer from currency mismatch effect hinges on their prospect of obtaining bailout or other subsidies in crises.

[Table 8 here]

---

<sup>30</sup>My empirical results are robust to including Thailand and Philippines data, where Faccio (2006) identifies 84 and 5 politically connected firms in Thailand and Philippines, respectively.

<sup>31</sup>It is a dummy variable which takes 1 if a firm has foreign currency debt and 0 otherwise.

## 7 Conclusion

In this paper, I investigated the optimal bailout policy and monetary policy in open economies. I started from empirical evidence from financial crisis episodes and found that higher foreign currency liability before crises is associated with larger devaluation during crises. This finding is at odds with what a currency mismatch argument alone would predict for policies. I proposed that taking into account inflation tax to bailout helps to reconcile the pattern. My empirical results further show that higher foreign currency liability/GDP ratio is associated with higher inflation and larger bailout.

I then built up a quantitative open economy model with both nominal rigidities and financial frictions. The framework nests both currency mismatch and inflation tax to bailout. When there is only currency mismatch effect, larger foreign currency liability implies that the government needs to be more concerned about the currency mismatch cost. Therefore, the government chooses less devaluation. I find that with using inflation tax to bailout option, in my calibrated model, bailout incentives can dominate currency mismatch concerns for government, leading to a large devaluation in a financial crisis. Higher foreign currency liability calls for larger bailout and thus larger devaluation, consistent with the above-mentioned empirical patterns.

Finally, I performed firm-level empirical studies to show that the extent a firm suffers from currency mismatch effect depends on its chance of obtaining bailout. This echoes my emphasis on not only the existence of currency mismatch effect but also the important role of bailout.

My theoretical framework introduced explicit financial frictions into a New Keynesian open economy model and discusses optimal policies. In the current work, I have exclusively focused on bailout policies and monetary policies and neglected many other important aspects of macro policies, e.g., foreign reserves, capital controls and financial regulations on leverage etc. I also have not studied the currency composition of external debt, see e.g., Salomao and Varela (2016) and the implications on optimal policy response in this paper. I view these as fruitful research agenda in my future work in open economy framework with nominal rigidities and financial frictions.

## References

- Acemoglu, Daron, Simon Johnson, Amir Kermani, James Kwak, and Todd Mitton.** 2016. “The value of connections in turbulent times: Evidence from the United States.” Journal of Financial Economics, 121(2): 368–391.
- Acemoglu, Daron, Simon Johnson, James Robinson, and Yunyong Thaicharoen.** 2003. “Institutional causes, macroeconomic symptoms: volatility, crises and growth.” Journal of monetary economics, 50(1): 49–123.
- Aguiar, Mark.** 2005. “Investment, devaluation, and foreign currency exposure: The case of Mexico.” Journal of Development Economics, 78(1): 95–113.
- Aoki, Kosuke, Gianluca Benigno, and Nobuhiro Kiyotaki.** 2016. “Monetary and Financial Policies in Emerging Markets.”
- Aslund, Anders.** 2015. “Ukraine: What went wrong and how to fix it.”
- Bai, Chong-En, and Shang-Jin Wei.** 2000. “Quality of bureaucracy and open-economy macro policies.” National bureau of economic research.
- Bénétrix, Agustín S, Philip R Lane, and Jay C Shambaugh.** 2015. “International currency exposures, valuation effects and the global financial crisis.” Journal of International Economics, 96: S98–S109.
- Bianchi, Javier.** 2011. “Overborrowing and Systemic Externalities in the Business Cycle.” The American Economic Review, 101(7): 3400.
- Bianchi, Javier.** 2016. “Efficient Bailouts?” American Economic Review, 106(12): 3607–59.
- Bianchi, Javier, and Enrique G Mendoza.** 2013. “Optimal time-consistent macroprudential policy.” National Bureau of Economic Research.
- Bleakley, Hoyt, and Kevin Cowan.** 2008. “Corporate dollar debt and depreciations: much ado about nothing?” The Review of Economics and Statistics, 90(4): 612–626.
- Bocola, Luigi, and Guido Lorenzoni.** 2017. “Financial Crises and Lending of Last Resort in Open Economies.” mimeo.
- Bolton, Patrick.** 2016. “Presidential Address: Debt and Money: Financial Constraints and Sovereign Finance.” The Journal of Finance, 71(4): 1483–1510.

- Bolton, Patrick, and Howard Rosenthal.** 2002. “Political intervention in debt contracts.” Journal of Political Economy, 110(5): 1103–1134.
- Brav, Alon, John R Graham, Campbell R Harvey, and Roni Michaely.** 2005. “Payout policy in the 21st century.” Journal of Financial Economics, 77(3): 483–527.
- Brunnermeier, Markus K, and Yuliy Sannikov.** 2014. “A macroeconomic model with a financial sector.” The American Economic Review, 104(2): 379–421.
- Bu, Yisheng.** 2006. “Fixed capital stock depreciation in developing countries: Some evidence from firm level data.” The Journal of Development Studies, 42(5): 881–901.
- Calvo, Guillermo A, and Carmen M Reinhart.** 2002. “Fear of floating.” The Quarterly Journal of Economics, 117(2): 379–408.
- Céspedes, Luis Felipe, Roberto Chang, Andrés Velasco, et al.** 2004. “Balance Sheets and Exchange Rate Policy.” American Economic Review, 94(4): 1183–1193.
- Chari, VV, and Patrick J Kehoe.** 2016. “Bailouts, time inconsistency, and optimal regulation: A macroeconomic view.” The American Economic Review, 106(9): 2458–2493.
- Chetty, Raj, Adam Guren, Day Manoli, and Andrea Weber.** 2011. “Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins.” The American Economic Review, 101(3): 471–475.
- Clarida, Richard, Jordi Gali, and Mark Gertler.** 2001. “Optimal monetary policy in open versus closed economies: an integrated approach.” The American Economic Review, 91(2): 248–252.
- Cook, David.** 2004. “Monetary policy in emerging markets: Can liability dollarization explain contractionary devaluations?” Journal of Monetary Economics, 51(6): 1155–1181.
- Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini.** 1999. “Paper tigers?: A model of the Asian crisis.” European Economic Review, 43(7): 1211–1236.
- Du, Wenxin, and Jesse Schreger.** 2016. “Sovereign risk, currency risk, and corporate balance sheets.” Working Paper.
- Du, Wenxin, Carolin E Pflueger, and Jesse Schreger.** 2016. “Sovereign debt portfolios, bond risks, and the credibility of monetary policy.” National Bureau of Economic Research.

- Eggertsson, Gauti B, and Paul Krugman.** 2012. “Debt, deleveraging, and the liquidity trap: A Fisher-Minsky-Koo approach.” The Quarterly Journal of Economics, 127(3): 1469–1513.
- Eichengreen, Barry, Ricardo Hausmann, and Ugo Panizza.** 2003. “The pain of original sin.” Other People’s Money: Debt Denomination and Financial Instability in Emerging Market Economies, 1–49.
- Faccio, Mara.** 2006. “Politically connected firms.” The American economic review, 96(1): 369–386.
- Faccio, Mara, Ronald W Masulis, and John McConnell.** 2006. “Political connections and corporate bailouts.” The Journal of Finance, 61(6): 2597–2635.
- Fisman, Raymond.** 2001. “Estimating the value of political connections.” The American economic review, 91(4): 1095–1102.
- Frankel, Jeffrey A.** 2005. “Contractionary currency crashes in developing countries.” National Bureau of Economic Research.
- Gali, Jordi, and Tommaso Monacelli.** 2005. “Monetary policy and exchange rate volatility in a small open economy.” The Review of Economic Studies, 72(3): 707–734.
- Gertler, Mark, and Nobuhiro Kiyotaki.** 2010. “Financial intermediation and credit policy in business cycle analysis.” Handbook of monetary economics, 3(3): 547–599.
- Gertler, Mark, and Nobuhiro Kiyotaki.** 2015. “Banking, liquidity, and bank runs in an infinite horizon economy.” The American Economic Review, 105(7): 2011–2043.
- Gertler, Mark, Nobuhiro Kiyotaki, and Albert Queralto.** 2012. “Financial crises, bank risk exposure and government financial policy.” Journal of Monetary Economics, 59: S17–S34.
- Gilchrist, Simon, and Jae W Sim.** 2007. “Investment during the Korean financial crisis: a structural econometric analysis.” National Bureau of Economic Research.
- Huang, Haizhou, and Shang-Jin Wei.** 2006. “Monetary policies for developing countries: The role of institutional quality.” Journal of International Economics, 70(1): 239–252.
- Jácome, Luis I, Tahsin Saadi-Sedik, and Simon Baker Townsend.** 2011. “Can emerging market central banks bail out banks? A cautionary tale from Latin America.” IMF Working Paper.
- Jiao, Yang.** 2016. “When it rains, it pours: capital flows with twin external crises.”

- Johnson, Simon, and Todd Mitton.** 2003. "Cronyism and capital controls: evidence from Malaysia." Journal of financial economics, 67(2): 351–382.
- Kim, Yun Jung, Linda L Tesar, and Jing Zhang.** 2015. "The impact of foreign liabilities on small firms: Firm-level evidence from the Korean crisis." Journal of International Economics, 97(2): 209–230.
- Korinek, Anton, and Damiano Sandri.** 2016. "Capital controls or macroprudential regulation?" Journal of International Economics, 99: S27–S42.
- Krugman, Paul.** 1999. "Balance sheets, the transfer problem, and financial crises." International finance and financial crises, 6(4): 459–472.
- Krugman, Paul R.** 1998. "What happened to Asia?"
- Laeven, Luc, and Fabián Valencia.** 2012. "Systemic Banking Crises Database: An Update."
- Lane, Philip R, and Gian Maria Milesi-Ferretti.** 2007. "The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004." Journal of international Economics, 73(2): 223–250.
- Lane, Philip R, and Jay C Shambaugh.** 2010. "Financial exchange rates and international currency exposures." The American Economic Review, 100(1): 518–540.
- Mendoza, Enrique G.** 2010. "Sudden stops, financial crises, and leverage." The American Economic Review, 100(5): 1941–1966.
- Myers, Stewart C, and Nicholas S Majluf.** 1984. "Corporate financing and investment decisions when firms have information that investors do not have." Journal of financial economics, 13(2): 187–221.
- Neumeyer, Pablo A, and Fabrizio Perri.** 2005. "Business cycles in emerging economies: the role of interest rates." Journal of monetary Economics, 52(2): 345–380.
- Obstfeld, Maurice, and Kenneth Rogoff.** 1995. "Exchange rate dynamics redux." Journal of political economy, 103(3): 624–660.
- Ottobello, Pablo.** 2014. "Optimal Exchange-Rate Policy Under Collateral Constraints and Wage Rigidity."
- Rotemberg, Julio J.** 1982. "Sticky prices in the United States." Journal of Political Economy, 90(6): 1187–1211.

- Rotemberg, Julio J, and Michael Woodford.** 1997. “An optimization-based econometric framework for the evaluation of monetary policy.” NBER macroeconomics annual, 12: 297–346.
- Rotemberg, Julio J, and Michael Woodford.** 1999. “Interest rate rules in an estimated sticky price model.” In Monetary policy rules. 57–126. University of Chicago Press.
- Rozada, Martín González, Pablo Andrés Neumeyer, Alejandra Clemente, Diego Luciano Sasson, and Nicholas Trachter.** 2004. “The Elasticity of Substitution in Demand for Non-Tradable Goods in Latin America: The Case of Argentina.”
- Salomao, Juliana, and Liliana Varela.** 2016. “Exchange Rate Exposure and Firm Dynamics.”
- Schmitt-Grohé, Stephanie, and Martin Uribe.** 2016a. “Downward nominal wage rigidity, currency pegs, and involuntary unemployment.” Journal of Political Economy, 124(5): 1466–1514.
- Schmitt-Grohé, Stephanie, and Martín Uribe.** 2016b. “Is Optimal Capital-Control Policy Countercyclical In Open-Economy Models With Collateral Constraints?” National Bureau of Economic Research.
- Stockman, Alan C, and Linda L Tesar.** 1995. “Tastes and technology in a two-country model of the business cycle: explaining international comovements.” The American Economic Review, 85(1): 168–185.
- Uribe, Martín, and Stephanie Schmitt-Grohé.** 2017. “Open economy macroeconomics.” Princeton University Press.
- Uribe, Martin, and Vivian Z Yue.** 2006. “Country spreads and emerging countries: Who drives whom?” Journal of international Economics, 69(1): 6–36.
- Van der Ghote, Alejandro.** 2016. “Coordinating Monetary and Financial Regulatory Policies.” Tech. rep., Princeton University.
- Vegh, Carlos A, and Guillermo Vuletin.** 2015. “How is tax policy conducted over the business cycle?” American Economic Journal: Economic Policy, 7(3): 327–370.
- Wang, Pengfei, and Yi Wen.** 2012. “Hayashi meets Kiyotaki and Moore: A theory of capital adjustment costs.” Review of Economic Dynamics, 15(2): 207–225.
- Woodford, Michael.** 2002. “Inflation stabilization and welfare.” Contributions in Macroeconomics, 2(1).

## Tables

Table 1: Foreign Currency Liability/GDP and Currency Devaluation

|                       | (1)                  | (2)                  | (3)                  | (4)                 | (5)                 |
|-----------------------|----------------------|----------------------|----------------------|---------------------|---------------------|
|                       | devaluation          | devaluation          | devaluation          | devaluation         | devaluation         |
| FC liability/GDP      | 0.138**<br>(0.061)   | 0.196***<br>(0.063)  | 0.199***<br>(0.066)  | 0.197**<br>(0.074)  | 0.194**<br>(0.083)  |
| LC liability/GDP      | -0.324***<br>(0.092) | -0.371***<br>(0.099) | -0.373***<br>(0.103) | -0.297**<br>(0.115) | -0.293**<br>(0.119) |
| control of corruption | -0.071*<br>(0.040)   | -0.101**<br>(0.040)  | -0.103**<br>(0.041)  | -0.202<br>(0.125)   | -0.201<br>(0.126)   |
| q GDP loss            |                      | -0.025<br>(0.109)    |                      | -0.006<br>(0.130)   |                     |
| h GDP loss            |                      |                      | 0.078<br>(0.305)     |                     | 0.143<br>(0.460)    |
| OECD dummy            |                      |                      |                      | 0.284<br>(0.358)    | 0.279<br>(0.365)    |
| export/GDP            |                      |                      |                      | -0.447<br>(0.417)   | -0.465<br>(0.408)   |
| broad money/reserves  |                      |                      |                      | -0.104<br>(0.181)   | -0.056<br>(0.233)   |
| $N$                   | 47                   | 40                   | 40                   | 39                  | 39                  |
| $R^2$                 | 0.174                | 0.260                | 0.260                | 0.324               | 0.326               |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between FC liability/GDP before crises and currency devaluation rate during crises. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 2: Foreign Currency Liability/GDP and Currency Devaluation (non OECD sample)

|                       | (1)         | (2)         | (3)         | (4)         | (5)         |
|-----------------------|-------------|-------------|-------------|-------------|-------------|
|                       | devaluation | devaluation | devaluation | devaluation | devaluation |
| FC liability/GDP      | 0.235*      | 0.418**     | 0.434**     | 0.393**     | 0.409**     |
|                       | (0.122)     | (0.173)     | (0.183)     | (0.184)     | (0.191)     |
| LC liability/GDP      | -0.106      | -0.457      | -0.447      | -0.270      | -0.145      |
|                       | (0.349)     | (0.366)     | (0.363)     | (0.406)     | (0.411)     |
| control of corruption | 0.080       | 0.037       | 0.034       | 0.043       | 0.048       |
|                       | (0.107)     | (0.099)     | (0.106)     | (0.104)     | (0.108)     |
| q GDP loss            |             | 0.057       |             | 0.080       |             |
|                       |             | (0.127)     |             | (0.158)     |             |
| h GDP loss            |             |             | 0.279       |             | 0.593       |
|                       |             |             | (0.382)     |             | (0.443)     |
| export/GDP            |             |             |             | -0.317      | -0.450      |
|                       |             |             |             | (0.378)     | (0.404)     |
| broad money/reserves  |             |             |             | 0.113       | 0.271       |
|                       |             |             |             | (0.215)     | (0.208)     |
| <i>N</i>              | 31          | 27          | 27          | 27          | 27          |
| <i>R</i> <sup>2</sup> | 0.086       | 0.197       | 0.209       | 0.224       | 0.268       |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between FC liability/GDP before crises and currency devaluation rate during crises for non-OECD sample. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 3: Foreign Currency Liability/GDP and Inflation

|                       | (1)                  | (2)                  | (3)                  | (4)                 | (5)                  |
|-----------------------|----------------------|----------------------|----------------------|---------------------|----------------------|
|                       | inflation            | inflation            | inflation            | inflation           | inflation            |
| FC liability/GDP      | 0.073**<br>(0.030)   | 0.064**<br>(0.028)   | 0.064**<br>(0.028)   | 0.073**<br>(0.030)  | 0.077**<br>(0.029)   |
| LC liability/GDP      | -0.116***<br>(0.040) | -0.084***<br>(0.027) | -0.085***<br>(0.027) | -0.089**<br>(0.038) | -0.095**<br>(0.036)  |
| control of corruption | -0.056***<br>(0.015) | -0.066***<br>(0.015) | -0.065***<br>(0.014) | -0.101**<br>(0.038) | -0.102***<br>(0.037) |
| q GDP loss            |                      | -0.009<br>(0.031)    |                      | -0.025<br>(0.035)   |                      |
| h GDP loss            |                      |                      | -0.031<br>(0.095)    |                     | -0.158<br>(0.141)    |
| OECD dummy            |                      |                      |                      | 0.104<br>(0.109)    | 0.114<br>(0.106)     |
| export/GDP            |                      |                      |                      | -0.013<br>(0.106)   | 0.002<br>(0.104)     |
| broad money/reserves  |                      |                      |                      | -0.119<br>(0.078)   | -0.152*<br>(0.084)   |
| $N$                   | 46                   | 40                   | 40                   | 39                  | 39                   |
| $R^2$                 | 0.304                | 0.358                | 0.358                | 0.411               | 0.426                |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between foreign currency liability/GDP before crises and CPI inflation during crises. Each observation is a financial crisis. Dependent variable is  $\ln(\text{inflation}/(1+\text{inflation}))$ , where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 4: Foreign Currency Liability/GDP and Bailout

|                       | (1)                  | (2)                  | (3)                  | (4)                  | (5)                 |
|-----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
|                       | bailout              | bailout              | bailout              | bailout              | bailout             |
| FC liability/GDP      | 0.346**<br>(0.158)   | 0.396**<br>(0.176)   | 0.371*<br>(0.189)    | 0.423**<br>(0.198)   | 0.396*<br>(0.209)   |
| LC liability/GDP      | -1.496***<br>(0.434) | -1.575***<br>(0.499) | -1.526***<br>(0.501) | -1.454**<br>(0.590)  | -1.409**<br>(0.593) |
| control of corruption | -0.679***<br>(0.150) | -0.663***<br>(0.154) | -0.671***<br>(0.150) | -0.889***<br>(0.310) | -0.879**<br>(0.311) |
| q GDP loss            |                      | 0.139<br>(0.456)     |                      | 0.135<br>(0.482)     |                     |
| h GDP loss            |                      |                      | 1.101<br>(0.888)     |                      | 0.868<br>(0.921)    |
| OECD dummy            |                      |                      |                      | 0.398<br>(0.722)     | 0.361<br>(0.732)    |
| export/GDP            |                      |                      |                      | -0.122<br>(1.042)    | -0.201<br>(1.060)   |
| broad money/reserves  |                      |                      |                      | 0.202<br>(0.734)     | 0.245<br>(0.732)    |
| $N$                   | 34                   | 30                   | 30                   | 29                   | 29                  |
| $R^2$                 | 0.666                | 0.680                | 0.689                | 0.707                | 0.712               |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ 

Notes: this table shows the relationship between foreign currency liability/GDP before crises and bailout during crises. Each observation is a financial crisis. Dependent variable bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . T is crisis starts year. Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 5: Foreign Currency Liability/GDP and Inflation, Bailout (non OECD sample)

|                       | (1)       | (2)       | (3)       | (4)      | (5)      | (6)      |
|-----------------------|-----------|-----------|-----------|----------|----------|----------|
|                       | inflation | inflation | inflation | bailout  | bailout  | bailout  |
| FC liability/GDP      | 0.101*    | 0.113     | 0.108     | 1.095    | 1.796*   | 1.681*   |
|                       | (0.054)   | (0.082)   | (0.079)   | (0.695)  | (0.816)  | (0.898)  |
| LC liability/GDP      | 0.044     | -0.004    | -0.010    | -3.037** | -4.479** | -3.901** |
|                       | (0.117)   | (0.170)   | (0.148)   | (1.351)  | (1.475)  | (1.673)  |
| control of corruption | -0.051    | -0.055    | -0.055    | -0.279   | -0.397   | -0.365   |
|                       | (0.045)   | (0.047)   | (0.047)   | (0.241)  | (0.256)  | (0.327)  |
| q GDP loss            |           | 0.003     |           |          | 0.727    |          |
|                       |           | (0.047)   |           |          | (0.428)  |          |
| h GDP loss            |           |           | -0.050    |          |          | 1.547    |
|                       |           |           | (0.143)   |          |          | (1.018)  |
| export/GDP            |           | -0.017    | -0.005    |          | 2.009*   | 1.707    |
|                       |           | (0.144)   | (0.139)   |          | (0.903)  | (1.037)  |
| broad money/reserves  |           | -0.044    | -0.064    |          | 10.701   | 7.518    |
|                       |           | (0.078)   | (0.078)   |          | (10.930) | (13.164) |
| $N$                   | 30        | 27        | 27        | 18       | 17       | 17       |
| $R^2$                 | 0.224     | 0.199     | 0.202     | 0.308    | 0.584    | 0.521    |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ 

Notes: this table shows the relationship between foreign currency liability/GDP before crises and inflation, bailout during crises. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Dependent variable in the last 3 columns is bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio. Statistical significance in Columns (2) and (3) is restored if I substitute FC liability/GDP, LC liability/GDP by their logarithm values.

Table 6: Parameter Values

|  |                         |  |
|--|-------------------------|--|
| Risk Aversion                                    | $\sigma = 2$            | standard   |
| Elast. of Subs. btw. Tradables and Non-Tradables | $\xi = 0.44$            | Rozada et al. (2004)                                 |
| Elast. of Subs. btw. Non-tradable Varieties      | $\gamma = 3$            | standard   |
| Labor Supply Elasticity                          | $1/\chi = 1.5$          | within range of literature                           |
| Depreciation Rate                                | $\delta = 0.05$         | Bu (2006)  |
| Labor Share                                      | $\alpha_h = 0.42$       | PWT  |
| Capital Share                                    | $\alpha_k = 0.53$       | $1 - \alpha_h - \alpha_l$                            |
| Share of Tradables in Consumption                | $a = 0.42$              | IO Table consumption composite                       |
| Labor Disutility Coefficient                     | $\psi_h = 0.17$         | mean(hours worked)=1                                 |
| Labor Productivity Scale Parameter               | $z = 0.12$              | mean(nontradable real output)= 1                     |
| Subjective Discount Factor                       | $\beta = 0.985$         | capital/nontradable output= 8.7                      |
| Capital Adjustment Cost                          | $\phi = 9$              | std of inv./nontradable output=2.3                   |
| Tight Borrowing Constraint                       | $\kappa_L = 0.42$       | average NFA/annual GDP=-0.4                          |
| Loose Borrowing Constraint                       | $\kappa_H = 0.52$       | large enough to be unconstrained                     |
| Equity Friction Parameter                        | $\underline{d} = -0.01$ | half prob. of binding                                |
| Price Adjustment Cost                            | $\psi = 0.4$            | std( $\pi^N$ )=0.007 with bailout                    |
| Quantity Theory Parameter                        | $\theta = 0.5$          | money supply/GDP=0.5                                 |
| Bailout Fixed Cost                               | $f_e = 0.0002$          | equivalent $\approx 0.01\%$ consumption              |
| Bailout Inefficiency Parameter                   | $\phi^b = 1.0$          | equivalent $\approx 10\%$ efficiency loss of bailout |
| Grid range for debt                              | [2, 2.9]                |  |
| Grid range for capital                           | [4.65,6.3]              |  |
| Grid range for nontradable relative price        | [0.4,0.8]               |  |

Notes: this table summarizes calibration of the quantitative model at quarterly frequency.

Table 7: Model Implied Regression Results

|            | Optimal Policy with Bailout | Optimal Policy without Bailout |
|------------|-----------------------------|--------------------------------|
| $\beta_1$  | 0.601***                    | -0.874***                      |
| $\gamma_1$ | 0.484***                    | -0.522***                      |
| $\zeta_1$  | 1.209***                    | no prediction                  |

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows regression results from simulating the model 1 million times and taking out bailout episodes.  $\beta_1$ ,  $\gamma_1$  and  $\zeta_1$  are the coefficients of regressing devaluation rate, inflation and bailout when bailout happens, on debt/GDP before bailout incidences (1 year before). I feed in the corresponding policy functions under "Optimal Policy with Bailout" and "Optimal Policy without Bailout" to obtain devaluation rate, inflation and bailout under these two policies.

Table 8: Firm Level Foreign Currency Debt before Crises and Sales Growth in Crises

|                       | (1)                  | (2)                  | (3)                  |
|-----------------------|----------------------|----------------------|----------------------|
|                       | sales growth         | sales growth         | sales growth         |
| leverage              | -0.780***<br>(0.237) | -0.786***<br>(0.222) | -0.748***<br>(0.246) |
| FC leverage           | -1.786*<br>(0.895)   | -1.023<br>(0.660)    | -1.582*<br>(0.838)   |
| leverage*connected    |                      |                      | -0.205<br>(0.474)    |
| FC leverage*connected |                      |                      | 2.631**<br>(1.048)   |
| connected             |                      |                      | -0.089<br>(0.194)    |
| Observations          | 454                  | 554                  | 554                  |
| $R^2$                 | 0.235                | 0.214                | 0.219                |

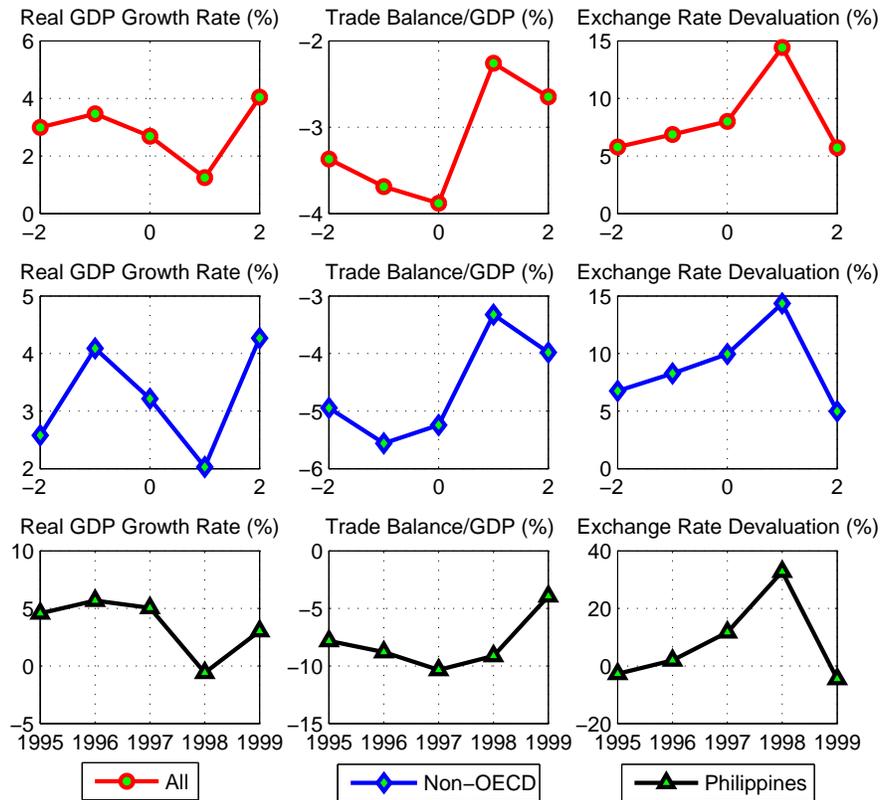
Standard errors clustered at country-industry (2-digit) group in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between firm level foreign currency debt/asset in 1997June and their sales growth in year 1997-1999 (dependent variable) for Indonesia and Malaysia. Country-industry (2-digit) group dummies, access to foreign currency debt dummy and size are included as control variables. Variable leverage and FC leverage are debt/asset and foreign currency debt/asset in 1997June (firm balance sheet is annual information, so leverage takes end of year 1996 value). Variable size is measured as  $\log(\text{asset})$  at the end of year 1996. Variable connected is a dummy variable which takes value 1 if a firm is identified as a politically connected firm in Faccio (2006). Column (1) excludes politically connected firms.

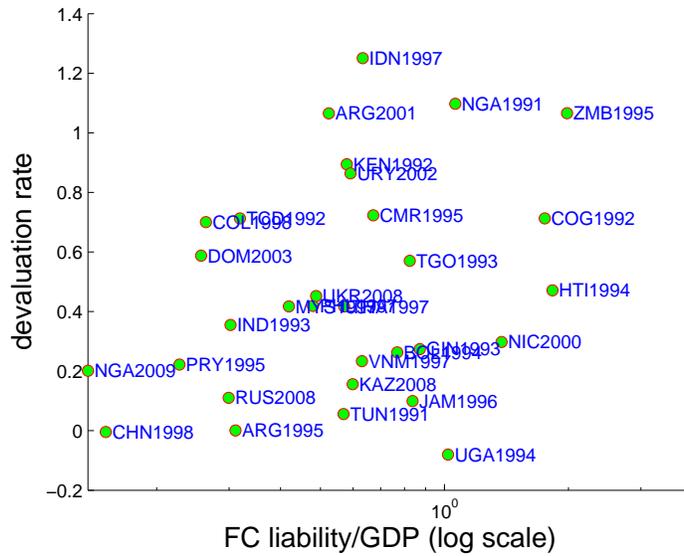
# Figures

Figure 1: (Median) Crisis Dynamics around Financial Crises



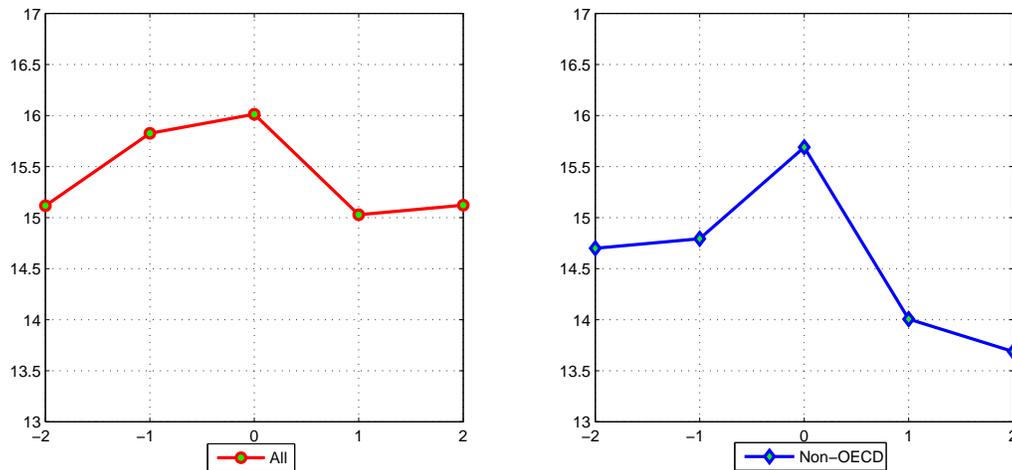
Notes: this figure shows the median crisis dynamics around financial crises. The x-axis is in annual unit and year 0 means crisis starts year. The y-axis represents the median value of each variable across crises. The first row is all sample with available data. The second row is non-OECD group with available data. The third row is Philippines data in the Asian Financial Crises and x-axis is year. I show Philippines data as in my model calibration, I use data from Philippines.

Figure 2: Currency Devaluation Rate and FC Liability/GDP (non-OECD)



Notes: this figure shows the raw data of currency devaluation rate (relative to U.S. dollars) in crises against FC (foreign currency) liability/GDP before crises for non-OECD group. Each dot is a financial crisis with country code and year on the right of each dot. Currency devaluation rate is the change in  $\ln(\text{exchange rate})$  from T-2 to T+2, where T is crisis start year.

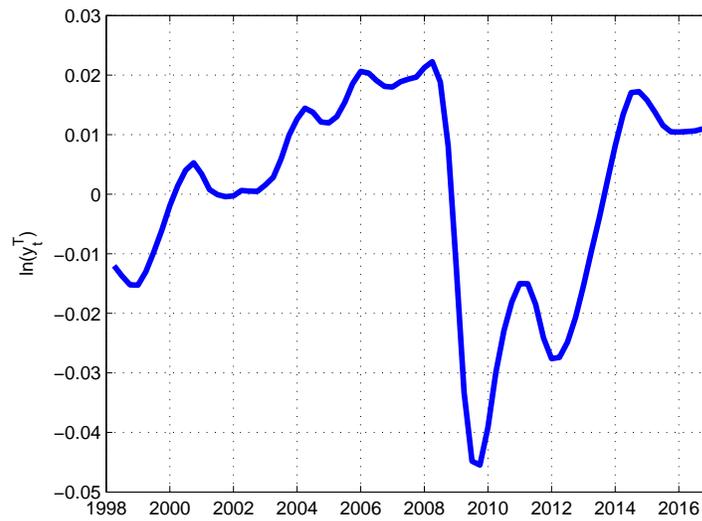
Figure 3: (Median) Effective Tax Rate around Financial Crises



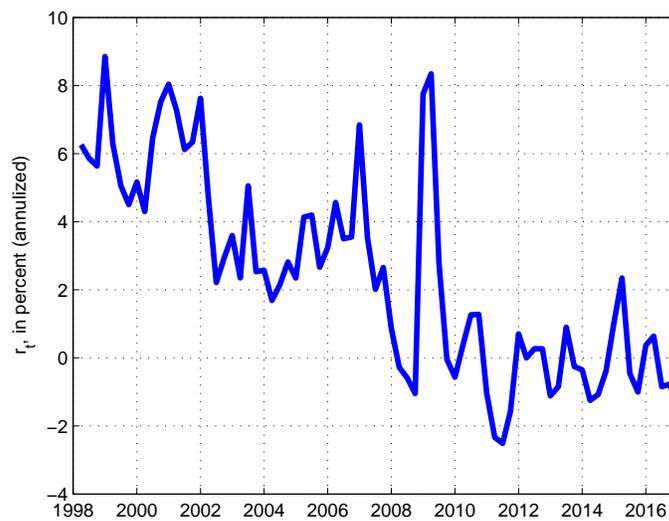
Notes: this figure shows the median effective tax rate around financial crises. Effective tax rate is defined as tax revenues/GDP. The x-axis is in annual unit and year 0 is crisis starts year. The y-axis represents the average of effective tax rates across crises. The left panel is all sample with available data and the right panel is non-OECD group with available data.

Figure 4: Tradable Output and Interest Rate of Philippines

(a) Tradable Output

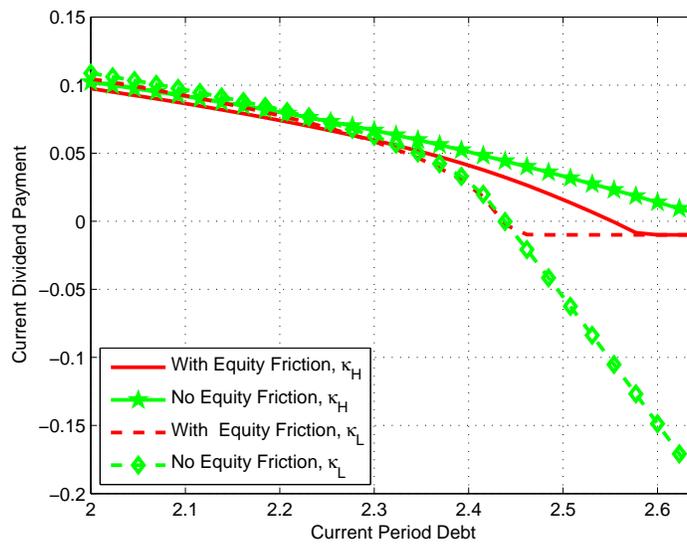


(b) Interest Rate



Notes: this figure shows tradable output and real external borrowing interest rate of Philippines. Tradable output is quadratic detrended.

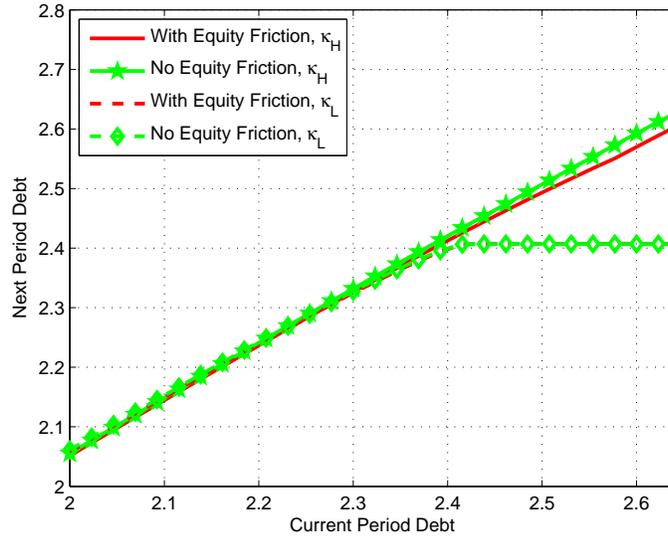
Figure 5: Dividend Payment Policy Functions



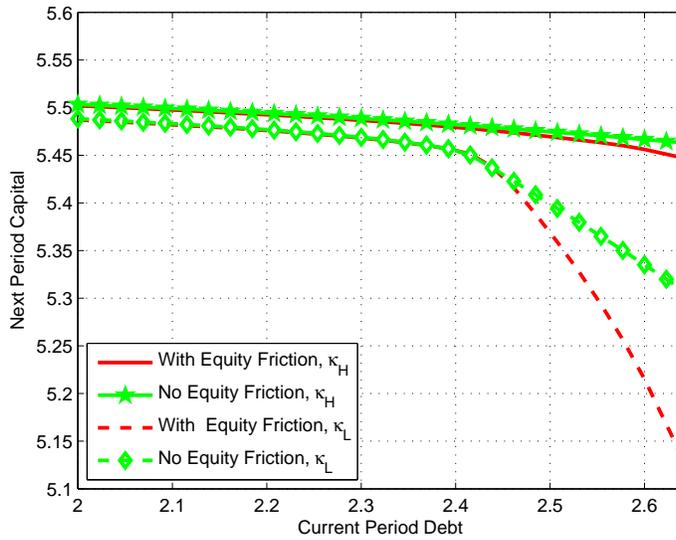
Notes: this figure shows the policy functions of dividend payment under inflation stabilization policy. Policy functions are evaluated at mean capital stock in the simulation with equity frictions; tradable output and interest rate are  $((y^T)^t, r^t)$ .

Figure 6: Debt and Capital Policy Functions

(a) Debt  $b'$



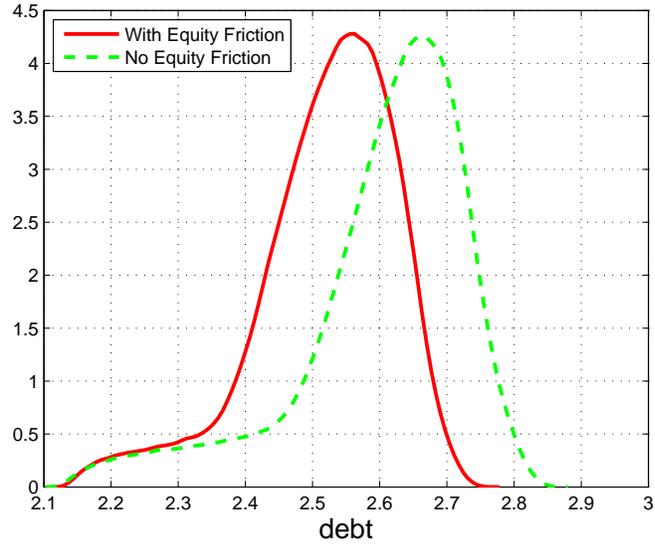
(b) Capital  $k'$



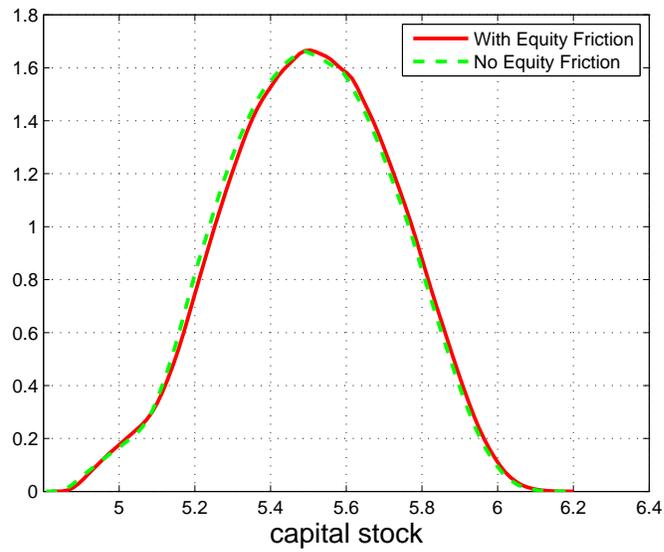
Notes: this figure shows the policy functions of debt and capital under inflation stabilization policy. Policy functions are evaluated at mean capital stock in the simulation with equity frictions; tradable output and interest rate are  $((y^T)^t, r^h)$ .

Figure 7: Ergodic Distributions of Debt and Capital

(a) Debt  $b'$

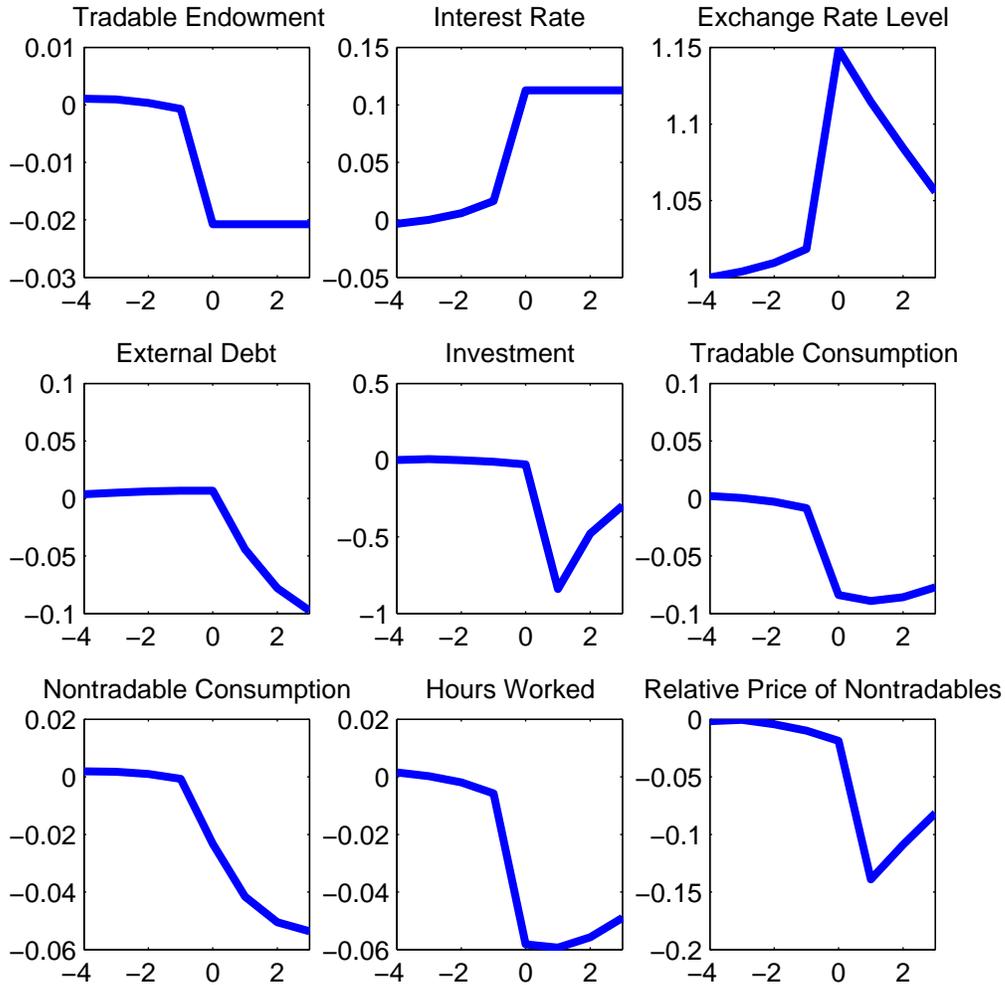


(b) Capital  $k'$



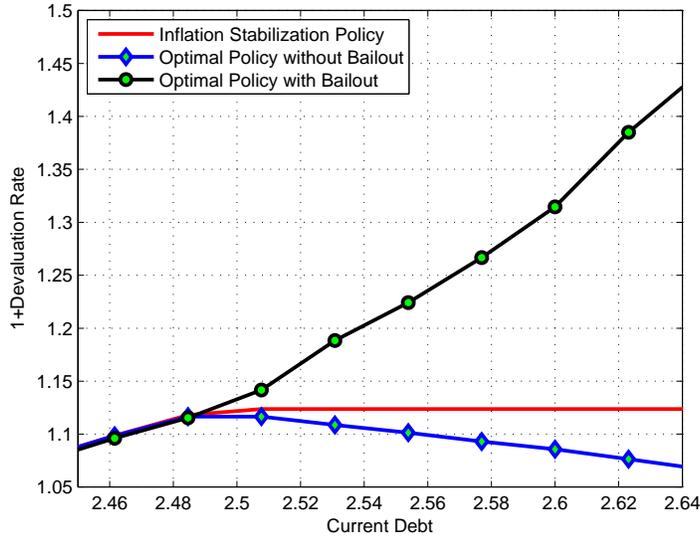
Notes: this figure shows ergodic distributions of debt and capital with and without equity frictions, both under inflation stabilization policy.

Figure 8: Sudden Stop Dynamics under Inflation Stabilization Policy



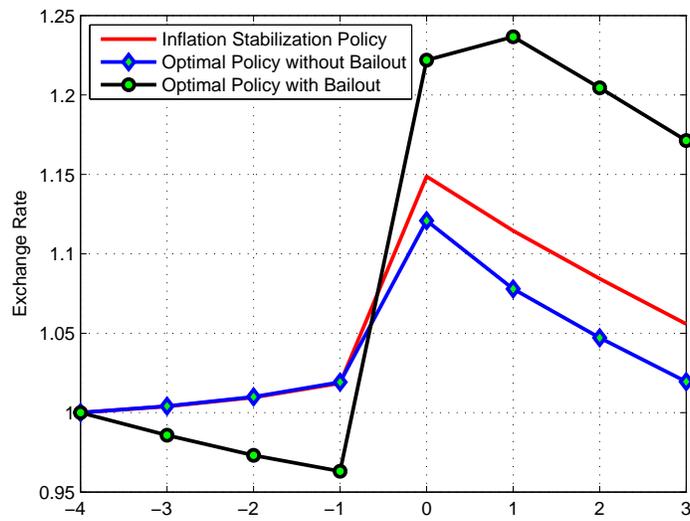
Notes: this figure shows sudden stop dynamics under inflation stabilization policy. I take out the sudden stop windows (tightening borrowing constraint  $\kappa_L$  shock arrives in period 0 and lasts to period 3) and average across these windows. Each variable is expressed as the deviation from mean except that exchange rate at period -4 is normalized to 1 while the devaluation rate used is averaged across windows.

Figure 9: Exchange Rate Policy Functions under Different Policies



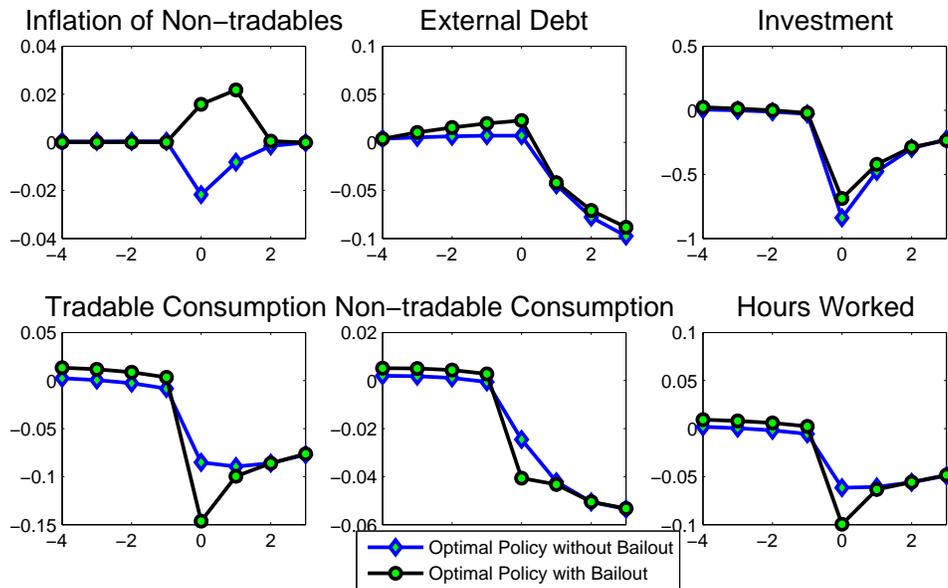
Notes: this figure compares exchange rate policy functions under different policy choices. Policy functions are evaluated at mean capital, mean non-tradable relative price (under inflation stabilization policy) and exogenous state transits from last period state  $((y^T)^L, r^H, \kappa^H)$  to current period state  $((y^T)^L, r^H, \kappa^L)$ .

Figure 10: Exchange Rate Dynamics under Different Policies



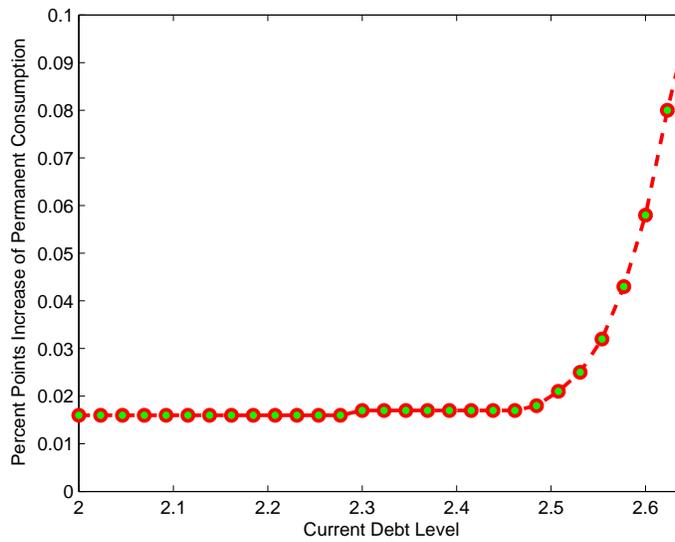
Notes: this figure compares exchange rate dynamics under different policy choices. I simulate the economy under inflation stabilization policy. I take out the sudden stop windows (tightening borrowing constraint  $\kappa_L$  shock arrives in period 0 and lasts to period 3) and feed in policy functions under different policy choices with the same starting period -4. Then I average across these windows. Exchange rate at time -4 is normalized to 1 while the devaluation rate used is averaged across windows.

Figure 11: Sudden Stop Dynamics under Different Policies



Notes: this figure compares various endogenous variables' dynamics under different policy choices. I simulate the economy under inflation stabilization policy. I take out the sudden stop windows (tightening borrowing constraint  $\kappa_L$  shock arrives in period 0 and lasts to period 3) and feed in policy functions under different policy choices with the same starting period -4. Then I average across these windows. Each variable is expressed as deviation from mean derived under inflation stabilization policy.

Figure 12: Welfare Gains from Bailout Policy



Notes: this figure shows the welfare gains (expressed in permanent percentage increase in consumption) from optimal policy with bailout option compared to optimal policy without bailout option. Welfare gains are evaluated at mean capital, mean non-tradable relative price (under inflation stabilization policy) and exogenous state transits from last period state  $((y^T)^L, r^H, \kappa^H)$  to current period state  $((y^T)^L, r^H, \kappa^L)$ .

## Appendix

### Demand for Money

In this section, I micro-found the demand equation for money by introducing tradable good producers who need to hold money to purchase intermediate inputs  $g_t$  from households.

$$M_t = P_t^G g_t,$$

where  $M_t$  is their money holding before production,  $P_t^G$  is intermediate inputs' price.<sup>32</sup> At the end of each period, they rebate their profits to households. Their production function is

$$y_t^T = g_t^\theta,$$

where  $\theta \in (0, 1)$ . The problem of tradable final good producers is

$$\max_{s_t} P_t^T g_t^\theta - P_t^G g_t,$$

where  $P_t^T$  is price of tradable final good. The first order condition is simply

$$\theta P_t^T y_t^T = P_t^G g_t.$$

Therefore, I obtain the money demand equation

$$M_t = \theta P_t^T y_t^T.$$

### Competitive Equilibrium with Given Exchange Rate Policy $\epsilon_t$ (No Bailout)

**Definition 3** *A competitive equilibrium with given exchange rate policy  $\epsilon_t$  is defined as stochastic processes  $\{c_t, c_t^T, c_t^N, y_t^N, \lambda_t, h_t, i_t, k_{t+1}, b_{t+1}, \nu_t, \mu_t, p_t^N, w_t, \pi_t^N\}_{t=0}^{+\infty}$  satisfying the following equilibrium conditions*

$$[c_t - \psi_h(1 + \chi)^{-1} h_t^{1+\chi}]^{-\sigma} [a c_t^{T^{1-\frac{1}{\xi}}} + (1-a) c_t^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}} a (c_t^T)^{-\frac{1}{\xi}} = \lambda_t \quad (60)$$

$$\psi_h h_t^\chi = [a c_t^{T^{1-\frac{1}{\xi}}} + (1-a) c_t^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}} a (c_t^T)^{-\frac{1}{\xi}} w_t \quad (61)$$

$$p_t^N = \frac{1-a}{a} \left( \frac{c_t^N}{c_t^T} \right)^{-\frac{1}{\xi}} \quad (62)$$

---

<sup>32</sup>See Bolton (2016) for a similar way to introduce quantity theory of money.

$$(1 + \mu_t) \left( (\gamma - 1) y_t^N p_t^N (1 + \tau_y) - w_t h_t \frac{\gamma}{\alpha_h} + \psi (\pi_t^N - 1) \pi_t^N \right) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \psi (\pi_{t+1}^N - 1) \pi_{t+1}^N (1 + \mu_{t+1}) \quad (63)$$

$$(1 + \mu_t) \frac{1}{1 + r_t} - \frac{\nu_t}{1 + r_t} = \beta E_t \left( \frac{\lambda_{t+1}}{\lambda_t} (1 + \mu_{t+1}) \right) \quad (64)$$

$$(1 + \mu_t) \left( 1 + \phi \left( \frac{k_{t+1}}{k_t} - 1 \right) \right) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left\{ \left[ \left( 1 - \delta + \frac{\phi}{2} \left[ \left( \frac{k_{t+2}}{k_{t+1}} \right)^2 - 1 \right] \right) + \frac{\alpha_k}{\alpha_h} \frac{w_{t+1} h_{t+1}}{k_{t+1}} \right] (1 + \mu_{t+1}) + \kappa_{t+1} \nu_{t+1} \right\} \quad (65)$$

$$\frac{b_{t+1}}{1 + r_t} \leq \kappa_t k_t \quad (66)$$

$$\left( \kappa_t k_t - \frac{b_{t+1}}{1 + r_t} \right) \nu_t \geq 0 \quad (67)$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta) k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \frac{\psi}{2} (\pi_t^N - 1)^2 \geq \underline{d} \quad (68)$$

$$\mu_t \left( p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta) k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - b_t + \frac{b_{t+1}}{1 + r_t} - \underline{d} - \frac{\psi}{2} (\pi_t^N - 1)^2 \right) \geq 0 \quad (69)$$

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1 + r_t} - k_{t+1} + (1 - \delta) k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t - \frac{\psi}{2} (\pi_t^N - 1)^2 \quad (70)$$

$$y_t^N = c_t^N \quad (71)$$

$$y_t^N = k_t^{\alpha_k} (z h_t)^{\alpha_h} \quad (72)$$

$$i_t = k_{t+1} - (1 - \delta) k_t + \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t \quad (73)$$

$$c_t = [a c_t^{T1-\frac{1}{\xi}} + (1 - a) c_t^{N1-\frac{1}{\xi}}]^{\frac{1}{1-\frac{1}{\xi}}} \quad (74)$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\epsilon_t} \quad (75)$$

given exogenous stochastic shocks  $\{y_t^T, r_t, \kappa_t\}$  and initial conditions  $k_0, b_0, p_{-1}^N$ .

## The Maximum Debt an Economy Can Service

For a given capital  $k$ , the maximum level of debt the economy can support is to guarantee that under debt collateral constraint, the dividend constraint is not violated and consumption has to be non-negative (in fact, I need to check  $c > v(h)$ ) with the worst exogenous shock  $y_{min}^T, r_{max}, \kappa_{min}$ . It is similar to the natural debt limit concept in an endowment economy. In this section, I provide numerical algorithm to find the the maximum debt an economy can service.

For a given capital stock  $k$ , the maximum debt  $b_{max}(k)$  the economy can serve is

$$b_{max}(k) = \max_{b', k', h} \left( p^N y^N (1 + \tau_y) - wh + t \right) - \underline{d} + \frac{b'}{1 + r_{max}} - k' + (1 - \delta)k - \frac{\phi}{2} \left( \frac{k'}{k} - 1 \right)^2 k, \quad (76)$$

subject to

$$\begin{aligned} b' &\leq \kappa_{min} \cdot k, \\ y^N &= k^{\alpha_k} (zh)^{\alpha_h}, \end{aligned}$$

where

$$\begin{aligned} p^N &= \frac{1 - a}{a} \left( \frac{c^N}{c^T} \right)^{-\frac{1}{\xi}}, \\ c^N &= y^N \\ c^T &= y_{min}^T - b_{max}(k) + \frac{b'}{1 + r} - k' + (1 - \delta)k - \frac{\phi}{2} \left( \frac{k'}{k} - 1 \right)^2 k, \\ t &= -\tau_y p^N y^N. \end{aligned}$$

Note labor supply (which will be taken as given by individual firms) is solved by households:

$$w = \frac{\psi_h h^\chi}{[ac^T^{1-\frac{1}{\xi}} + (1-a)c^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}} ac^T^{-\frac{1}{\xi}}}.$$

The optimal demand of  $h$  picked by firms is

$$\alpha_h \frac{p^N y^N}{h} = w.$$

Substitute  $wh$  by  $\alpha_h p^N y^N$  in equation (76). The above two equations also show that  $h$  is the solution to

$$\alpha_h (1 - a) [k^{\alpha_k} (zh)^{\alpha_h}]^{1-\frac{1}{\xi}} = \frac{\psi_h h^{1+\chi}}{[ac^T^{1-\frac{1}{\xi}} + (1-a)c^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}}}. \quad (77)$$

Check whether  $c > v(h)$ , if not, re-set  $b_{max}$  in the following way:

$$b_{max}(k) = \arg \max_{b', k', h} c - v(h) = 0$$

where

$$\begin{aligned} c^T &= y_{min}^T - b_{max}(k) + \frac{b'}{1 + r} - k' + (1 - \delta)k - \frac{\phi}{2} \left( \frac{k'}{k} - 1 \right)^2 k, \\ c &= [ac^T^{1-\frac{1}{\xi}} + (1-a)c^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}}, \end{aligned}$$

$$c^N = k^{\alpha_k} (zh)^{\alpha_h}.$$

I define the feasible set as

$$\Theta = \{(b, k) \in \mathbb{R} \times \mathbb{R}_+, b \leq b_{max}(k)\}. \quad (78)$$

The numerical algorithm is as follows:

1. Guess an initial  $b_{max,s}(k)$  (large enough) for each grid on capital stock  $k$ , where  $s = 0$ . Set  $s=1$  and go to 2.
2. In iteration  $s$ , update  $b_{max,s}(k)$  using the procedures described above. When picking up  $(b', k')$ , I only select  $b' \leq b_{max,s-1}(k')$  from the previous iteration.
3. Check convergence. If  $\sup_k |b_{max,s}(k) - b_{max,s-1}(k)| < \varepsilon$ , stop. We have found the feasible set  $\Theta$ . Otherwise, set  $s \rightarrow s + 1$  and return to 2.

In Figure 13, the red solid line is the found  $b_{max}(k)$  under my calibrated parameters and the blue "+" is simulated ergodic distributions in the real economy. We can see that the ergodic distribution is always under the maximum debt the economy can service. The monotonically increasing solid line implies that higher capital stock can support more debt. For the stationary distribution, the economy's capital stock and debt move together: higher capital stock is associated with higher debt.

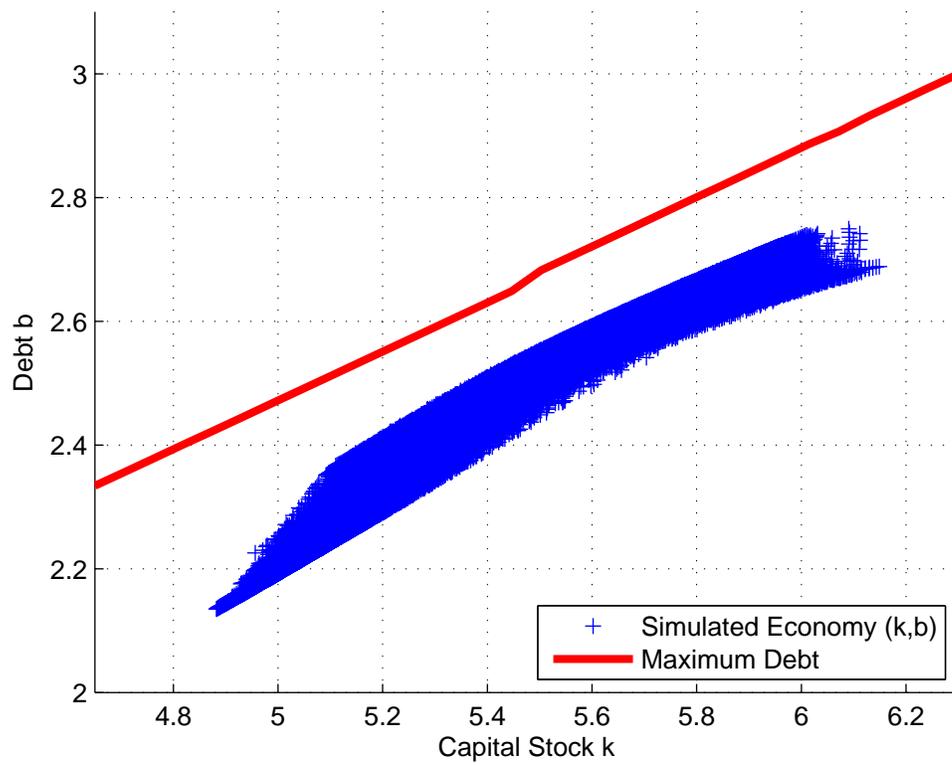
### Exogenous Shocks: Transition Matrix of $(\ln(y^T), r, \kappa)$

To add exogenous  $\kappa_t$ , I take a practical stand to assume that the transition from  $\kappa_H$  to  $\kappa_L$  is independent with current  $(y_t^T, r_t)$ . That is, the current account reversal is not predictable by current  $(y^T, r)$ . I set  $\pi(\kappa_L|\kappa_H) = 0.02$  to target 2.5 sudden stop episodes (at least 1 year  $\kappa_t = \kappa_L$  is treated as a sudden stop episodes) in 100 years. Therefore,  $\Pi(i, 6) = 0.02$  and  $\Pi(i, 5) = \Pi^0(i, 5) - \Pi(i, 6)$ ,<sup>33</sup>  $i = 1, 2, 3, 4, 5$ . As regard  $\Pi(6, \cdot)$ , I first target the average duration of  $\kappa_L$  as 4 quarters, so  $\Pi(6, 6) = 0.75$ . I assume that when the  $\kappa_L$  state is over, bad state  $(\ln(y^T)^l, r^h)$  will also not last, so  $\Pi(6, 5) = 0$ . Finally,  $\Pi(i, 6) = \frac{\Pi^0(i, 5)}{1 - \Pi(6, 6)}$ ,  $i=1, 2, 3, 4$ . I have now calculated the transition matrix  $\Pi$  of  $(\ln(y^T), r, \kappa)$  and the transition matrix of  $(\ln(y^T), r)$  will remain the same as  $\Pi^0$  under  $\Pi$ . I report the transition matrix below

$$\Pi = \begin{pmatrix} 0.5372 & 0.1154 & 0.1156 & 0.1150 & 0.0969 & 0.0200 \\ 0.2143 & 0.6702 & 0.0484 & 0.0662 & 0.0000 & 0.0009 \\ 0.1975 & 0.0497 & 0.6953 & 0.0005 & 0.0370 & 0.0200 \\ 0.1963 & 0.0575 & 0.0005 & 0.6955 & 0.0302 & 0.0200 \\ 0.2156 & 0.0008 & 0.0655 & 0.0491 & 0.6490 & 0.0200 \\ 0.1628 & 0.0006 & 0.0495 & 0.0371 & 0.0000 & 0.7500 \end{pmatrix},$$

<sup>33</sup>To ensure all elements in the transition matrix is non-negative, if  $\Pi^0(i, 5) < \Pi(i, 6)$ , I set  $\Pi(i, 6) = \Pi^0(i, 5)$  and  $\Pi(i, 5) = 0$ .

Figure 13: Maximum Debt an Economy Can Support



Note: '+' plots the stationary distribution of pair  $(k,b)$  and solid line is the maximum debt the economy can support given any capital stock level  $k$

where the six states by order are  $(\ln(y^T)^a, r^a, \kappa^H)$ ,  $(\ln(y^T)^h, r^l, \kappa^H)$ ,  $(\ln(y^T)^h, r^h, \kappa^H)$ ,  $(\ln(y^T)^l, r^l, \kappa^H)$ ,  $(\ln(y^T)^l, r^h, \kappa^H)$  and  $(\ln(y^T)^l, r^h, \kappa^L)$ .

## Computational Algorithm for the Competitive Equilibrium under Inflation Stabilization Policy

I denote  $\{\mathbb{C}, \mathbb{C}^T, \mathbb{C}^N, \mathbb{Y}^N, \Lambda, \mathbb{H}, \mathbb{I}, \mathbb{K}, \mathbb{B}, \mathbb{N}, \mathbb{M}, \mathbb{P}^N, \mathbb{W}\}$  as the policy functions for variables  $\{c_t, c_t^T, c_t^N, y_t^N, \lambda_t, h_t, i_t, k_{t+1}, b_{t+1}, \nu_t, \mu_t, p_t^N, w_t\}$ . I work on discretized  $nb$  grids for debt,  $nk$  grids for capital and  $nES$  exogenous states  $ES_t = \{y_t^T, r_t, \kappa_t\}$ . For a current state  $X = \{b, k, ES\}$  with  $ES = \{y^T, r, \kappa\}$ , the equilibrium conditions are recursively expressed as

$$[\mathbb{C}(X) - \psi_h(1 + \chi)^{-1}\mathbb{H}(X)^{1+\chi}]^{-\sigma} [a\mathbb{C}^T(X)^{1-\frac{1}{\xi}} + (1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}} a(\mathbb{C}^T(X))^{-\frac{1}{\xi}} = \Lambda(X) \quad (79)$$

$$\psi_h\mathbb{H}(X)^\chi = [a\mathbb{C}^T(X)^{1-\frac{1}{\xi}} + (1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}} a(\mathbb{C}^T(X))^{-\frac{1}{\xi}} \mathbb{W}(X) \quad (80)$$

$$\mathbb{P}^N(X) = \frac{1-a}{a} \left( \frac{\mathbb{C}^N(X)}{\mathbb{C}^T(X)} \right)^{-\frac{1}{\xi}} \quad (81)$$

$$(\gamma - 1)\mathbb{Y}^N(X)\mathbb{P}^N(X)(1 + \tau_y) = \mathbb{W}(X)\mathbb{H}(X)\frac{\gamma}{\alpha_h} \quad (82)$$

$$(1 + \mathbb{M}(X))\frac{1}{1+r} - \frac{\mathbb{N}(X)}{1+r} = \beta E_t \left( \frac{\Lambda(X')}{\Lambda(X)} (1 + \mathbb{M}(X')) \right) \quad (83)$$

$$(1 + \mathbb{M}(X)) \left( 1 + \phi \left( \frac{\mathbb{K}(X)}{k} - 1 \right) \right) = \beta E_t \frac{\Lambda(X')}{\Lambda(X)} \left\{ \left[ \left( 1 - \delta + \frac{\phi}{2} \left[ \left( \frac{\mathbb{K}(X')}{\mathbb{K}(X)} \right)^2 - 1 \right] \right) + \frac{\alpha_k}{\alpha_h} \frac{\mathbb{W}(X')\mathbb{H}(X')}{\mathbb{K}(X)} \right] (1 + \mathbb{M}(X')) + \kappa' \mathbb{N}(X') \right\} \quad (84)$$

$$\frac{\mathbb{B}(X)}{1+r} \leq \kappa k \quad (85)$$

$$(\kappa k - \frac{\mathbb{B}(X)}{1+r})\mathbb{N}(X) \geq 0 \quad (86)$$

$$\mathbb{P}^N(X)\mathbb{Y}^N(X) - \mathbb{W}(X)\mathbb{H}(X) - \mathbb{K}(X) + (1 - \delta)k - \frac{\phi}{2} \left( \frac{\mathbb{K}(X)}{k} - 1 \right)^2 k - b + \frac{\mathbb{B}(X)}{1+r} \geq \underline{d} \quad (87)$$

$$\mathbb{M}(X) \left( \mathbb{P}^N(X)\mathbb{Y}^N(X) - \mathbb{W}(X)\mathbb{H}(X) - \mathbb{K}(X) + (1 - \delta)k - \frac{\phi}{2} \left( \frac{\mathbb{K}(X)}{k} - 1 \right)^2 k - b + \frac{\mathbb{B}(X)}{1+r} - \underline{d} \right) \geq 0 \quad (88)$$

$$\mathbb{C}^T(X) + b = y^T + \frac{\mathbb{B}(X)}{1+r} - \mathbb{K}(X) + (1 - \delta)k - \frac{\phi}{2} \left( \frac{\mathbb{K}(X)}{k} - 1 \right)^2 k \quad (89)$$

$$\mathbb{Y}^N(X) = \mathbb{C}^N(X) \quad (90)$$

$$\mathbb{Y}^N(X) = k^{\alpha_k} (z\mathbb{H}(X))^{\alpha_h} \quad (91)$$

$$\mathbb{I}(X) = \mathbb{K}(X) - (1 - \delta)k + \frac{\phi}{2} \left( \frac{\mathbb{K}(X)}{k} - 1 \right)^2 k. \quad (92)$$

$$\mathbb{C}(X) = [a\mathbb{C}^T(X)^{1-\frac{1}{\xi}} + (1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{1-\frac{1}{\xi}}} \quad (93)$$

where  $X' = \{\mathbb{B}(X), \mathbb{K}(X), ES'\}$ . The computational algorithm is designed as follows and I use piecewise linear interpolation to evaluate functions outside the grid whenever needed.

1. Find the maximum debt level given any grid for capital and I work on those grids which fall into the feasible set  $\Theta$ .

2. Guess initial policy functions  $\{\mathbb{C}_j, \mathbb{C}_j^T, \mathbb{C}_j^N, \mathbb{Y}_j^N, \Lambda_j, \mathbb{H}_j, \mathbb{I}_j, \mathbb{K}_j, \mathbb{B}_j, \mathbb{N}_j, \mathbb{M}_j, \mathbb{P}_j^N, \mathbb{W}_j\}$ , where  $j = 0$ , for any state on the grids. Set  $j=1$  and go to 3 below.

3. At step  $j \geq 1$ , use policy functions from step  $j - 1$  when evaluating functions of  $X'$ . For each state:

(a) Guess neither debt limit constraint nor dividend constraint are binding. Solve for allocations. Notice the system can be reduced to three equations and three unknowns  $\mathbb{C}(X)^T, \mathbb{K}(X), \mathbb{P}^N(X)$ . Check if debt limit constraint and dividend constraint are violated. If both equation (85) and (87) are satisfied, move to next grid. However, if debt limit constraint is violated, go to (b) and if only dividend constraint is violated, go to (c).

(b) Guess only equation (85) is binding and solve all the policy functions. Then check whether dividend constraint is satisfied, if yes, move to next grid, if not, move to (d).

(c) Guess only equation (87) is binding and solve all the policy functions. Then check whether debt limit constraint is satisfied, if yes, move to next grid, if not, move to (d).

(d) Guess both equation (85) and (87) are binding and solve all the policy functions.

4. Evaluate convergence. If  $\sup_{\{k,b,ES\}} |x_j - x_{j-1}| < \varepsilon$  for any  $x = \mathbb{C}, \mathbb{C}^T, \mathbb{C}^N, \mathbb{Y}^N, \Lambda, \mathbb{H}, \mathbb{I}, \mathbb{K}, \mathbb{B}, \mathbb{N}, \mathbb{M}, \mathbb{P}^N, \mathbb{W}$ , then stop. We have gotten the policy functions. Otherwise, update new policy functions and set  $j \rightarrow j + 1$ , return to 3.

## Data Sources

**Financial crises dating:** from Laeven and Valencia (2012)

**Real GDP in local currency:** from World Development Indicators

**Export/GDP:** from World Development Indicators

**Exchange rate:** annual period average, from World Development Indicators

**FC liability/GDP and LC liability/GDP:** from Lane and Shambaugh (2010)

**Control of corruption index:** from World Governance Indicators

**Broad money/reserves:** from World Development Indicators

**Consumer price index:** annual period average, from World Development Indicators

**Fiscal cost of restructuring the financial sector:** % financial sector asset, from Laeven and Valencia (2012)

**Sovereign debt crises dating:** from Laeven and Valencia (2012)

**Foreign currency and local currency debt held by foreign banks:** from Bank of International Settlement-Locational Banking Statistics (BIS-LBS)

**Banks' foreign currency and local currency debt held by foreign banks:** from Bank of International Settlement-Locational Banking Statistics (BIS-LBS)

**Tax revenue/GDP:** from World Development Indicators

**Philippines tradable output:** Agriculture, Hunting, Forestry, Fishing, Mining, Quarrying and Manufacturing, from Philippine Statistics Authority <http://psa.gov.ph/>

**Philippines EMBI global spread:** from Datastream

**US 3-month T-bill rate:** from FRED

**US quarterly CPI inflation rate:** from FRED

**Philippines labor share:** from Penn World Table 9.0

**Philippines tradable consumption share:** Input-Output Table from Philippine Statistics Authority <http://psa.gov.ph/>

**Philippines net foreign asset position/GDP:** from Lane and Milesi-Ferretti (2007)

**Philippines CPI and money supply:** from Bangko Sentral ng Pilipinas <http://www.bsp.gov.ph>

**Politically connected firms:** from Faccio (2006)

**Malaysia, Indonesia, Philippines and Thailand firm balance sheets:** from Worldscope

**Malaysia, Indonesia, Philippines and Thailand firm foreign currency debt:** from Thomson One loan and bond

## Proofs

### Proof of Proposition 3

First, it is optimal to set  $\pi_t^N = 1$ . By substituting  $c_t^N$  and  $c_t$  expressions to the objective function, I can re-write the social planner problem as

$$\max_{\{c_t^T, h_t, b_{t+1}, k_{t+1}\}} E_0 \sum_{t=0}^{+\infty} \beta^t u(\Omega(c_t^T, k_t^{\alpha_k} (zh_t)^{\alpha_h}) - v(h_t)), \quad (94)$$

subject to

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2} \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 k_t, \quad (95)$$

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t \quad (96)$$

Denoting  $\lambda_t$  and  $\lambda_t \nu_t$  as the lagrange multipliers of the above two constraints, I have the first order conditions with respect to  $c_t^T$ ,  $h_t$ ,  $b_{t+1}$ ,  $k_{t+1}$ :

$$u'(c_t - v(h_t)) \Omega_1(c_t^T, c_t^N) = \lambda_t \quad (97)$$

$$\Omega_2(c_t^T, c_t^N) \frac{\alpha_h c_t^N}{h_t} = \psi_h h_t^\chi \quad (98)$$

$$\frac{\lambda_t}{1+r_t} - \frac{\lambda_t \nu_t}{1+r_t} = \beta E_t \lambda_{t+1} \quad (99)$$

$$\lambda_t \left( 1 + \phi \left( \frac{k_{t+1}}{k_t} - 1 \right) \right) = \beta E_t \lambda_{t+1} \left[ 1 - \delta + \frac{\phi}{2} \left[ \left( \frac{k_{t+2}}{k_{t+1}} \right)^2 - 1 \right] \right] + \beta E_t u'(c_{t+1} - v(h_{t+1})) \Omega_2(c_{t+1}^T, c_{t+1}^N) \frac{\alpha_k c_{t+1}^N}{k_{t+1}} + \beta E_t \lambda_{t+1} \kappa_{t+1} \nu_{t+1} \quad (100)$$

plus complementary slackness conditions on debt constraint.

Define  $p_t^N = \frac{1-a}{a} \left( \frac{c_t^N}{c_t^T} \right)^{-\frac{1}{\xi}}$  and  $w_t = \frac{\alpha_h p_t^N c_t^N}{h_t}$ . Then the above first order conditions become (substitute consumption aggregator and labor disutility functional form)

$$u'(c_t - v(h_t)) \Omega_1(c_t^T, c_t^N) = \lambda_t \quad (101)$$

$$\Omega_1(c_t^T, c_t^N) w_t = \psi_h h_t^\chi \quad (102)$$

$$\frac{1}{1+r_t} - \frac{\nu_t}{1+r_t} = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \quad (103)$$

$$1 + \phi \left( \frac{k_{t+1}}{k_t} - 1 \right) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[ 1 - \delta + \frac{\phi}{2} \left[ \left( \frac{k_{t+2}}{k_{t+1}} \right)^2 - 1 \right] \right] + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \frac{\alpha_k p_{t+1}^N c_{t+1}^N}{k_{t+1}} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \kappa_{t+1} \nu_{t+1} \quad (104)$$

Now it is straightforward to see these equilibrium conditions coincide with the competitive equilib-

rium when  $\mu_t = 0$  ( $\underline{d} = -\infty$ )  $\forall t$ .

#### Proof of Proposition 4

Set lump sum transfer  $LT_t \geq \underline{d} - \{p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t}\}^{SP}$ . In each period, dividend constraint then will never bind thus  $\mu_t = 0 \forall t$ . Therefore, the social planner solution is achieved.

#### Proof of Proposition 5

The binding dividend constraint says

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi_t^N - 1)^2 = \underline{d}. \quad (105)$$

Market clearing condition for tradable good is

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1 - \delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2. \quad (106)$$

Combining the above two equations to arrive at

$$c_t^T = y_t^T + \underline{d} - (p_t^N c_t^N - w_t h_t). \quad (107)$$

Since the non-tradable relative price is

$$p_t^N = \frac{1-a}{a} \left( \frac{c_t^N}{c_t^T} \right)^{-\frac{1}{\xi}}, \quad (108)$$

we obtain

$$p_t^N c_t^N = \left( \frac{a}{1-a} \right)^{-\xi} (p_t^N)^{1-\xi} c_t^T. \quad (109)$$

As I assume in the future the government commits to inflation stabilization policy, the Euler equation for non-tradable price gives

$$(\gamma - 1)y_t^N p_t^N (1 + \tau_y) - w_t h_t \frac{\gamma}{\alpha_h} + \psi(\pi_t^N - 1)\pi_t^N = 0. \quad (110)$$

By substituting  $p_t^N c_t^N$  and  $w_t h_t$  in equation (107), we get

$$c_t^T = \frac{y_t^T + \underline{d}}{1 + [(1 - \alpha_h) - \frac{\alpha_h}{\gamma}\psi(\pi_t^N - 1)\pi_t^N] \left( \frac{a}{1-a} \right)^{-\xi} (p_t^N)^{1-\xi}}. \quad (111)$$

On the other hand, the first order condition for hours worked can be re-written as

$$\psi_h h_t^\chi = \left[ a + (1-a) \left( \frac{ap_t^N}{1-a} \right)^{1-\xi} \right]^{-\frac{1}{1-\xi}} aw_t.$$

Remember that I use  $\hat{x}$  to represent percentage deviation from variable  $x$  under inflation stabilization policy in time  $t$ . The equilibrium equations are

$$\chi \hat{h}_t + \frac{(1-a) \left( \frac{ap_t^N}{1-a} \right)^{1-\xi}}{a + (1-a) \left( \frac{ap_t^N}{1-a} \right)^{1-\xi}} \hat{p}_t^N = \hat{w}_t, \quad (112)$$

$$\hat{p}_t^N = -\frac{1}{\xi} (\hat{c}_t^N - \hat{c}_t^T), \quad (113)$$

$$\frac{\psi}{\gamma} \hat{\pi}_t^N + \hat{p}_t^N + \hat{c}_t^N = \hat{w}_t + \hat{h}_t, \quad (114)$$

$$\hat{c}_t^T = \frac{w_t h_t}{c_t^T} (\hat{w}_t + \hat{h}_t) - \frac{p_t^N c_t^{N,N}}{c_t^T} (\hat{p}_t^N + \hat{c}_t^N), \quad (115)$$

$$\hat{c}_t^N = \alpha_h \hat{h}_t. \quad (116)$$

Finally, we also have

$$\hat{p}_t^N = \hat{\pi}_t^N - \hat{\epsilon}_t. \quad (117)$$

We now have a six-equation system. First, note that when  $\psi = 0$ , the last equation becomes redundant, confirming that exchange rate policy is irrelevant if there is no price adjustment cost.

Otherwise, denoting  $s_t = \frac{(1-a) \left( \frac{ap_t^N}{1-a} \right)^{1-\xi}}{a + (1-a) \left( \frac{ap_t^N}{1-a} \right)^{1-\xi}} < 1$ , the first five equations deliver a two-equation system

$$\begin{bmatrix} s_t - 1 & \frac{\chi+1}{\alpha_h} - 1 \\ \xi + \frac{p_t^N c_t^{N,N}}{c_t^T} - \frac{w_t h_t}{c_t^T} s_t & 1 + \frac{p_t^N c_t^{N,N}}{c_t^T} - \frac{w_t h_t}{c_t^T} \frac{1+\chi}{\alpha_h} \end{bmatrix} \begin{bmatrix} \hat{p}_t^N \\ \hat{c}_t^N \end{bmatrix} = \begin{bmatrix} \frac{\psi}{\gamma} \\ 0 \end{bmatrix} \hat{\pi}_t^N \quad (118)$$

Denote

$$B = \begin{bmatrix} s_t - 1 & \frac{\chi+1}{\alpha_h} - 1 \\ \xi + \frac{p_t^N c_t^{N,N}}{c_t^T} - \frac{w_t h_t}{c_t^T} s_t & 1 + \frac{p_t^N c_t^{N,N}}{c_t^T} - \frac{w_t h_t}{c_t^T} \frac{1+\chi}{\alpha_h} \end{bmatrix} \quad (119)$$

We can see  $B_{11} < 0, B_{12} > 0, B_{21} > 0$ . The solution gives  $\hat{p}_t^N = \frac{B_{22}}{B_{11}B_{22} - B_{12}B_{21}} \frac{\psi}{\gamma} \hat{\pi}_t^N$ . Suppose

$B_{22} > 0$  i.e.  $\frac{p_t^N c_t^N}{c_t^T} \chi < 1$ , then  $\frac{B_{22}}{B_{11}B_{22} - B_{12}B_{21}} < 0$ . Therefore, if  $\hat{e}_t > 0$ , then  $\hat{p}_t^N < 0$ ,  $\hat{\pi}_t^N > 0$  and according to equation (111), we further get  $\hat{c}_t^T > 0$  thus  $\hat{i}_t < 0$ .

## Robustness on FC Liability/GDP and Currency Devaluation

Table 9: Foreign Currency Liability/GDP and Currency Devaluation (excluding sovereign debt crises)

|                       | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                       | devaluation          | devaluation          | devaluation          | devaluation          | devaluation          |
| FC liability/GDP      | 0.151**<br>(0.060)   | 0.192***<br>(0.056)  | 0.199***<br>(0.057)  | 0.208***<br>(0.060)  | 0.217***<br>(0.066)  |
| LC liability/GDP      | -0.289***<br>(0.083) | -0.306***<br>(0.076) | -0.323***<br>(0.083) | -0.261***<br>(0.083) | -0.278***<br>(0.087) |
| control of corruption | -0.075**<br>(0.036)  | -0.106***<br>(0.034) | -0.102***<br>(0.036) | -0.332**<br>(0.126)  | -0.331**<br>(0.128)  |
| q GDP loss            |                      | -0.123<br>(0.086)    |                      | -0.133<br>(0.099)    |                      |
| h GDP loss            |                      |                      | -0.193<br>(0.220)    |                      | -0.315<br>(0.396)    |
| OECD dummy            |                      |                      |                      | 0.615<br>(0.382)     | 0.628<br>(0.387)     |
| export/GDP            |                      |                      |                      | -0.077<br>(0.447)    | -0.078<br>(0.452)    |
| broad money/reserves  |                      |                      |                      | -0.096<br>(0.148)    | -0.111<br>(0.202)    |
| $N$                   | 43                   | 36                   | 36                   | 35                   | 35                   |
| $R^2$                 | 0.189                | 0.300                | 0.284                | 0.456                | 0.445                |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between FC liability/GDP before crises and currency devaluation rate during crises but excludes sovereign debt crises (defined as default within 3 years after financial crises happen) sample. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 10: Foreign Currency Liability/GDP and Inflation, Bailout (excluding sovereign debt crises)

|                       | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                       | inflation            | inflation            | inflation            | bailout              | bailout              | bailout              |
| FC liability/GDP      | 0.076**<br>(0.030)   | 0.077**<br>(0.028)   | 0.083***<br>(0.026)  | 0.342**<br>(0.150)   | 0.488**<br>(0.172)   | 0.471**<br>(0.184)   |
| LC liability/GDP      | -0.110**<br>(0.041)  | -0.073*<br>(0.038)   | -0.084**<br>(0.035)  | -1.389***<br>(0.399) | -1.388**<br>(0.514)  | -1.372**<br>(0.542)  |
| control of corruption | -0.057***<br>(0.015) | -0.134***<br>(0.039) | -0.135***<br>(0.038) | -0.671***<br>(0.154) | -1.195***<br>(0.280) | -1.180***<br>(0.289) |
| q GDP loss            |                      | -0.046<br>(0.032)    |                      |                      | -0.181<br>(0.455)    |                      |
| h GDP loss            |                      |                      | -0.244*<br>(0.141)   |                      |                      | 0.174<br>(1.013)     |
| OECD dummy            |                      | 0.185<br>(0.114)     | 0.198*<br>(0.113)    |                      | 1.157<br>(0.796)     | 1.141<br>(0.802)     |
| export/GDP            |                      | 0.040<br>(0.122)     | 0.063<br>(0.121)     |                      | 0.811<br>(1.207)     | 0.663<br>(1.245)     |
| broad money/reserves  |                      | -0.119<br>(0.073)    | -0.164**<br>(0.078)  |                      | 0.501<br>(0.587)     | 0.484<br>(0.612)     |
| $N$                   | 42                   | 35                   | 35                   | 30                   | 25                   | 25                   |
| $R^2$                 | 0.306                | 0.481                | 0.509                | 0.665                | 0.756                | 0.753                |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between foreign currency liability/GDP before crises and inflation, bailout during crises but excludes sovereign debt crises (defined as default within 3 years after financial crises happen) sample. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Dependent variable in the last 3 columns is bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . Variables FC liability/GDP and LC liability/GDP are foreign currency and local currency external liability/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 11: Foreign Currency Debt/GDP and Currency Devaluation

|                       | (1)                | (2)                 | (3)                 | (4)                 | (5)                  |
|-----------------------|--------------------|---------------------|---------------------|---------------------|----------------------|
|                       | devaluation        | devaluation         | devaluation         | devaluation         | devaluation          |
| FC liability/GDP      | 0.100<br>(0.070)   | 0.148**<br>(0.062)  | 0.151**<br>(0.063)  | 0.198***<br>(0.071) | 0.201**<br>(0.083)   |
| LC liability/GDP      | -1.073*<br>(0.552) | -1.217**<br>(0.543) | -1.216**<br>(0.545) | -1.552**<br>(0.593) | -1.701***<br>(0.572) |
| control of corruption | -0.071<br>(0.043)  | -0.099**<br>(0.044) | -0.101**<br>(0.045) | -0.181<br>(0.127)   | -0.171<br>(0.129)    |
| q GDP loss            |                    | -0.046<br>(0.115)   |                     | 0.026<br>(0.139)    |                      |
| h GDP loss            |                    |                     | 0.080<br>(0.312)    |                     | 0.377<br>(0.415)     |
| OECD dummy            |                    |                     |                     | 0.306<br>(0.360)    | 0.294<br>(0.365)     |
| export/GDP            |                    |                     |                     | -0.701<br>(0.416)   | -0.733*<br>(0.396)   |
| broad money/reserves  |                    |                     |                     | 0.039<br>(0.165)    | 0.152<br>(0.193)     |
| $N$                   | 47                 | 40                  | 40                  | 39                  | 39                   |
| $R^2$                 | 0.126              | 0.198               | 0.196               | 0.329               | 0.343                |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between FC debt/GDP before crises and currency devaluation rate during crises. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variable control of corruption is the 2005-2014 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 12: Foreign Currency Debt/GDP and Inflation, Bailout

|                       | (1)                  | (2)                 | (3)                 | (4)                  | (5)                 | (6)                 |
|-----------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|
|                       | inflation            | inflation           | inflation           | bailout              | bailout             | bailout             |
| FC liability/GDP      | 0.071**<br>(0.029)   | 0.074**<br>(0.031)  | 0.073**<br>(0.028)  | 0.030<br>(0.244)     | 0.321<br>(0.234)    | 0.316*<br>(0.177)   |
| LC liability/GDP      | -0.605***<br>(0.208) | -0.473**<br>(0.224) | -0.447**<br>(0.208) | -3.915<br>(2.475)    | -6.700**<br>(2.707) | -7.016**<br>(2.585) |
| control of corruption | -0.046***<br>(0.015) | -0.094**<br>(0.038) | -0.097**<br>(0.038) | -0.648***<br>(0.196) | -0.817**<br>(0.334) | -0.787**<br>(0.338) |
| q GDP loss            |                      | -0.016<br>(0.038)   |                     |                      | 0.171<br>(0.547)    |                     |
| h GDP loss            |                      |                     | -0.093<br>(0.130)   |                      |                     | 1.589<br>(1.020)    |
| OECD dummy            |                      | 0.112<br>(0.108)    | 0.117<br>(0.107)    |                      | 0.315<br>(0.807)    | 0.269<br>(0.812)    |
| export/GDP            |                      | -0.088<br>(0.100)   | -0.082<br>(0.100)   |                      | -1.225<br>(1.136)   | -1.283<br>(1.134)   |
| broad money/reserves  |                      | -0.075<br>(0.068)   | -0.097<br>(0.074)   |                      | 2.379<br>(1.748)    | 2.633<br>(1.734)    |
| <i>N</i>              | 46                   | 39                  | 39                  | 34                   | 29                  | 29                  |
| <i>R</i> <sup>2</sup> | 0.303                | 0.417               | 0.422               | 0.534                | 0.645               | 0.665               |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ 

Notes: this table shows the relationship between foreign currency debt/GDP before crises and inflation, bailout during crises. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Dependent variable in the last 3 columns is bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 13: Foreign Currency Debt/GDP Held by Foreign Banks and Currency Devaluation (BIS-LBS data)

|                       | (1)                  | (2)                  | (3)                  | (4)                 | (5)                 |
|-----------------------|----------------------|----------------------|----------------------|---------------------|---------------------|
|                       | devaluation          | devaluation          | devaluation          | devaluation         | devaluation         |
| FC liability/GDP      | 0.478***<br>(0.163)  | 0.440***<br>(0.112)  | 0.462***<br>(0.115)  | 0.439***<br>(0.122) | 0.461***<br>(0.128) |
| LC liability/GDP      | -2.466***<br>(0.840) | -2.477***<br>(0.776) | -2.555***<br>(0.789) | -2.110**<br>(0.838) | -2.178**<br>(0.848) |
| control of corruption | -0.101**<br>(0.043)  | -0.097**<br>(0.045)  | -0.094**<br>(0.046)  | -0.099<br>(0.082)   | -0.101<br>(0.082)   |
| q GDP loss            |                      | -0.056<br>(0.097)    |                      | -0.060<br>(0.099)   |                     |
| h GDP loss            |                      |                      | -0.182<br>(0.300)    |                     | -0.183<br>(0.342)   |
| OECD dummy            |                      |                      |                      | -0.023<br>(0.187)   | -0.010<br>(0.193)   |
| export/GDP            |                      |                      |                      | -0.497**<br>(0.244) | -0.494**<br>(0.241) |
| broad money/reserves  |                      |                      |                      | 0.030<br>(0.130)    | 0.015<br>(0.149)    |
| <i>N</i>              | 61                   | 49                   | 49                   | 48                  | 48                  |
| <i>R</i> <sup>2</sup> | 0.212                | 0.261                | 0.262                | 0.332               | 0.333               |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between FC debt/GDP held by foreign banks before crises and currency devaluation rate during crises. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio. Note to facilitate comparison with Lane and Shambaugh (2010) data result (whose data is from 1990 on), I only look at post-1990 crises. I have a larger sample now but I will drop crises with devaluation rate > 1.5 sample (exchange rate devalues by 350%) and Liberia 1991 financial crisis as Liberia enters into a civil war from 1989 to 1997.

Table 14: Foreign Currency Debt/GDP Held by Foreign Banks and Inflation, Bailout (BIS-LBS data)

|                       | (1)                  | (2)                 | (3)                 | (4)                   | (5)                  | (6)                  |
|-----------------------|----------------------|---------------------|---------------------|-----------------------|----------------------|----------------------|
|                       | inflation            | inflation           | inflation           | bailout               | bailout              | bailout              |
| FC liability/GDP      | 0.124**<br>(0.049)   | 0.110**<br>(0.042)  | 0.134***<br>(0.042) | 0.812***<br>(0.291)   | 0.959***<br>(0.307)  | 0.763**<br>(0.355)   |
| LC liability/GDP      | -0.650**<br>(0.268)  | -0.566*<br>(0.307)  | -0.624*<br>(0.314)  | -10.234***<br>(2.313) | -9.771***<br>(2.810) | -9.452***<br>(2.801) |
| control of corruption | -0.062***<br>(0.016) | -0.069**<br>(0.029) | -0.070**<br>(0.029) | -0.463**<br>(0.195)   | -0.584*<br>(0.307)   | -0.548*<br>(0.304)   |
| q GDP loss            |                      | -0.035<br>(0.035)   |                     |                       | 0.110<br>(0.513)     |                      |
| h GDP loss            |                      |                     | -0.174<br>(0.132)   |                       |                      | 1.352<br>(1.156)     |
| OECD dummy            |                      | 0.014<br>(0.072)    | 0.024<br>(0.073)    |                       | -0.017<br>(0.661)    | -0.058<br>(0.653)    |
| export/GDP            |                      | -0.002<br>(0.104)   | 0.008<br>(0.098)    |                       | -0.523<br>(0.824)    | -0.584<br>(0.853)    |
| broad money/reserves  |                      | -0.076<br>(0.055)   | -0.105*<br>(0.060)  |                       | 0.923<br>(0.677)     | 1.052<br>(0.630)     |
| $N$                   | 57                   | 47                  | 47                  | 35                    | 29                   | 29                   |
| $R^2$                 | 0.289                | 0.368               | 0.388               | 0.649                 | 0.702                | 0.716                |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between foreign currency debt/GDP held by foreign banks before crises and inflation, bailout during crises. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Dependent variable in the last 3 columns is bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year  $[T, T+2]$  using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/foreign reserves ratio is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Table 15: Banks' Foreign Currency Debt/GDP Held by Foreign Banks and Currency Devaluation (BIS-LBS data)

|                       | (1)                  | (2)                  | (3)                  | (4)                 | (5)                 |
|-----------------------|----------------------|----------------------|----------------------|---------------------|---------------------|
|                       | devaluation          | devaluation          | devaluation          | devaluation         | devaluation         |
| FC liability/GDP      | 0.362*<br>(0.187)    | 0.479***<br>(0.139)  | 0.499***<br>(0.147)  | 0.450***<br>(0.139) | 0.462***<br>(0.151) |
| LC liability/GDP      | -2.464***<br>(0.912) | -2.982***<br>(0.898) | -3.059***<br>(0.934) | -2.494**<br>(0.955) | -2.554**<br>(0.962) |
| control of corruption | -0.099**<br>(0.042)  | -0.100**<br>(0.044)  | -0.097**<br>(0.045)  | -0.097<br>(0.085)   | -0.099<br>(0.086)   |
| q GDP loss            |                      | -0.072<br>(0.101)    |                      | -0.071<br>(0.106)   |                     |
| h GDP loss            |                      |                      | -0.185<br>(0.308)    |                     | -0.154<br>(0.353)   |
| OECD dummy            |                      |                      |                      | -0.026<br>(0.196)   | -0.014<br>(0.203)   |
| export/GDP            |                      |                      |                      | -0.479*<br>(0.243)  | -0.471*<br>(0.239)  |
| broad money/reserves  |                      |                      |                      | 0.055<br>(0.142)    | 0.058<br>(0.156)    |
| <i>N</i>              | 61                   | 49                   | 49                   | 48                  | 48                  |
| <i>R</i> <sup>2</sup> | 0.160                | 0.229                | 0.227                | 0.298               | 0.295               |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Notes: this table shows the relationship between domestic banks' FC debt/GDP held by foreign banks before crises and currency devaluation rate during crises. Each observation is a financial crisis. Dependent variable devaluation is currency devaluation rate from year T-2 to T+2, where T is crisis starts year. Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable control of corruption is the 2005-2014 ten year average control of corruption index. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio. Note to facilitate comparison with Lane and Shambaugh (2010) data result (whose data is from 1990 on), I only look at post-1990 crises. I have a larger sample now but I will drop crises with devaluation rate > 1.5 sample (exchange rate devalues by 350%) and Liberia 1991 financial crisis as Liberia enters into a civil war from 1989 to 1997.

Table 16: Banks' Foreign Currency Debt/GDP Held by Foreign Banks and Inflation, Bailout (BIS-LBS data)

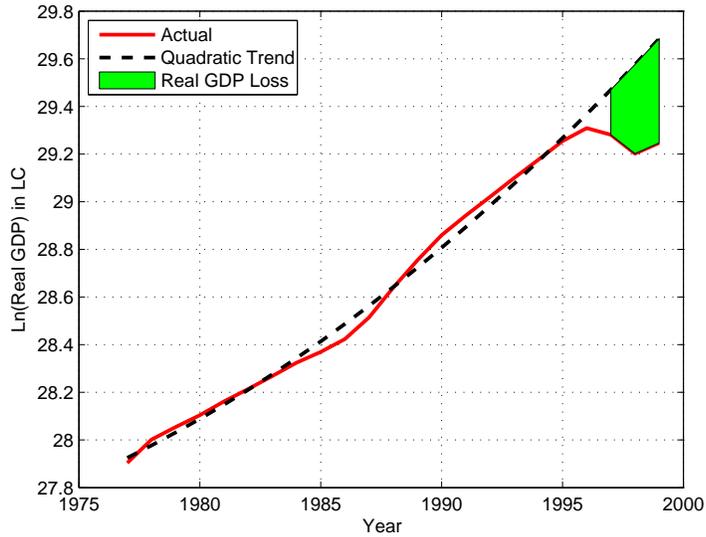
|                       | (1)                  | (2)                 | (3)                 | (4)                   | (5)                   | (6)                   |
|-----------------------|----------------------|---------------------|---------------------|-----------------------|-----------------------|-----------------------|
|                       | inflation            | inflation           | inflation           | bailout               | bailout               | bailout               |
| FC liability/GDP      | 0.147*<br>(0.077)    | 0.108<br>(0.074)    | 0.135*<br>(0.073)   | 0.999**<br>(0.427)    | 1.221***<br>(0.398)   | 0.929*<br>(0.490)     |
| LC liability/GDP      | -0.819**<br>(0.377)  | -0.667<br>(0.400)   | -0.736*<br>(0.405)  | -13.267***<br>(3.045) | -12.704***<br>(3.395) | -12.120***<br>(3.478) |
| control of corruption | -0.063***<br>(0.016) | -0.068**<br>(0.030) | -0.070**<br>(0.030) | -0.476**<br>(0.194)   | -0.577*<br>(0.316)    | -0.542*<br>(0.312)    |
| q GDP loss            |                      | -0.036<br>(0.036)   |                     |                       | 0.082<br>(0.520)      |                       |
| h GDP loss            |                      |                     | -0.160<br>(0.133)   |                       |                       | 1.347<br>(1.184)      |
| OECD dummy            |                      | 0.013<br>(0.074)    | 0.023<br>(0.076)    |                       | -0.093<br>(0.697)     | -0.131<br>(0.693)     |
| export/GDP            |                      | 0.001<br>(0.105)    | 0.009<br>(0.100)    |                       | -0.647<br>(0.843)     | -0.703<br>(0.866)     |
| broad money/reserves  |                      | -0.069<br>(0.054)   | -0.092<br>(0.059)   |                       | 0.936<br>(0.645)      | 1.091*<br>(0.622)     |
| <i>N</i>              | 57                   | 47                  | 47                  | 35                    | 29                    | 29                    |
| <i>R</i> <sup>2</sup> | 0.280                | 0.352               | 0.366               | 0.638                 | 0.694                 | 0.708                 |

Robust standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

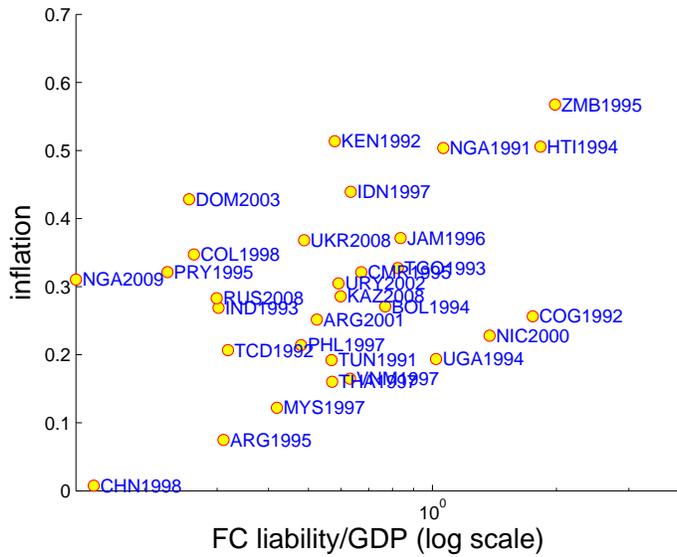
Notes: this table shows the relationship between domestic banks' foreign currency debt/GDP held by foreign banks before crises and inflation, bailout during crises. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is  $\ln(\text{CPI})$  change from year T-2 to T+2, and T is crisis starts year. Dependent variable in the last 3 columns is bailout is  $\ln(\text{fiscal cost of restructuring financial sector/financial sector asset})$ . Variables FC debt/GDP and LC debt/GDP are foreign currency and local currency external debt/GDP at the end of period T-2. Variable control of corruption is the 2006-2015 ten year average control of corruption index. Variables quadratic GDP loss and HP GDP loss are cumulative GDP loss in year [T,T+2] using pre-crisis 20 years' quadratic trend and HP trend. Variable OECD dummy takes 1 if a country has OECD membership as of year 2017. Variables export/GDP and broad money/reserves is year T-2 export/GDP ratio and broad money/foreign reserves ratio.

Figure 14: Calculation of GDP Loss: Thailand 1997 Financial Crisis



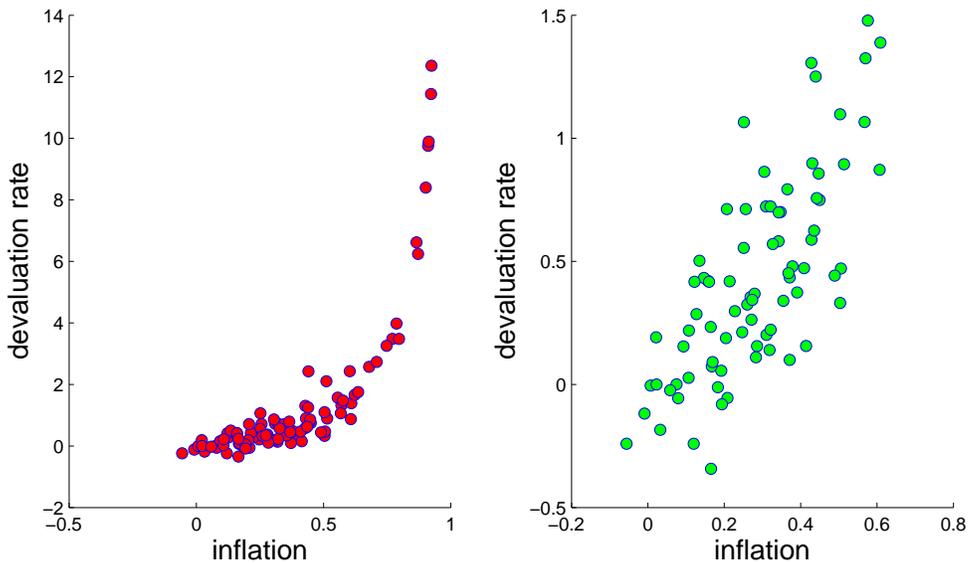
Notes: this figure illustrates the construction of 3-year GDP loss. Year 1997 is the crisis start year. I use year 1977-1996 real GDP to estimate a quadratic trend and predict year 1997-1999 real GDP. Real GDP loss is calculated as the cumulative gap between predicted  $\ln(GDP)$  and actual  $\ln(GDP)$  in year 1997-1999.

Figure 15: Inflation and FC Liability/GDP (non-OECD)



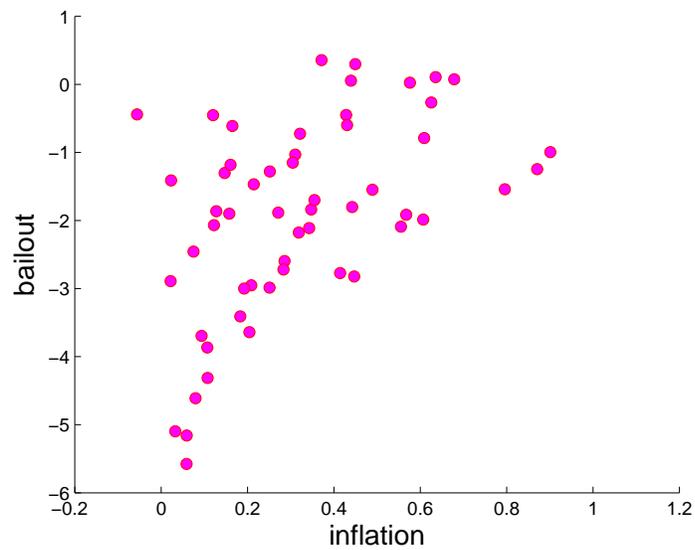
Notes: this figure shows the raw data of inflation in crises against FC (foreign currency) liability/GDP before crises for non-OECD group. Each dot is a financial crisis with country code and year on the right of each dot. Inflation is  $\pi/(1 + \pi)$  (for noise reducing purpose), where  $\pi$  is  $\ln(\text{CPI})$  change from T-2 to T+2 and T is crisis start year.

Figure 16: Devaluation Rate and Inflation



Notes: this figures shows the raw data of currency devaluation rate against inflation rate in crises. Each dot is a financial crisis. Inflation is  $\pi/(1 + \pi)$ , where  $\pi$  is  $\ln(\text{CPI})$  change from T-2 to T+2 and T is crisis start year and devaluation is  $\ln(\text{exchange rate})$  change from T-2 to T+2. The left panel is all sample and the right panel only keeps devaluation rate < 1.5 (devalue by less than 350%) sample.

Figure 17: Bailout and Inflation



Notes: this figures shows the raw data of bailout against inflation rate in crises. Each dot is a financial crisis. Inflation is  $\pi/(1 + \pi)$ , where  $\pi$  is  $\ln(\text{CPI})$  change from T-2 to T+2 and T is crisis start year. Bailout is measured as  $\ln(\text{fiscal cost of restructuring financial sector}/\text{financial sector asset})$ .