Essays in International Macroeconomics and Trade

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Submitted in partial fulfillment of the

requirements for the degree

of Doctor of Philosophy

in the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2018

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ABSTRACT

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I study bailout policy in open economies and the relationship between openness and institutions. **Chapter 1** 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. **Chapter 2** examines the joint dynamics of private and public external debt for countries. We develop a model with the co-occurrence of banking crisis and sovereign debt crisis in open economies, formalizing Reinhart and Rogoff (2011) findings "from financial crash to debt crisis". External interest rate spikes or sudden stop shocks force banks to cut down debt position and fire-sale capital. The existence of frictions in bank equity market creates incentives for the government to initiate a bailout. The government bails out banks by increasing external borrowing and implementing fiscal austerity to undo inefficiencies in the private sector. Under optimal bailout scheme, the model generates diverging external debt dynamics for the private sector and the government during a crisis, as we document in the European data. Finally, we investigate two rationales for ex-ante macro-prudential regulations on

private external debt: fire-sale externalities between banks and moral hazard by banks. **Chapter 3** (joint with Shang-Jin Wei) explores the relationship between openness and institutions. Quality of public institutions has been recognized as a crucial determinant of macroeconomic outcomes. We propose that a country's intrinsic level of openness (due to population size, geography, or exogenous trade opportunities) affects its incentives in investing in better institutions. We present a simple theory and extensive empirical evidence validating the role of intrinsic openness in determining institutional quality. This suggests an indirect but important channel for globalization to improve welfare by raising the quality of institutions.

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Acknowledgement

I owe a tremendous debt of thanks to my main advisors. Numerous discussions with Stephanie Schmitt-Grohé and Shang-Jin Wei help shape my critical thinking, and form the habit of connecting models with data. I am extremely lucky to develop my modeling, quantitative, and empirical skills with their continuous and patient support and guidance. Stephanié's high standards for elegance of modeling have always pushed me to pursue more concise economic insights. I learn a lot from Shang-Jin's ability of associating seemingly unrelated but economically quite relevant concepts using rigorous methodologies. Their always positive attitudes have also deeply influenced my attitudes towards ups and downs in research and life.

I am incredibly thankful to Patrick Bolton. His deep thinking in both micro side, e.g., corporate decision and macro side e.g., sovereign decision, has largely broadened my vision. Patrick has always been encouraging to me and the finance seminar he co-organizes in Columbia is always very helpful to push my research forward, in addition to his highly efficient guidance during his office hours. Jesse Schreger became one of my role models among young scholars in international finance field after I read his papers, before we personally met in Columbia years later. A substantial part of my job market paper is inspired by the seminar which Jesse Schreger gave in Columbia macro seminar before he joined Columbia. After he moved to Columbia, Jesse is more than willing to help me, as a student, from any possible dimension. The debt of gratitude I owe to him can never be repaid. I am also so fortunate to get Martin Uribe's advice and I am very grateful for his kind help. One of the big reasons that I chose Columbia to do my Ph.D. is that I realized Martin is working on important international macroeconomics topics in Columbia. Martin is always more than glad to help in a timely manner and understands students' difficulties very well. His suggestions and comments on my research are constantly sharp and to the point.

I am very grateful to Yi Wen, Jiandong Ju, Ping He and other professors in Tsinghua University, who led me to the research on macroeconomics, international trade and finance. I thank Sakai Ando, Yan Bai, Cynthia Mei Balloch, Yvan Becard, Luigi Bocola, Robin Burgess, Tuo Chen, Feng Dong, David Dorn, Andres Drenik, Jonathan Eaton, Xiang Fang, Simon Gilchrist, Juan Carlos Hatchondo, Harrison Hong, Yoon Joo Jo, Jiandong Ju, Zhen Huo, Réka Juhász, Kang Shi, Ryan Kim, Rishabh Kirpalani, Dirk Krueger, Jennifer La'O, Shu Lin, Qing Liu, Benjamin Moll, Frederic Mishkin, Seunghoon Na, Emi Nakamura, Serena Ng, Pablo Ottonello, Min Ouyang, B. Ravikumar, Stephen Redding, Bernard Salanié, Juan Sanchez, José Scheinkman, Michael Song, Jón Steinsson, Jian Wang, Neng Wang, Pengfei Wang, Yicheng Wang, David Weinstein, Yi Wen, Mike Woodford, Peifan Wu, Pierre Yared, Jing Zhou for comments and suggestions on various chapters of the dissertation. It was also great fun to study with my classmates and other Ph.D. students at Columbia economics department and business school who have generously offered their comments and inspirations.

Part of my dissertation was written in the Asian Development Bank headquartered in Manila and the Federal Reserve Bank of St. Louis. I thank their hospitality.

Finally, I would love to thank my parents and other friends. It is impossible to finish the dissertation without their support. I hope that I can bring more happiness to them after the graduate school.

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Chapter 1

Financial Crises, Bailouts and Monetary Policy in Open Economies

1.1 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.[1]

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

[1] 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.

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[2] via inflation tax.[3] Data shows that, during financial crises, larger foreign currency liability exposure is indeed associated with larger inflation and larger 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

[2]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.

[3]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".

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[4] 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

[4] 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.

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.

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 (2016*b*) 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 (2016*a*) 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 macro-prudential policy in an open economy context with production sector's nominal rigidities and banks' financial frictions as in Gertler, Kiyotaki et al. (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, Kiyotaki et al. (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. Empirically, Kaminsky, Reinhart and Végh (2004) investigate government's various dimensions of macroeconomic policies along business cycles, in particular, they pioneer the literature on cyclicality of fiscal policy. Vegh and Vuletin (2015) study tax policy along the business cycles by building a novel dataset on tax rates. My paper tries to focus only on severe financial crises where financial constraints of firms or banks are big concerns thus *bailout policy* is in urgent needs. To the best of my knowledge, my paper is also the first paper to conduct the empirical relationship between bailout size and external debt level.

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.

1.2 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).[5] I shall use letter "T" to denote crisis start year.[6]

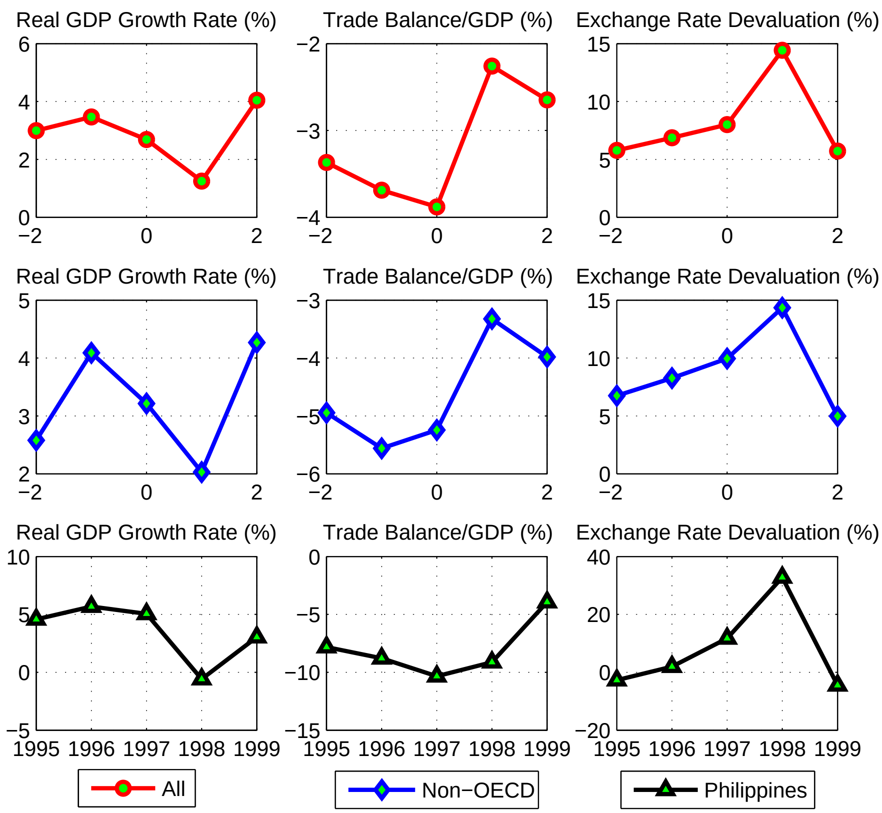
To have an idea of in general what happens in these crises, Figure 1.1 plots the median dynamics around financial crises. Not surprisingly, GDP growth rate slows down in these episodes. The trade balance improvement in crises is consistent with Mendoza (2010), which also motivates the consideration of 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 cur-

[5]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.

[6]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 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.

Figure 1.1: (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.

rency liability/GDP and currency devaluation. I then link foreign currency liability/GDP with inflation and bailout. Various robustness checks are performed in the Appendix.

1.2.1 Foreign Currency Liability and Currency Devaluation

My first empirical setting across crises is

$$devaluation\ rate_i = \beta_0 + \beta_1 * FC\ liability/GDP_i + \beta_2 * LC\ liability/GDP_i + \delta_e * X_i' + \epsilon_i, \quad (1.2.1)$$

where i denotes a crisis observation. The left hand side *devaluation rate* is the devaluation rate during the crisis from [T-2,T+2][7], 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.[8] *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 affect monetary policy credibility. Huang and Wei (2006) endogenize monetary policy credibility using institutional quality, e.g., cor-

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

[8] 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.

ruption.[9] 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.[10]

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 $[T-20, T-1]$.[11] I then use the estimated trend to predict GDP in $[T, T+2]$. Figure A.2 in the Appendix gives a graphic example (Thailand 1997 crisis) on how *GDP loss* is constructed.

The first three columns of Table 1.1 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[12]). 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

[9]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.

[10]I use year 2006-2015 ten years' average of the control of corruption index.

[11]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.

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

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 1.1: Foreign Currency Liability/GDP and Currency Devaluation

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) devaluation
FC liability/GDP	0.138**	0.196***	0.199***	0.197**	0.194**
	(0.061)	(0.063)	(0.066)	(0.074)	(0.083)
LC liability/GDP	-0.324***	-0.371***	-0.373***	-0.297**	-0.293**
	(0.092)	(0.099)	(0.103)	(0.115)	(0.119)
control of corruption	-0.071*	-0.101**	-0.103**	-0.202	-0.201
	(0.040)	(0.040)	(0.041)	(0.125)	(0.126)
q GDP loss		-0.025		-0.006	
		(0.109)		(0.130)	
h GDP loss			0.078		0.143
			(0.305)		(0.460)
OECD dummy				0.284	0.279
				(0.358)	(0.365)
export/GDP				-0.447	-0.465
				(0.417)	(0.408)
broad money/reserves				-0.104	-0.056
				(0.181)	(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 1.2 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. LC liability/GDP is no longer statistically significant and institutions also cease to be significant. Figure 1.2 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 1.2: Foreign Currency Liability/GDP and Currency Devaluation (non OECD sample)

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) 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)
N	31	27	27	27	27
R^2	0.086	0.197	0.209	0.224	0.268

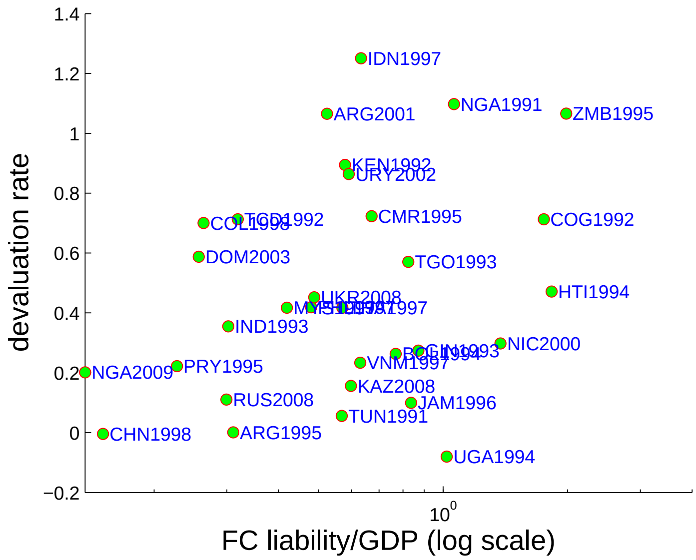
Robust standard errors in parentheses

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

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.

In summary, my empirical finding shows a positive relationship between before crises

Figure 1.2: 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(exchange rate) from T-2 to T+2, where T is crisis start year.

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.

1.2.2 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 π is inflation. This measure is not only noise reducing but also sometimes can be mapped to the size of inflation tax.[13]) and bailout

$$inflation_i = \gamma_0 + \beta_1 * FC\ liability/GDP_i + \gamma_2 * LC\ liability/GDP_i + \delta_\pi * X_i' + \varepsilon_i, \quad (1.2.2)$$

$$bailout_i = \zeta_0 + \zeta_1 * FC\ liability/GDP_i + \zeta_2 * LC\ liability/GDP_i + \delta_b * X_i' + u_i, \quad (1.2.3)$$

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 1.3 and 1.4 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 1.5 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.

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

[13] For example, a 100% (π) 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) (where they also document this inflation tax is countercyclical for many developing countries as my model will generate). I have also used inflation π directly, and my empirical results are robust.

Table 1.3: Foreign Currency Liability/GDP and Inflation

	(1) inflation	(2) inflation	(3) inflation	(4) inflation	(5) inflation
FC liability/GDP	0.073**	0.064**	0.064**	0.073**	0.077**
	(0.030)	(0.028)	(0.028)	(0.030)	(0.029)
LC liability/GDP	-0.116***	-0.084***	-0.085***	-0.089**	-0.095**
	(0.040)	(0.027)	(0.027)	(0.038)	(0.036)
control of corruption	-0.056***	-0.066***	-0.065***	-0.101**	-0.102***
	(0.015)	(0.015)	(0.014)	(0.038)	(0.037)
q GDP loss		-0.009		-0.025	
		(0.031)		(0.035)	
h GDP loss			-0.031		-0.158
			(0.095)		(0.141)
OECD dummy				0.104	0.114
				(0.109)	(0.106)
export/GDP				-0.013	0.002
				(0.106)	(0.104)
broad money/reserves				-0.119	-0.152*
				(0.078)	(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 inflation/(1+inflation), where inflation rate is ln(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 1.4: Foreign Currency Liability/GDP and Bailout

	(1) bailout	(2) bailout	(3) bailout	(4) bailout	(5) bailout
FC liability/GDP	0.346**	0.396**	0.371*	0.423**	0.396*
	(0.158)	(0.176)	(0.189)	(0.198)	(0.209)
LC liability/GDP	-1.496***	-1.575***	-1.526***	-1.454**	-1.409**
	(0.434)	(0.499)	(0.501)	(0.590)	(0.593)
control of corruption	-0.679***	-0.663***	-0.671***	-0.889***	-0.879**
	(0.150)	(0.154)	(0.150)	(0.310)	(0.311)
q GDP loss		0.139		0.135	
		(0.456)		(0.482)	
h GDP loss			1.101		0.868
			(0.888)		(0.921)
OECD dummy				0.398	0.361
				(0.722)	(0.732)
export/GDP				-0.122	-0.201
				(1.042)	(1.060)
broad money/reserves				0.202	0.245
				(0.734)	(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(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 1.5: Foreign Currency Liability/GDP and Inflation, Bailout (non OECD sample)

	(1) inflation	(2) inflation	(3) inflation	(4) bailout	(5) bailout	(6) 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(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(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.

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.

1.3 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[14]) who produce non-tradable goods, a government 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.

[14] 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 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.

1.3.1 Money Demand

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

$$M_t = \theta P_t^T y_t^T, \tag{1.3.1}$$

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.

1.3.2 Households

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

$$\max_{\{c_t^T, c_t^N, h_t, x_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t - v(h_t)), \tag{1.3.2}$$

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 β is the subjective discount factor.

Function $\Omega(c^T, c^N)$ defined over positive values of its arguments is assumed to be homogeneous of degree one, increasing, concave and it also satisfies the Inada conditions.

I adopt the following CES form

$$\Omega(c_T, c_N) = [a{c^T}^{1-\frac{1}{\xi}} + (1-a){c^N}^{1-\frac{1}{\xi}}]^{\frac{1}{1-\frac{1}{\xi}}}. \tag{1.3.3}$$

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

$$v(h) = \psi_h \frac{h^{1+\chi}}{1+\chi}. \tag{1.3.4}$$

The parameter χ 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

$$P_t^T c_t^T + P_t^N c_t^N + x_{t+1} P_t^T (e_t - div_t) = [P_t^T y_t^T - M_t + M_{t-1}] + W_t h_t + x_t P_t^T e_t, \tag{1.3.5}$$

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

$$c_t^T + p_t^N c_t^N + x_{t+1}(e_t - div_t) = y_t^T - \frac{M_t - M_{t-1}}{P_t^T} + w_t h_t + x_t e_t, \tag{1.3.6}$$

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

Denoting λ_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}:

$$[c_t - \psi_h (1+\chi)^{-1} h_t^{1+\chi}]^{-\sigma} [a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}} a (c_t^T)^{-\frac{1}{\xi}} = \lambda_t \tag{1.3.7}$$

$$[c_t - \psi_h (1+\chi)^{-1} h_t^{1+\chi}]^{-\sigma} [a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}} (1-a) (c_t^N)^{-\frac{1}{\xi}} = \lambda_t p_t^N \tag{1.3.8}$$

$$[c_t - \psi_h(1+\chi)^{-1}h_t^{1+\chi}]^{-\sigma}\psi_h h_t^{\chi} = \lambda_t w_t \tag{1.3.9}$$

$$e_t = div_t + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} e_{t+1} \tag{1.3.10}$$

Equation (1.3.7) and (1.3.8) pin down the relative price of nontradable good

$$p_t^N = \frac{1-a}{a}\left(\frac{c_t^N}{c_t^T}\right)^{-\frac{1}{\xi}}. \tag{1.3.11}$$

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 (1.3.10) and rule out bubbles to arrive at

$$e_t = E_t \sum_{s=0}^{\infty} \beta^s \frac{\lambda_{t+s}}{\lambda_t} div_{t+s}. \tag{1.3.12}$$

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

1.3.3 Non-tradable Sector Firms

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

$$e_{j0} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} div_{jt}, \tag{1.3.13}$$

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

$$y^N = k^{\alpha_k}(zh)^{\alpha_h}, \tag{1.3.14}$$

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

$$y_t^N = \left[\int_0^1 (y_{jt}^N)^{\frac{\gamma-1}{\gamma}} dj \right]^{\frac{\gamma}{\gamma-1}} \tag{1.3.15}$$

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

$$P_t^N = \left[\int_0^1 P_{jt}^{N\,1-\sigma} dj \right]^{\frac{1}{1-\sigma}}. \tag{1.3.16}$$

Therefore, the demand function for variety j is

$$y_{jt}^N = \left(\frac{P_{jt}^N}{P_t^N} \right)^{-\gamma} y_t^N. \tag{1.3.17}$$

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.[15]

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 δ, 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 lá 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.[16] The purpose of introducing price adjustment cost is to generate price stickiness and thus cost of inflation including the currency mis-

[15] See more discussions on subsidies in Woodford (2002) in a monopolistic competitive environment.

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

match effect.

Firm j's budget constraint is written as

$$P_t^T div_{jt} = P_{jt}^N y_{jt}^N (1+\tau_y) - W_t h_{jt} \\ + P_t^T \left(-k_{j,t+1} + (1-\delta)k_{jt} - \frac{\phi}{2}(\frac{k_{j,t+1}}{k_{jt}} - 1)^2 k_{jt} - b_{jt} + \frac{b_{j,t+1}}{1+r_t} - \frac{\psi}{2}(\frac{P_{jt}^N}{P_{j,t-1}^N} - 1)^2 \right) - T_t. \tag{1.3.18}$$

T_t is equal to the subsidy to output

$$T_t = \tau_y P_t^N y_t^N. \tag{1.3.19}$$

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

$$div_{jt} = \frac{P_{jt}^N}{P_t^T} y_{jt}^N (1+\tau_y) - w_t h_{jt} - k_{j,t+1} + (1-\delta)k_{jt} - \frac{\phi}{2}(\frac{k_{j,t+1}}{k_{jt}} - 1)^2 k_{jt} - b_{jt} + \frac{b_{j,t+1}}{1+r_t} - \frac{\psi}{2}(\frac{P_{jt}^N}{P_{j,t-1}^N} - 1)^2 - t_t. \tag{1.3.20}$$

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

$$\frac{b_{j,t+1}}{1+r_t} \leq \kappa_t k_{jt}, \tag{1.3.21}$$

where they can pledge their own capital's book value as collateral for international borrowing. I take κ_t as sudden stop shocks.[17] 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. [18] The debt constraint attempts to

[17] See also Eggertsson and Krugman (2012) for deleveraging shocks in a closed economy.

[18] 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

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,

$$P_t^T div_{jt} \geq P_t^T \underline{\mathrm{d}}, \tag{1.3.22}$$

where $\underline{\mathrm{d}}$ 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 $\underline{\mathrm{d}} = 0$ 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 $\underline{\mathrm{d}} < 0$, 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

$$div_{jt} \geq \underline{\mathrm{d}}. \tag{1.3.23}$$

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 ν_t and μ_t as the Lagrange multipliers associated with debt market and equity market constraint

doesn't focus on the pecuniary externality mechanism, so I take book value of collateral for simplicity.

respectively):

$$(1+\mu_t)\left((\gamma-1)y_t^N p_t^N(1+\tau_y)-w_t h_t\frac{\gamma}{\alpha_h}+\psi(\pi_t^N-1)\pi_t^N\right)=\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\psi(\pi_{t+1}^N-1)\pi_{t+1}^N(1+\mu_{t+1}). \tag{1.3.24}$$

$$(1+\mu_t)\frac{1}{1+r_t}-\frac{\nu_t}{1+r_t}=\beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}(1+\mu_{t+1})\right), \tag{1.3.25}$$

$$(1+\mu_t)\left(1+\phi(\frac{k_{t+1}}{k_t}-1)\right)=\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\left\{\left[\left(1-\delta+\frac{\phi}{2}[(\frac{k_{t+2}}{k_{t+1}})^2-1]\right)+\frac{\alpha_k}{\alpha_h}\frac{w_{t+1}h_{t+1}}{k_{t+1}}\right](1+\mu_{t+1})+\kappa_{t+1}\nu_{t+1}\right\}, \tag{1.3.26}$$

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

Equation (1.3.24) 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 τ_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 (1.3.25) is the Euler equation for debt. The appearance of ν_t reflects the shadow cost of borrowing due to the borrowing constraint. μ_t reflects borrowing one more unit today relaxes equity market constraint while μ_{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 (1.3.26) is the Euler equation for capital. μ_t on the left hand side captures that increasing capital stock for next period (chosen at current period) tightens equity market constraint today while μ_{t+1} on the right hand side captures that it relaxes next period's equity market constraint. Finally, ν_{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

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t, \tag{1.3.27}$$

$$(\kappa_t k_t - \frac{b_{t+1}}{1+r_t})\nu_t \geq 0, \tag{1.3.28}$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi_t^N - 1)^2 \geq \underline{\mathrm{d}}, \tag{1.3.29}$$

$$\mu_t \left(p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \underline{\mathrm{d}} - \frac{\psi}{2}(\pi_t^N - 1)^2 \right) \geq 0. \tag{1.3.30}$$

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 κ 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.

1.3.4 Government

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

$$\epsilon_t = \frac{\Xi_t}{\Xi_{t-1}} = \frac{P_t^T}{P_{t-1}^T}, \tag{1.3.31}$$

where Ξ_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

$$it_t = \frac{M_t - M_{t-1}}{P_t^T} = \theta(y_t^T - \frac{y_{t-1}^T}{\epsilon_t}). \tag{1.3.32}$$

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

$$\frac{p_t^N}{p_{t-1}^N} = \frac{P_t^N/\Xi_t}{P_{t-1}^N/\Xi_{t-1}} = \frac{\pi_t^N}{\epsilon_t}. \tag{1.3.33}$$

1.3.5 General Equilibrium

The market clearing conditions for tradables and nontradables are

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2, \tag{1.3.34}$$

$$y_t^N = c_t^N. \tag{1.3.35}$$

The nontradable sector production function is

$$y_t^N = k_t^{\alpha_k}(zh_t)^{\alpha_h}. \tag{1.3.36}$$

Investment is

$$i_t = k_{t+1} - (1-\delta)k_t + \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t. \tag{1.3.37}$$

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 (A.2.1) to equation (A.2.15). 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 π_t^N is not relevant from equation (A.2.1) to equation (A.2.15), therefore, I can solve the equilibrium allocation without looking at exchange rate policy ϵ_t in equation (A.2.16). After obtaining p_t^N, inflation π_t^N just moves with ϵ_t according to equation (A.2.16). □

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 (A.2.1) to equation (A.2.15), 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.

1.3.6 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

$$\max_{\{c_t^T, c_t^N, h_t, b_{t+1}, k_{t+1}, \pi_t^N\}} E_0 \sum_{t=0}^{+\infty} \beta^t u(\Omega(c_t^T, c_t^N) - v(h_t)), \tag{1.3.38}$$

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

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2, \tag{1.3.39}$$

$$c_t^N = k_t^{\alpha_k}(zh_t)^{\alpha_h}, \tag{1.3.40}$$

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t. \tag{1.3.41}$$

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 (1.3.33) then provides solution to exchange rate by setting $\pi_t^N = 1$:

$$\epsilon_t(b_t, k_t, p_{t-1}^N, ES_t) = \frac{p_{t-1}^N}{p_t^N}, \tag{1.3.42}$$

where ES_t means "exogenous shock" (y_t^T, r_t, κ_t). After a "sudden stop" shock (κ falls), tradable goods consumption falls in the economy, generating a fall in p_t^N as well. Therefore, inflation stabilization means an increase in ϵ_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.

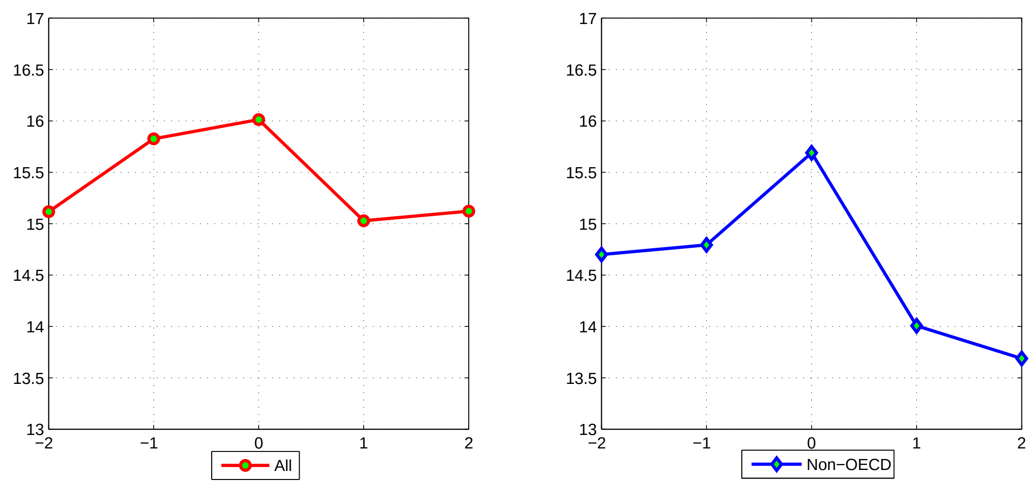
When domestic frictions disappear ($\underline{d} = -\infty$), the competitive equilibrium coincides with social planner solution as there are no other domestic inefficiency source . Since the domestic financial friction is crucial and it impedes fund flows from households, a direct policy implication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

Proposition 4. *The social planner solution can be replicated by imposing a lump sum transfer* $LT_t \geq \underline{d} - \{p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t}\}^{SP}$ *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 1.3 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 1.3: (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.

1.4 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.

1.4.1 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

$$\frac{b_{t+1}}{1+r_t} = \kappa_t k_t, \tag{1.4.1}$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi_t^N - 1)^2 = \underline{d}. \tag{1.4.2}$$

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*

$$\frac{p_t^N c_t^N}{c_t^T}\chi < 1, \tag{1.4.3}$$

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 $\frac{p^N c^N}{c^T}\chi < 1$ is a sufficient condition that is not hard to be satisfied empirically. On the one hand, χ 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 χ) 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 χ 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:*

$$V^{cm}(b,k,p_{-1}^N,ES) = \max_{\{\epsilon,c,c^T,c^N,y^N,\lambda,h,i,k',b',\nu,\mu,p^N,w,\pi^N\}} u(c-v(h)) + \beta E V^{cm}(b',k',p^N,ES') \quad (1.4.4)$$

subject to the equilibrium conditions from equation (A.2.1) to (A.2.16). Time consistency requires current policy coincides with future policy.

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

1.4.2 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 ω_t^b

$$div_t = p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\ \pi_t^N - 1)^2 + \omega_t^b. \quad (1.4.5)$$

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 κ_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 ϵ and bailout policy ω^b, and implied future private sector policy functions, the government solves the Bellman problem at each time:*

$$V^{bt}(b,k,p^N_{-1},ES_{-1},ES) = \max_{\{\epsilon,it,\omega^b,c,c^T,c^N,y^N,\lambda,h,i,k',b',\nu,\mu,p^N,w,\pi^N\}} u(c-v(h))-f_e 1_{\omega^b>0}+\beta EV^{bt}(b',k',p^N,ES,ES') \tag{1.4.6}$$

subject to

$$\omega^b_t \leq it_t - \frac{\phi_b}{2} it_t^2, \tag{1.4.7}$$

$$it_t = \theta(y^T_t - \frac{y^T_{t-1}}{\epsilon_t}), \tag{1.4.8}$$

and equilibrium conditions from equation (A.2.1) to (A.2.16), except equation (A.2.9) and (A.2.10) are replaced by

$$p^N_t y^N_t - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi^N_t - 1)^2 + \omega^b_t \geq \underline{d},$$

$$\mu_t\left(p^N_t y^N_t - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi^N_t - 1)^2 + \omega^b_t - \underline{d}\right) \geq 0.$$

Time consistency requires current policy coincides with future policy.

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

1.5 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.

1.5.1 Calibration

1.5.1.1 Exogenous Processes

The model has exogenous shocks of a triplet (y_t^T, r_t, κ_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

$$\begin{bmatrix} \log y_t^T \\ \log(\frac{1+r_t}{1+r}) \end{bmatrix} = A \begin{bmatrix} \log y_{t-1}^T \\ \log(\frac{1+r_{t-1}}{1+r}) \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \tag{1.5.1}$$

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.[19] 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.[20]

The estimates of coefficient matrix A, covariance matrix Σ and mean real interest rate are

$$A = \begin{bmatrix} 0.9593 & -0.0001 \\ 0.0341 & 0.8037 \end{bmatrix}; \Sigma = \begin{bmatrix} 0.000023 & -0.000005 \\ -0.000005 & 0.000286 \end{bmatrix}; r = 0.0048 \qquad (1.5.2)$$

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 $ln(y^T)^a$ and r^a as the mean of $\ln(y_t^T)$ and r_t; $ln(y^T)^l$ and r^l as one standard deviation below mean; $ln(y^T)^h$ and r^h as one standard deviation above mean.[21] The first state is the "average state" $(ln(y^T)^a, r^a)$. The other four states are $(ln(y^T)^h, r^l)$, $(ln(y^T)^h, r^h)$, $(ln(y^T)^l, r^l)$, $(ln(y^T)^l, r^h)$. Similar to Schmitt-Grohé and Uribe (2016*a*), I construct the transition probability matrix by simulating equation (1.5.1) 1 million times. I associate each observation in the time series with one of the 5 possible discrete states by euclidean distance minimization. Therefore, I obtain a 5×5 transition matrix Π^0 for $(ln(y^T), r)$.

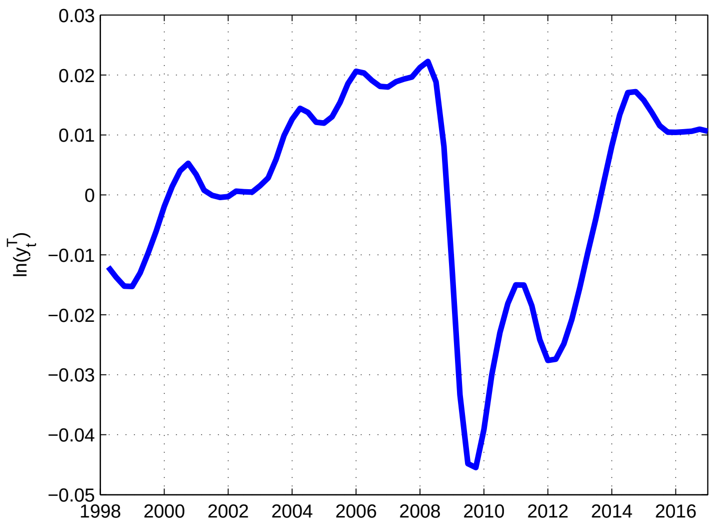
I further insert κ_t shock. I pick up two values κ^H and κ^L. As will be clearer in the calibration, κ^H is chosen to be large enough so that debt constraint will never bind in that state. But κ^L is the state where it is possible that debt constraint becomes binding. I assume that κ^L only possibly 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

[19] I implement seasonal adjustment to the raw data before removing the trend component using X13-ARIMA.

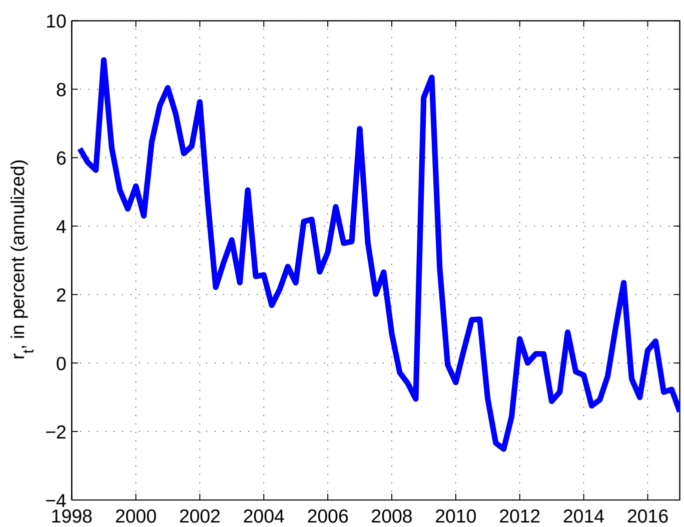
[20] I construct real interest rate r_t from $1 + r_t = (1 + i_t)E_t \frac{1}{1+\pi_{t+1}}$, where i_t is the sum of the EMBI global spread and US 3-month T-bill rate. I follow Schmitt-Grohé and Uribe (2016*a*) to obtain $E_t \frac{1}{1+\pi_{t+1}}$ by using the predicted value of $\frac{1}{1+\pi_{t+1}}$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

[21] 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.

Figure 1.4: 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.

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 κ_t, which is a 6×6 dimension matrix Π.

1.5.1.2 Parameter Values

Table 1.6 summarizes parameter values. Risk aversion σ is set to a standard value in macro literature as 2. The elasticity of substitution ξ 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 ξ, 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 γ 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 δ 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 α_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 ψ_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 β 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 ϕ^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 ϕ^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 ϕ^b to shut down bailout. Parameter θ is to match the M1/GDP of Philippines around Asian Financial Crises.[22] Finally, the price adjustment cost $\psi = 0.4$ is to match standard deviation of $\pi_t^N = 0.007$ as in Philippines data.[23]

[22]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.

[23]I have quarterly CPI information from year 1994 on from Bangko Sentral ng Pilipinas (central bank of

Table 1.6: 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	$\underline{\mathrm{d}} = -0.01$	half prob. of binding
Price Adjustment Cost	$\psi = 0.4$	std(π^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.

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.

1.5.2 Inflation Stabilization Policy

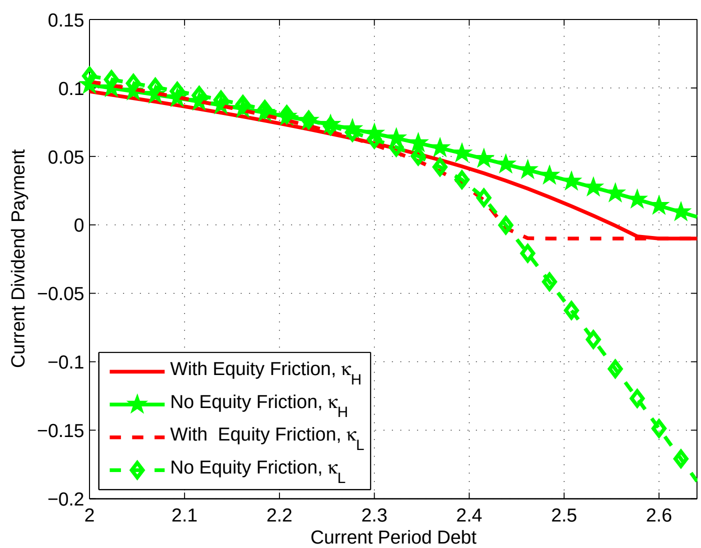
The inflation stabilization policy is my benchmark policy because 1) it replicates allocation of the economy without nominal rigidities ($\psi = 0$) and 2) if domestic equity friction has been non-existent, it achieves the social planner allocation. I will use this policy to

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.

inspect the basic model mechanism in the private sector.

Figure 1.5 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 κ_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 κ_L when existing debt is too high. Finally, the existence of tighter borrowing constraint (κ_L compares with κ_H) makes dividend constraint bind at a lower current debt threshold.

Figure 1.5: 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 $((y^T)^l, r^h)$.

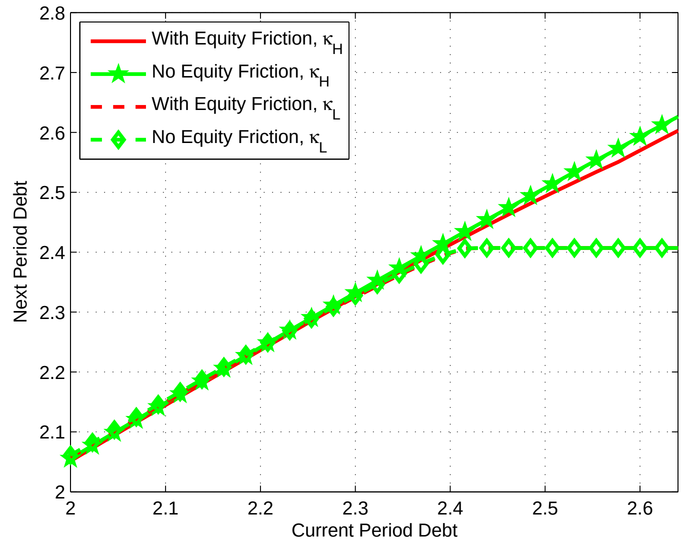
Figure 1.6 compares policy functions of debt and capital with equity friction and without equity friction. Panel (a) is debt policy. The first observation is due to domestic financial frictions, there is precautionary motive: under κ_H, the debt choice is more conservative with equity friction compared to the without equity friction case. This precautionary motive is more pronounced when current debt is already high. While under κ_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 κ_H, especially when current debt is high. On the contrary, under κ_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 1.7 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.

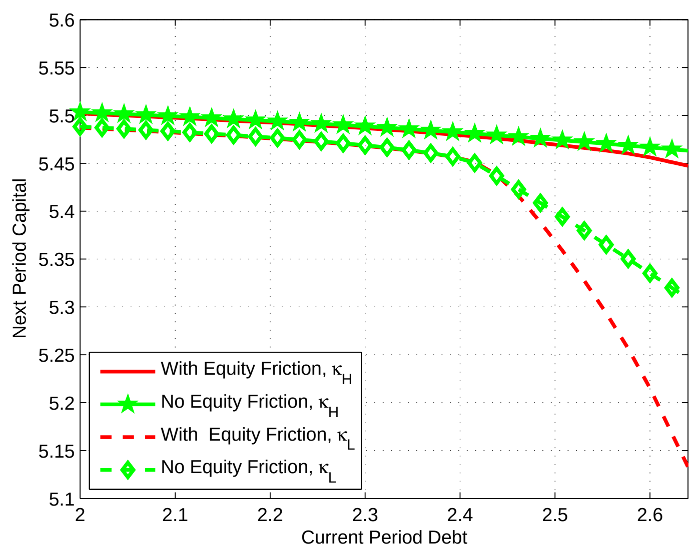
Lastly, I turn to sudden stop dynamics. Figure 1.8 shows the results. After I simulate

Figure 1.6: Debt and Capital Policy Functions

(a) Debt b'



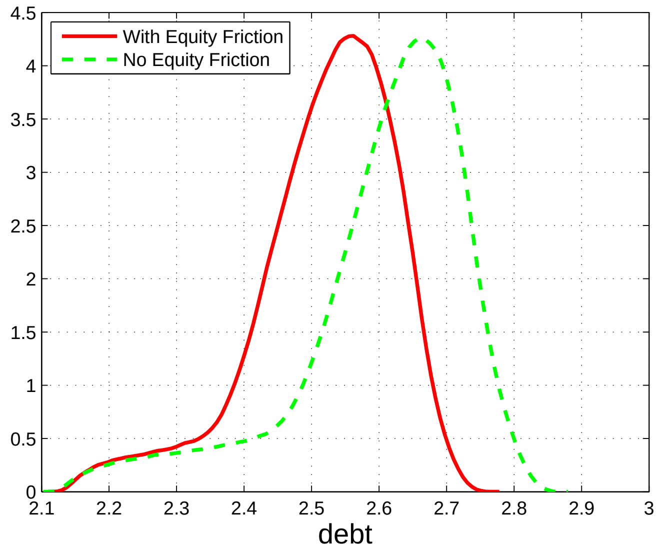
(b) Capital k'



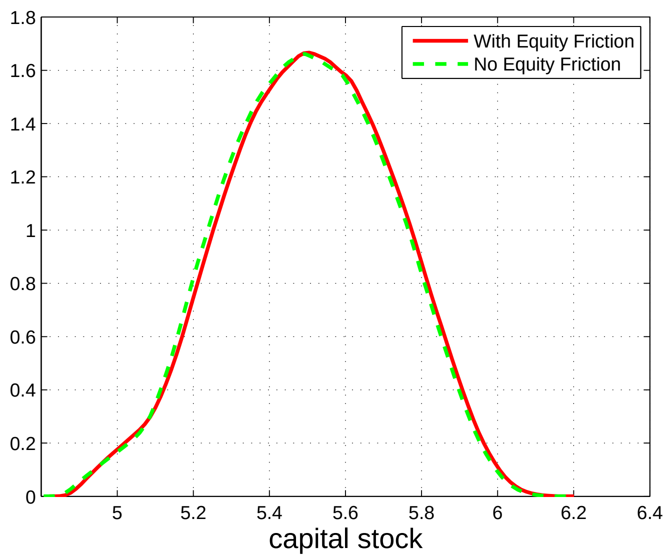
Notes: this figure shows the policy functions of debt and capital under inflation stabilization policy. Policy functions are evaluated at mean capital stock in the simulation with equity frictions; tradable output and interest rate are $((y^T)^l, r^h)$.

Figure 1.7: 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.

the economy, I take non-overlapping windows where the first 4 quarters are with κ_H (no bad financial shock) and the following 4 quarters are with κ_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.

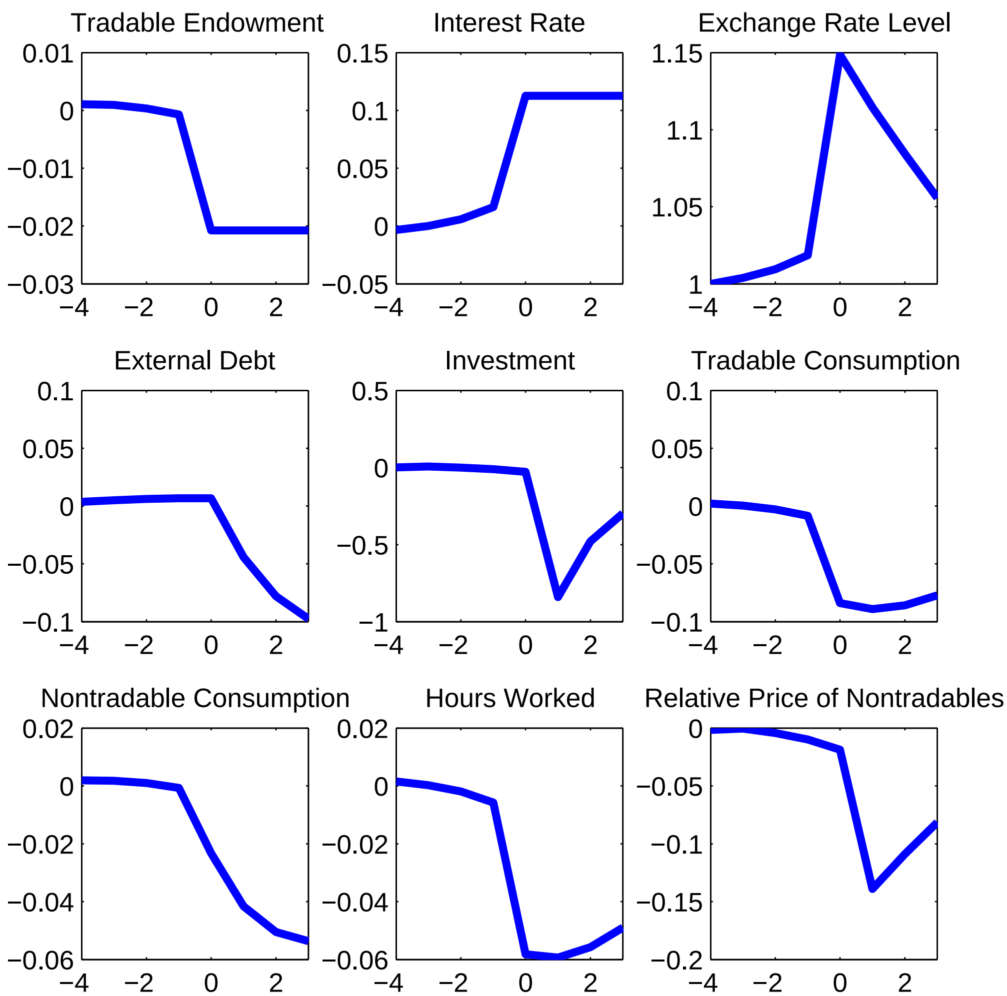
The sudden stop dynamics conforms to what I expect. Tradable output and interest rate are exogenous in my model. Since by construction I have related κ_L to (y^L, r^H), the drop in tradable endowment and rise in interest rate are in order. The decline in external debt is driven by the κ shock where firms 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.

1.5.3 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

Figure 1.8: 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 κ_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.

policy, the government also needs to monetize its chosen bailout size.

1.5.3.1 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^N_{t-1}) at their mean values under inflation stabilization policy's simulations conducted above and set previous period's exogenous state as (y^L, r^H, κ^H). The current period is hit by the sudden stop shock (y^L, r^H, κ^L). I vary the existing debt levels and compare the exchange rate policy functions under different policies.

Figure 1.9 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.[24] Therefore, the demand of non-tradable good ceases to fall as well.

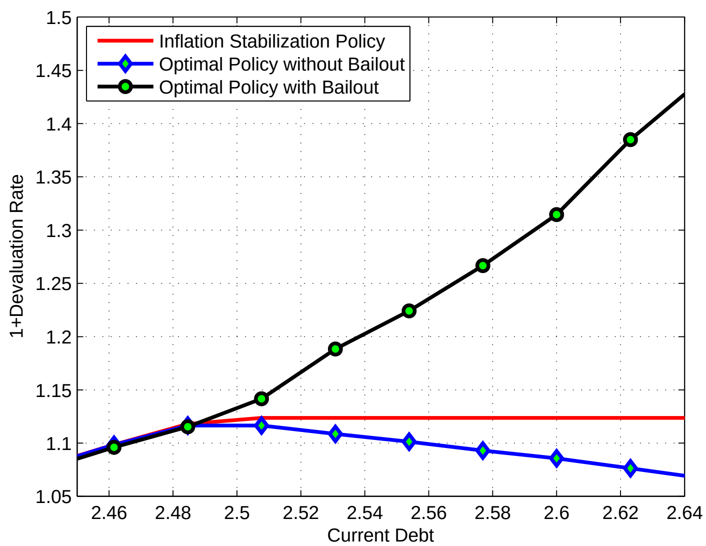
If bailout policy is not considered but currency mismatch effect is present, under optimal policy, exchange rate devaluation becomes more conservative compared to the inflation stabilization policy. Moreover, larger current debt calls for less devaluation. The reason is that larger existing debt makes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

[24]This doesn't mean there is consumption boom. In general, consumption still falls compared to pre-shock period.

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 1.9: 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 $((y^T)^L, r^H, \kappa^L)$.

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 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.[25] 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 $\log(\frac{\omega_t^b}{k_{t+1}})$[26] when bailout is implemented, on the pre-bailout debt/GDP (1 year before):

$$devaluation\ rate_i = \beta_0 + \beta_1 \cdot debt/GDP_i + \epsilon_i, \tag{1.5.3}$$

$$inflation_i = \gamma_0 + \gamma_1 \cdot debt/GDP_i + \varepsilon_i, \tag{1.5.4}$$

$$bailout_i = \zeta_0 + \zeta_1 \cdot debt/GDP_i + u_i. \tag{1.5.5}$$

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 1.7. 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.

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

[26]Using market value of firm asset instead of book value will not change the sign of my estimation.

Table 1.7: Model Implied Regression Results

	Optimal Policy with Bailout	Optimal Policy without Bailout
β_1	0.601***	-0.874***
γ_1	0.484***	-0.522***
ζ_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. β_1, γ_1 and ζ_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.

1.5.3.2 Ex-ante Risk Taking

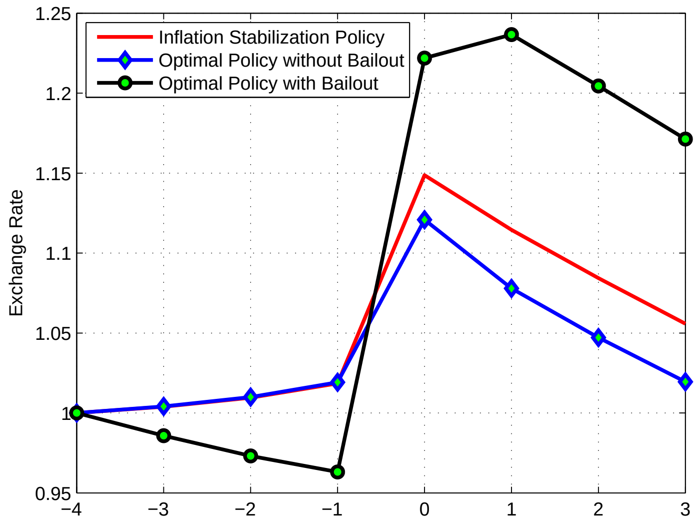
Having studied the ex-post policy responses, I now turn attention to ex-ante firm decisions. The anticipation of bailouts can possibly induce more risk-taking, making the economy more vulnerable when bad shocks hit.

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 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 1.10. 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.

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

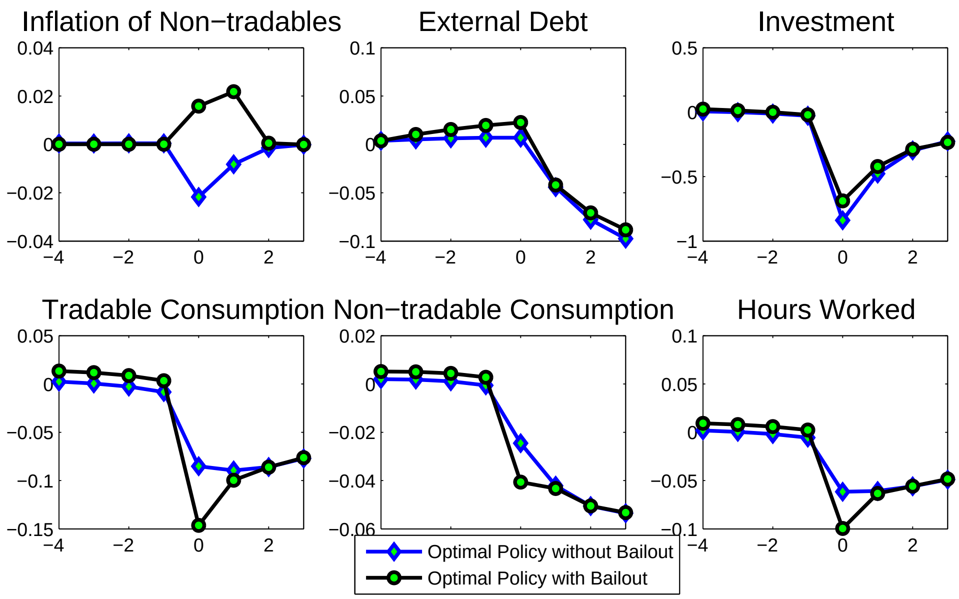
Figure 1.10: Exchange Rate Dynamics under Different Policies



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 κ_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.

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 1.11. 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 1.11: 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 κ_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.

1.5.3.3 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

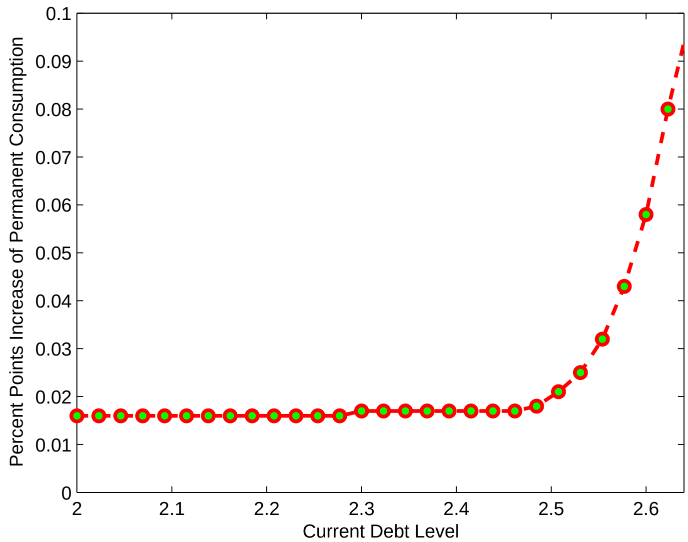
$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^* - v(h_t^*)) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t(1+g_0) - v(h_t)), \tag{1.5.6}$$

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 1.12 shows the welfare gains results by an example.[27] For exogenous state

[27] I also check every point on the grid, optimal policy with bailout gives higher welfare than that under

Figure 1.12: 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 $((y^T)^L, r^H, \kappa^L)$.

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.[28] 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.

optimal policy without bailout.

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

1.6 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.[29] 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 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)[30], and both countries suffer from the Asian Financial Crises. I thus create a dummy variable *connected* = 1 for politically connected

[29] See e.g., Faccio, Masulis and McConnell (2006), Acemoglu et al. (2016), and Johnson and Mitton (2003).

[30] 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.

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(*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 1.8 report the empirical results with which I always control for country-industry dummies, size and access to foreign currency debt.[31] 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.

[31] It is a dummy variable which takes 1 if a firm has foreign currency debt and 0 otherwise.

Table 1.8: Firm Level Foreign Currency Debt before Crises and Sales Growth in Crises

	(1) sales growth	(2) sales growth	(3) sales growth
leverage	-0.780***	-0.786***	-0.748***
	(0.237)	(0.222)	(0.246)
FC leverage	-1.786*	-1.023	-1.582*
	(0.895)	(0.660)	(0.838)
leverage*connected			-0.205
			(0.474)
FC leverage*connected			2.631**
			(1.048)
connected			-0.089
			(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(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.

1.7 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.

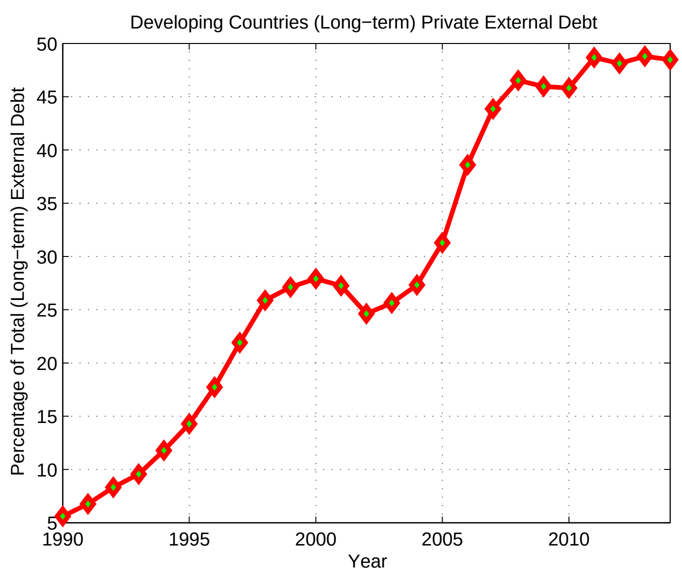
Chapter 2

Capital Flows with Twin External Crises

2.1 Introduction

The past several decades have been characterized by substantial increase in cross-border debt. In particular, the fraction of private sector debt stock now are unprecedentedly high, see Figure 2.1. The size of private gross external debt stock is almost on par with public gross external debt stock now. Nevertheless, international macroeconomics literature on cross-border debt flows has largely focused on representative private agents' borrowing or only government borrowing. It is not innocuous if analyzing only aggregate external debt masks interesting and important interactions between private debt and public debt that affect the boom-bust cycles and implications for policy interventions. This paper examines the joint dynamics of both private and public external debt to fill this void in the literature.

Figure 2.1: External Debt Stock in Private Sectors of Developing Countries



Notes: this figure displays private sector external debt stock's fraction of total external debt stock (long term) in developing countries. Data source: International Debt Statistics

The recent European financial integration and the ensuing debt crisis is among the notable examples to suggest why studying private and public external debt jointly might be of particular interest and of importance. Figure 2.2 breaks a panel of EU peripheral countries' net external debt into government external debt and private external debt.

It shows that during the recent debt crisis, by and large, government debt GDP ratio shoots up while private debt GDP ratio plummets. In other words, we observe divergent government and private debt dynamics during the crisis.[1] On the other hand, before the crises, in most countries we have witnessed massive net private capital inflows but little increase or even slightly decline in government debt/GDP.

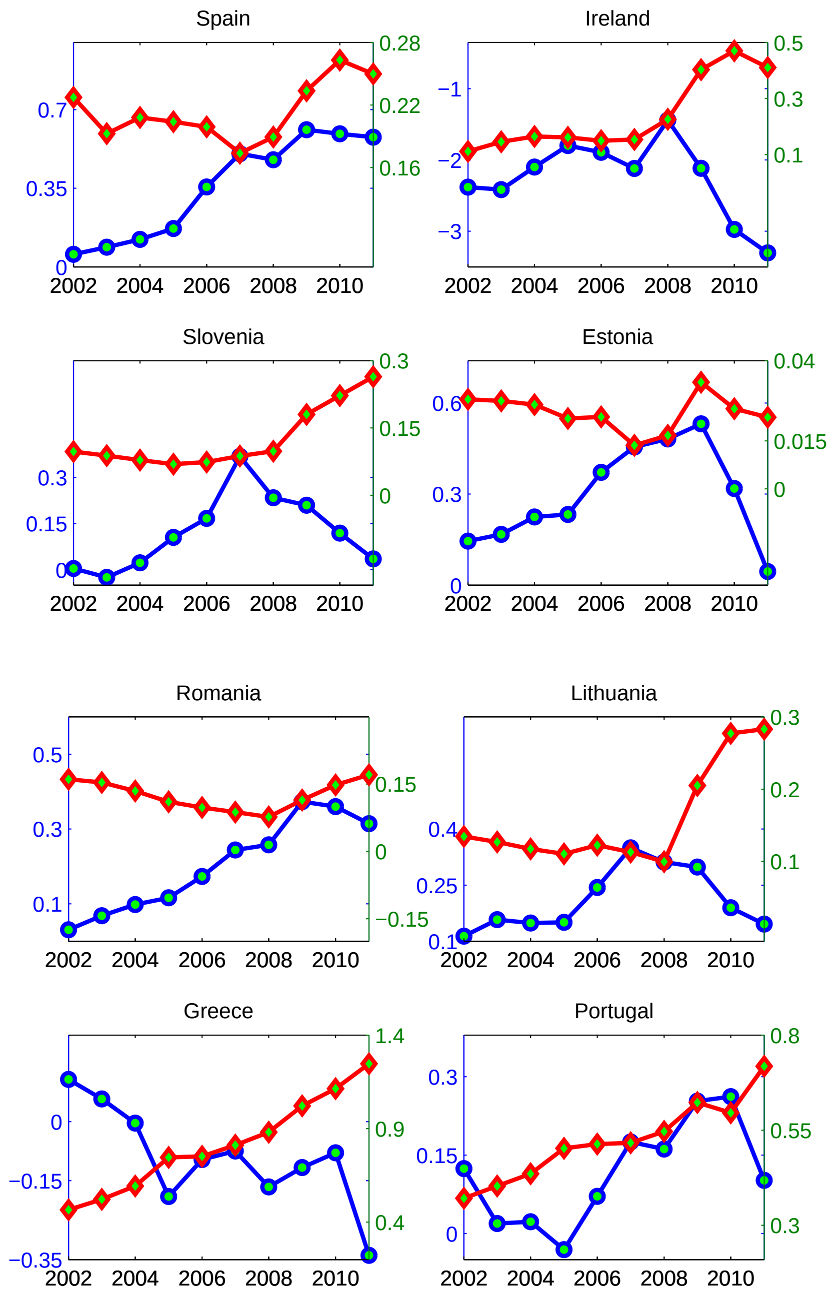
We notice that an important feature in the recent European debt crises is that government usually spends considerable resources on bailout. For instance, Ireland spends more than 40% GDP[2] on bank bailout, Slovenia casts more than 10% of its annual GDP.[3] These large scale government interventions pose additional burden on the government's balance sheet, pushing up sovereign debt. This narrative is far from unique. For example, in 1982, Chile was hit by an international debt crisis, resulting in deterioration in its borrowing terms and terms of trade. In order to mitigate the banking crisis, the Chilean government assumed external debt of several private banks. It contributed to the huge deficit on the government's balance sheet. In a recent illuminating empirical work by Reinhart and Rogoff (2011), they show that banking crisis and sovereign debt crisis usually go hand in hand. More importantly, they find that most often, banking crisis precedes sovereign debt crisis. In this paper, we explore a model to produce these European countries' private and public debt dynamics during crises, in a framework where banking external debt crisis ignites the hike of sovereign debt via optimal bailout policies.

[1] We don't have data on banking sector's net external debt position, the gross external debt of banking sectors, however, follow similar pattern, see Figure 2.3.

[2] See Laeven and Valencia (2013).

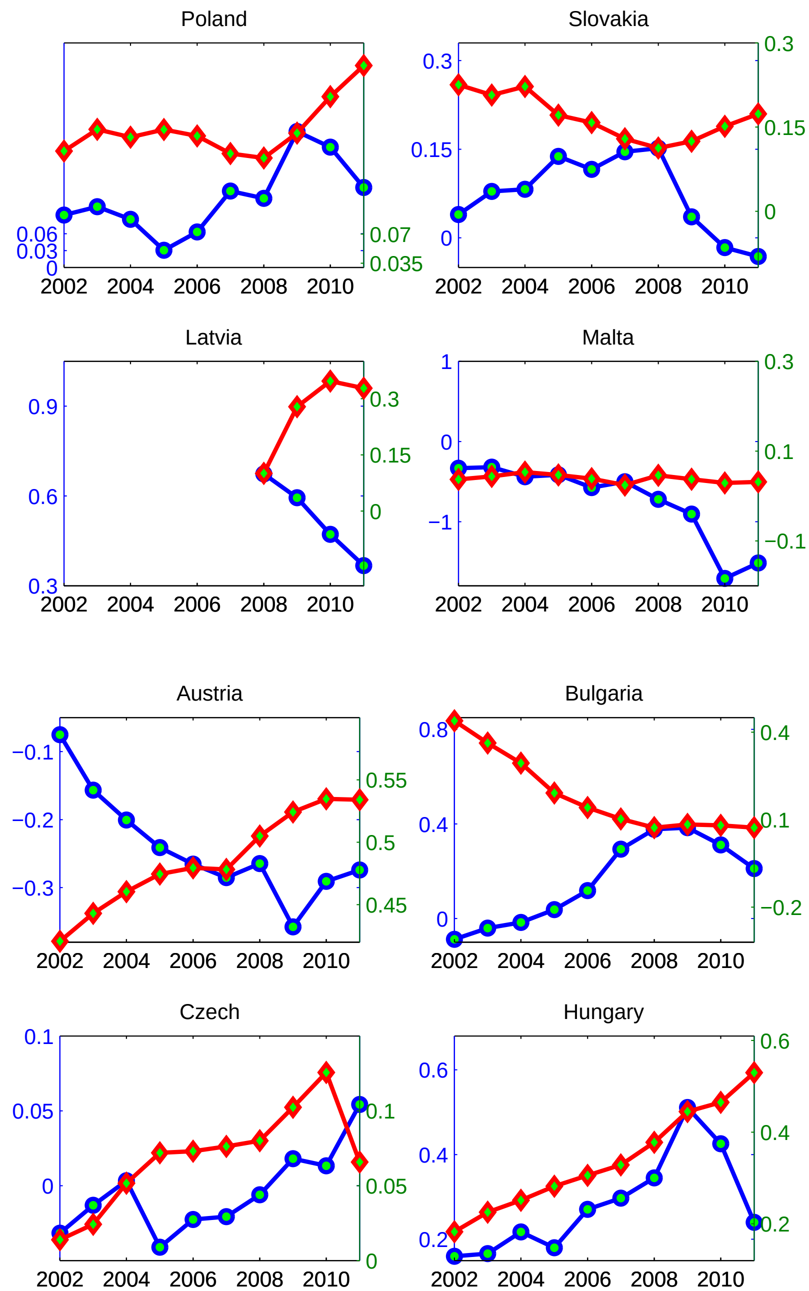
[3] See e.g., http://www.politico.eu/article/slovenia-turns-itself-around-greece-bailout-bank-crisis, where the article also explicitly mentions Slovenia funds bailout by government bond issuance and fiscal tightening, as we exactly model in this paper.

Figure 2.2: Private and Public Net External Debt/GDP



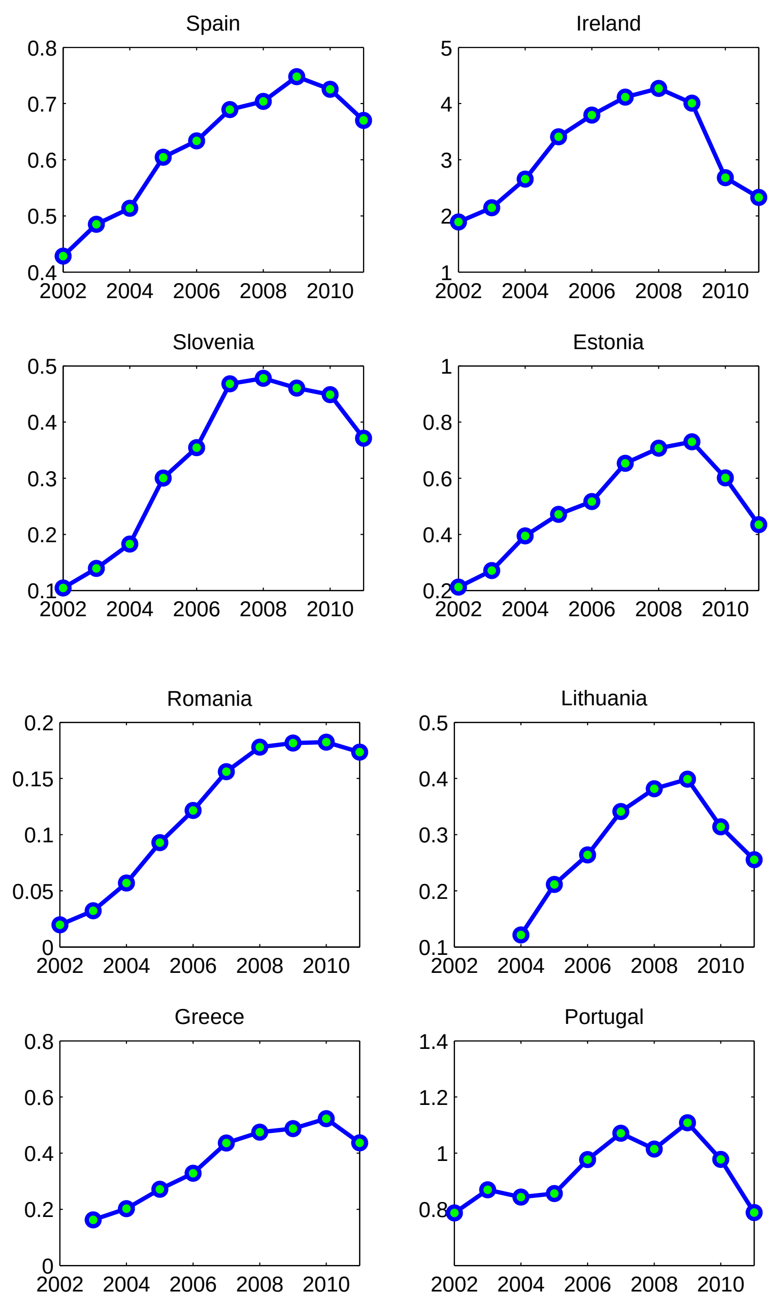
Notes: this figure displays private and public net external debt/GDP in year 2002-2011. Blue lines with circles are private sector net external debt/GDP and red lines with diamonds are government debt/GDP. Vertical axis on the left is private net external debt/GDP and vertical axis on the right is government debt/GDP. Notice Ireland is home to many international financial institutions (including hedge funds) due to tax reasons, so its total external debt/GDP (thus the constructed private external debt/GDP) should not be taken at its face value.

Figure 2.2 (continued): Private and Public Net External Debt/GDP



Notes: this figure displays private and public net external debt/GDP in year 2002-2011. Blue lines with circles are private sector net external debt/GDP and red lines with diamonds are government debt/GDP. Vertical axis on the left is private net external debt/GDP and vertical axis on the right is government debt/GDP.

Figure 2.3: Banking Sector Gross External Debt/GDP



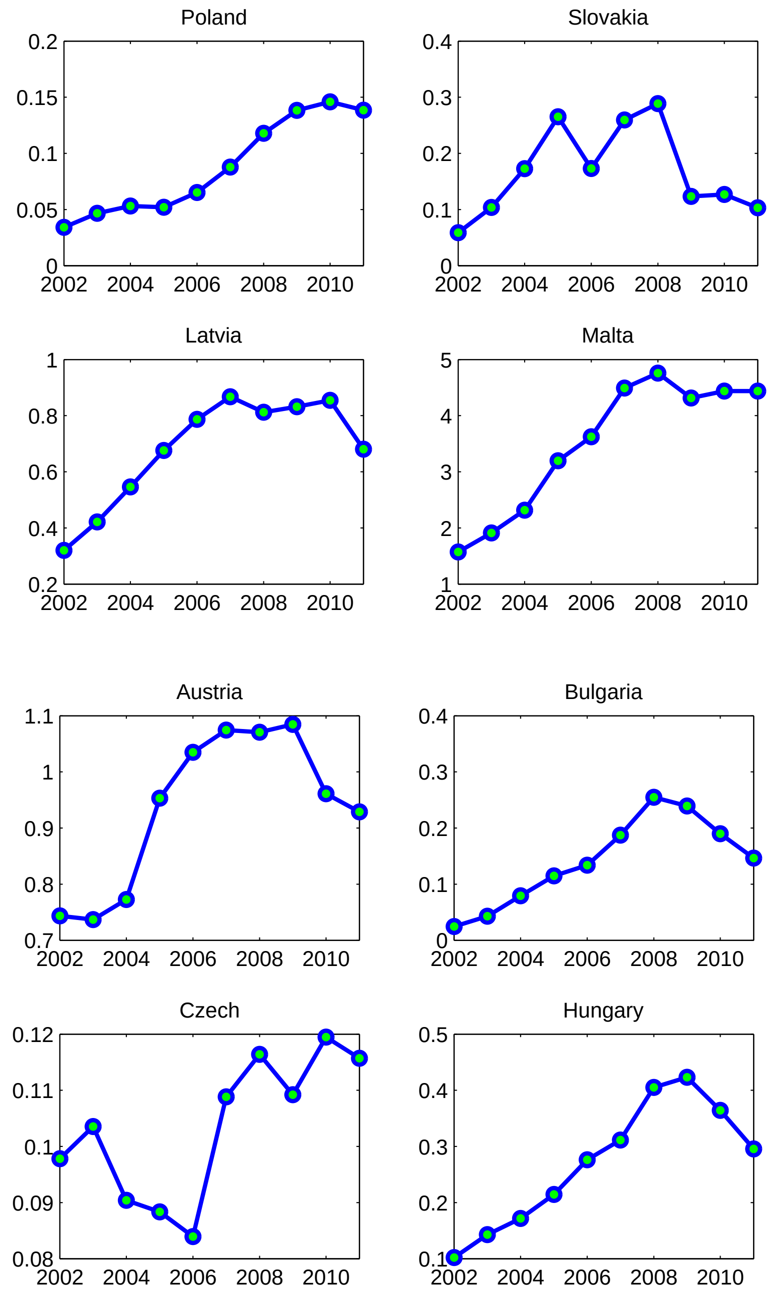
Notes: this figure displays banking sector gross external debt/GDP in year 2002-2011.

The severity of the European debt crises also naturally raises the question of whether ex-ante prudential regulations on bank external debt are desirable. Private and public debt are not isolated in our study. If these prudential policies have been implemented before the crisis, what are the implications for the severity of crisis and private and public debt dynamics during bad times?

This paper constructs a small open economy model nesting both private and public external debt flows. We first build up a banking crisis model. The model features that in bad times, banks have to fire-sale assets and capital misallocation becomes inevitable. We then explicitly incorporate government balance sheet with sovereign external debt. The above-mentioned inefficiencies call for the government to bail out banks. This is the intuitive reason government increases their debt even when borrowing also becomes more costly for the government in bad times, in contrast with private debt's dynamics. Finally, we propose two reasons why macro-prudential policies could improve upon the decentralized economy. The first one lies in fire-sale externalities between banks and the second one is collective moral hazard problem by banks.

In the banking crisis model, domestic banks issue debt to foreign investors and thus they are exposed to external interest rate shocks or borrowing constraint shocks. Banks also face equity market frictions, which prevent them from downsizing dividends freely (or raising equity freely) when facing adverse shocks. Therefore, upon bad shocks, banks have to sell part of its capital stock, creating mis-allocation of capital within the economy and it is translated into shriveling in aggregate output. Relied on the banking crisis model, we then insert a benevolent government who collects proportional output tax and funds public good to households. The inefficiencies associated with financial frictions in the private sector generate scope of the government's bailout to banks. When the optimal bailout package is large enough, the benevolent government finds it reluctant to reduce current public good provision too much so the government increases external debt to smooth public good across time. Public external debt dynamics are jointly driven by in-

Figure 2.3 (continued): Banking Sector Gross External Debt/GDP



Notes: this figure displays banking sector gross external debt/GDP in year 2002-2011.

terest rate and the amount of bailout to banks. The second force could possibly revert the drop in public debt (in the absence of bailout) to increase instead, offering an explanation to the observed diverging debt dynamics for private and public sector during crises.

Lastly, we show two reasons why macro-prudential policies are needed in good times. The first one is fire-sale externalities between banks. In a decentralized economy, banks take asset prices as given when they fire-sale assets. However, ex-ante choice of high debt leads to more sell of assets in bad times, pushing down asset prices. The dropping price tightens other banks' financial frictions in bad times. Nevertheless, these banks fail to internalize this pecuniary externalities when they borrow in good times. The second reason for prudential policies arises from moral hazard by the banking sector. Even though the bailout is designed for the problem of the whole banking sector's balance sheet, instead of an individual bank's balance sheet, banks know that in a systemic banking crisis ex-post, the government has no choice but to bailout. This makes banks more bold in borrowing ex-ante because they don't internalize the fiscal cost, i.e., reduction in public good provision to households when bailout is implemented.

Related Literature

This paper is connected to several strands of literature. It falls into the research on the relationship between sovereign debt and domestic banking sector. Sosa-Padilla (2012) and Bocola (2014) study how sovereign default affects banking sector's balance sheet and the associated output cost. Mengus (2014) and Perez (2015) further explore how this cost affects government's incentives to default. Different from their focus on sovereign default's disturbances on banks' balance sheet as banks hold domestic sovereign bond, our paper is on banks and the government's external debt dynamics. We abstract away from banks' holdings of sovereign bonds but instead focus on the link between banks and the sovereign through optimal bailout policies.

With the key role of bailout to banks during crises, our paper also relates to ex-post government intervention and bailout policy literature in macroeconomics. Gertler, Kiyotaki et al. (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 some exogenous rules instead of optimally derived. Bianchi (2012) study efficient bailout with distortionary tax instruments and government runs a balanced budget in each period. More importantly, this paper departs from this literature by studying government interventions' implications on external government debt dynamics.

Another contribution this paper adds value to is to the macro-prudential policies literature. Korinek (2010) and Bianchi (2011) emphasize fire-sale externalities related to collateral constraints. Schmitt-Grohé and Uribe (2015) pinpoint that in the presence of downward wage rigidity, firms don't internalize that during booms that they raise wages too high which are hard to adjust downward when adverse shocks arrive, leading to employment loss. This paper highlights the role of domestic financial constraints as opposed to external collateral constraint to induce fire-sale externalities. Secondly, we show that moral hazard is also a channel through which prudential policies on banks could be necessary. We are not the first to propose the second channel, e.g., Gertler, Kiyotaki and Queralto (2012) and Chari and Kehoe (2015) point out how the anticipation of ex-post government interventions or bailout can distort risk taking incentives. However, we additionally illustrate its implications on government external debt dynamics and severity of sovereign debt crises.

In a closely related paper, Acharya, Drechsler and Schnabl (2014) also study how banking problem will affect government debt via bank bailout in a three period model. As their paper is in the context of a closed economy, that paper is silent on external debt, which is the concentration of the current article. In their framework, banks are always passive in managing its debt, so how a banking crisis is triggered and how would drivers of the crises affect both private and public debt are not presented. Our paper also provides two rationales for the necessity of ex-ante prudential policies. Furthermore, in their model, the problem in the financial sector is a debt overhang problem which distorts bankers' effort supply, while our model delivers asset fire-sales and consequent misallocation thus inefficient output drop. The importance of misallocation channel during crises has been highlighted in recent empirical literature. Lastly, the cost of bailout in their model is future distortionary tax while we emphasize fiscal austerity in the form of government spending cut.

The current paper is also closely connected to the literature on cyclicality of fiscal policy and capital flows, pioneered by Kaminsky, Reinhart and Végh (2004). Their paper documents empirically that in most developing countries, government spending exhibits procyclicality, i.e. government spending increases in good times but falls in bad times. In my model, government spending on public good during banking crises also falls. The cut in public good expenditure is used to finance part of the bailout. However, aggregate government spending including bailout could increase given the large size of bailout packages in the crises. The increase in government bailout potentially brings about the hike of sovereign debt level and sovereign borrowing cost, leading to sovereign debt crises. When banking crises happen (it rains), sovereign debt crises can come along (it pours). Finally, the focus of the current paper is on periods when banking sector is in severe trouble and substantial bailout is usually needed, rather than all recession episodes, where sometimes financial or banking factors might not be the main concerns of a government.

Layout

The remainder of the paper is organized as follows. In Section 2, we present a banking crisis model in a small open economy. In Section 3, we incorporate government balance sheet to produce the divergent private and public debt dynamics in crises. In Section 4, we extend the model by making government debt from default-free debt to defaultable debt. In Section 5, we study two rationales for macro-prudential policies and its consequences. Finally, we conclude in Section 6.

2.2 Banking Crisis in Open Economy

In this section, we formulate an infinite horizon model of banking crisis in a small open economy. In the private sector, only banks have access to international debt market and a banking crisis is featured by bank capital fire-sales and inefficient aggregate output drop in the economy.

There is fixed capital stock (or land) K within the economy, which is not tradable internationally. Capital stock is allocated between productive household sector and banking sector [4]:

$$K = K_{ht} + K_{bt},$$

where K_{ht} denotes aggregate capital stock in the household sector and K_{bt} aggregate capital stock in the banking sector.

2.2.1 Households

Representative household's preferences are defined over an infinite stream of consumption:

$$E_0\left[\sum_{t=0}^{\infty}\beta^t u(C_t)\right],$$

where $\beta \in (0,1)$ is the subjective discount factor, C_t is consumption in period t and $u(\cdot)$ is increasing and strictly concave.

Households trade equity of banks, so in equilibrium they receive dividend flows div_t from banks. Each household can produce with capital good k_{ht} with technology $Z_tH(k_{ht})$, where Z_t is exogenous aggregate productivity shock that will also appear in the banking sector's production technology later. $H(\cdot)$ is increasing, concave and $\lim_{x\to 0} H'(x) = +\infty$. Besides, households engage in a competitive market where they can trade capital good

[4] The household sector in the model can be viewed as combination of households and banks who have little exposure to international debt market. What we attempt to capture here is that banks differ in their exposure to international debt market and those banks who borrow from abroad excessively will be more affected by external shocks.

with banks. Therefore, the budget constraint of a representative household is

$$C_t + x_{t+1}(e_t - div_t) = x_t e_t + Z_t H(k_{ht}) + q_t(k_{ht} - k_{h,t+1}),$$

where q_t is the price of capital good, e_t is the equity price of a bank, and x_t is the share of equity of banks.[5]

Denoting Λ_t as the Lagrangian multiplier of the budget constraint, we obtain the following first order conditions, with respect to C_t, $k_{h,t+1}$ and x_{t+1}:

$$u'(C_t) = \Lambda_t, \tag{2.2.1}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}H'(k_{h,t+1}) + q_{t+1})], \tag{2.2.2}$$

$$e_t = div_t + \beta E_t\left[\frac{\Lambda_{t+1}}{\Lambda_t}e_{t+1}\right]. \tag{2.2.3}$$

The second equation illustrates that capital good price is the summation of future discounted value of marginal product of capital. Iterate forward the last equation and rule out bubbles in the equity price to arrive at

$$e_t = E_t\left[\sum_{j=0}^{\infty}\beta^j \frac{\Lambda_{t+j}}{\Lambda_t} div_{t+j}\right].$$

Finally, the market clearing condition of the bank equity market is

$$x_t = 1,$$

so that

$$C_t = div_t + Z_t H(k_{ht}) + q_t(k_{ht} - k_{h,t+1}). \tag{2.2.4}$$

[5]By writing the budget constraint without household external borrowing, we have implicitly assumed that households don't have access to international debt market and we provide discussions on this assumption in the appendix.

2.2.2 Banks

A representative bank's objective is to maximize its equity price:

$$e_0 = E_0\left[\sum_{t=0}^{\infty}\beta^t \frac{\Lambda_t}{\Lambda_0} div_t\right]. \tag{2.2.5}$$

Banks have access to foreign external borrowing and possess production technology $Z_t F(k_{bt})$. Here Z_t, as mentioned above, is aggregate productivity shock and k_{bt} is capital stock owned by banks. $F(\cdot)$ is increasing, concave and $\lim_{x\to 0} F'(x) = +\infty$.[6] Banks can trade capital good with households in a competitive market. Therefore, the budget constraint of a bank is:

$$div_t = Z_t F(k_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt} - k_{b,t+1}), \tag{2.2.6}$$

where R_t is gross interest rate shock and b_{t+1} is bank's new borrowing that matures next period.

We then introduce the key financial friction in this model. We assume that when paying dividends, banks must pay at least a certain fraction of its revenue,

$$div_t \geq \underline{\mathrm{d}} Z_t F(k_{bt}), \tag{2.2.7}$$

or equivalently,

$$(1-\underline{\mathrm{d}})Z_t F(k_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt} - k_{b,t+1}) \geq 0, \tag{2.2.8}$$

where $\underline{\mathrm{d}}$ measures the extent of financial friction. The financial friction is an equity market friction, possibly originating from some agency or informational frictions between equity holders and managers. Empirically, Brav et al. (2005) find managers' particularly strong desire to avoid dividend cuts. A special setting $\underline{\mathrm{d}} = 0$ means banks cannot raise new funds from equity owners, which is a restriction widespread imposed in the existing

[6] Banks are endowed directly with a production technology, so we abstract away frictions between banks and firms as in Gertler and Kiyotaki (2015).

literature, e.g., Brunnermeier and Sannikov (2014). When $\underline{\mathrm{d}} < 0$, the friction restricts the amount of fund banks can raise from equity market to certain extent.

Banks pick up b_{t+1}, $k_{b,t+1}$ and div_t to maximize equity value as formalized in equation (2.2.5) , subject to budget constraint (2.2.6) and dividend constraint (2.2.8). Substituting equation (2.2.6) into equation (2.2.5) to replace div_t and denoting μ_t as the Lagrangian multiplier on the dividend constraint, we have the following first order conditions, with respect to b_{t+1} and $k_{b,t+1}$:

$$(1+\mu_t)\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right), \tag{2.2.9}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}F'(k_{b,t+1})+q_{t+1})(1+\mu_{t+1}) - \underline{\mathrm{d}}\mu_{t+1}Z_{t+1}F'(k_{b,t+1}))]\right). \tag{2.2.10}$$

Equation (2.2.9) is a revised Euler equation, taking into account the dividend constraints. The left hand side is the marginal value of one more unit of external borrowing, which could relax the dividend constraint, while the right hand side is the marginal cost of one more unit of external borrowing, which makes next period's dividend constraint possibly tighter. The Lagrangian multipliers show up in equation (2.2.10) as well. They also capture that by selling one unit of capital good, banks relax their current dividend constraint but also risk changing next period's tightness of dividend constraint.

Finally, the standard complementary slackness conditions are simply written as:

$$\mu_t\left((1-\underline{\mathrm{d}})Z_tF(k_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt}-k_{b,t+1})\right) = 0, \mu_t \geq 0, \tag{2.2.11}$$

$$(1-\underline{\mathrm{d}})Z_tF(k_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt}-k_{b,t+1}) \geq 0. \tag{2.2.12}$$

2.2.3 Equilibrium Conditions

Now we start to nail down the system of equilibrium conditions. Since we have representative households and banks, so in aggregation $K_{bt} = k_{bt}$ and $K_{ht} = k_{ht}$. Thereafter, we will only use capital letter K in equilibrium conditions. Furthermore, substitute equation (2.2.6) into equation (2.2.4) to get

$$C_t = Z_t H(K_{ht}) + Z_t F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t}, \tag{2.2.13}$$

which can be directly obtained as a market clearing condition as well. It is also clear that as aggregate capital stock is fixed in the economy, we will replace K_{ht} by $K - K_{bt}$ whenever possible.

Rewrite the above equation (2.2.13) and keep equations (2.2.1), (2.2.2), (2.2.9), (2.2.10), (2.2.11) and (2.2.12). A competitive equilibrium is defined as a set of sequences $\{C_t, \Lambda_t, b_{t+1}, K_{b,t+1}$ $, q_t, \mu_t \geq 0\}$ satisfying

$$C_t = Z_t F(K_{bt}) + Z_t H(K - K_{bt}) - b_t + \frac{b_{t+1}}{R_t}, \tag{2.2.14}$$

$$\Lambda_t = u'(C_t), \tag{2.2.15}$$

$$q_t = \beta E_t [\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1} H'(K - K_{b,t+1}) + q_{t+1})], \tag{2.2.16}$$

$$(1 + \mu_t)\frac{1}{R_t} = \beta E_t \left(\frac{\Lambda_{t+1}}{\Lambda_t}(1 + \mu_{t+1}) \right), \tag{2.2.17}$$

$$q_t(1 + \mu_t) = \beta E_t \left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1} F'(K_{b,t+1}) + q_{t+1})(1 + \mu_{t+1}) - \underline{\text{d}}\mu_{t+1} Z_{t+1} F'(K_{b,t+1})] \right), \tag{2.2.18}$$

$$\mu_t \left((1 - \underline{\text{d}}) Z_t F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) \right) = 0, \tag{2.2.19}$$

$$(1 - \underline{\text{d}}) Z_t F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) \geq 0, \tag{2.2.20}$$

given initial K_{b0}, b_0 and exogenous $\{Z_t, R_t\}$.

2.2.4 First Best Economy

Before gauging into deeper analysis of the competitive equilibrium, we first characterize the first-best allocation as a benchmark. The objective of a social planner is:

$$\max_{b_{t+1}, K_{b,t+1}} E_0 \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right],$$

subject to the resource constraint:

$$C_t = Z_t F(K_{bt}) + Z_t H(K - K_{bt}) - b_t + \frac{b_{t+1}}{R_t}.$$

Denoting Λ_t as the Lagrangian multiplier, we obtain the following first order conditions with respect to C_t, b_{t+1} and $K_{b,t+1}$:

$$\Lambda_t = u'(C_t),$$

$$\frac{1}{R_t} = \beta E_t \left(\frac{\Lambda_{t+1}}{\Lambda_t} \right),$$

$$F'(K_{b,t+1}) = H'(K - K_{b,t+1}).$$

In this economy, capital good allocation will always be efficient: the marginal products of capital in household sector and banking sector always coincide.

Proposition 6. *When* $\underline{d} = -\infty$*, the decentralized competitive economy is equivalent to first-best economy.*

Proof. If $\underline{d} = -\infty$, then dividend constraint never binds, thus we can set $\mu_t = 0$, $\forall t$, in the decentralized economy. It is easy to verify that it fully replicates the first-best allocation by comparing equilibrium conditions. □

This result is not surprising as the equity market friction is the key financial friction we add to a frictionless economy. Once we get rid of it, the economy returns to first-best efficiency.

2.2.5 Steady State

We further characterize the steady state of the competitive equilibrium, where $\{C_t, \Lambda_t, b_{t+1}, K_{b,t+1}, q_t, \mu_t \geq 0\}$ are constants. Assume that $R_t = \frac{1}{\beta}$ always holds and $Z_t = 1$. We let the economy stay at a steady state where the dividend constraint is not binding so that μ_t is nil. The steady state of the competitive equilibrium is described by:

$$C = F(K_b) + H(K - K_b) - b + \frac{b}{R},$$

$$\Lambda = u'(C),$$

$$q = \beta \frac{H'(K - K_b)}{1 - \beta},$$

$$q = \beta \frac{F'(K_b)}{1 - \beta},$$

$$(1 - \underline{\mathrm{d}})F(K_b) - b + \frac{b}{R} \geq 0.$$

Therefore, $H'(K - K_b^*) = F'(K_b^*)$ so that capital stock allocation is always efficient and $q^* = \frac{F'(K_b^*)}{1-\beta}$. As consumption is constant, next periods' bank debt also duplicates previous periods'. We will pick up the initial bank debt b_0 so that the dividend constraint doesn't bind. Absent from any shock, the competitive equilibrium shall stay in the steady state forever.

2.2.6 One Time Interest Rate Shock

To inspect the model's mechanism, we first do the following experimentation. Suppose interest rate R_t is always at its steady state $R_t = R = \frac{1}{\beta}, \forall t < 0$. At $t = 0$, the economy unexpectedly gets hit by an interest rate spike $\hat{R} > \frac{1}{\beta}$. But the interest rate R_t will immediately revert back to its steady state value $R_t = \frac{1}{\beta}, \forall t \geq 1$.

We have in mind that the shock is not too small so that the financial constraint at least binds at $t = 0$. Meanwhile, the shock is not so large such that the financial constraint will not bind more than once. We guess and verify numerically that this is true for some values of $\hat{R} > \frac{1}{\beta}$. The procedures to compute the dynamic responses to the shock is provided in the Appendix.

2.2.6.1 Parameterization

We are now ready to move to the numerical work. We specify the following functional forms:

$$u(C) = \frac{C^{1-\sigma} - 1}{1 - \sigma}$$

$$F(x) = A_b x^{\alpha}$$

$$H(x) = A_h x^{\alpha}$$

where $0 < \alpha < 1$.

We take one period as, say, 5 years to mimic an on average 5 years' crisis, which implies a relatively small $\beta = 0.75 = 0.944^5$. Capital share is set to 0.33. We set bank productivity twice as large as the household sector. For simplicity, we employ log utility. The minimum fraction of revenue that has to be paid to equity owners is assumed to be 0.5. Set initial debt $b_0 = 1.04$ so that debt GDP ratio is roughly 55%. The interest rate shock is an increase of 0.8/5 = 16% in annualized rate in crises. The parameter names and values are summarized in Table 2.1.

2.2.6.2 Dynamic Responses

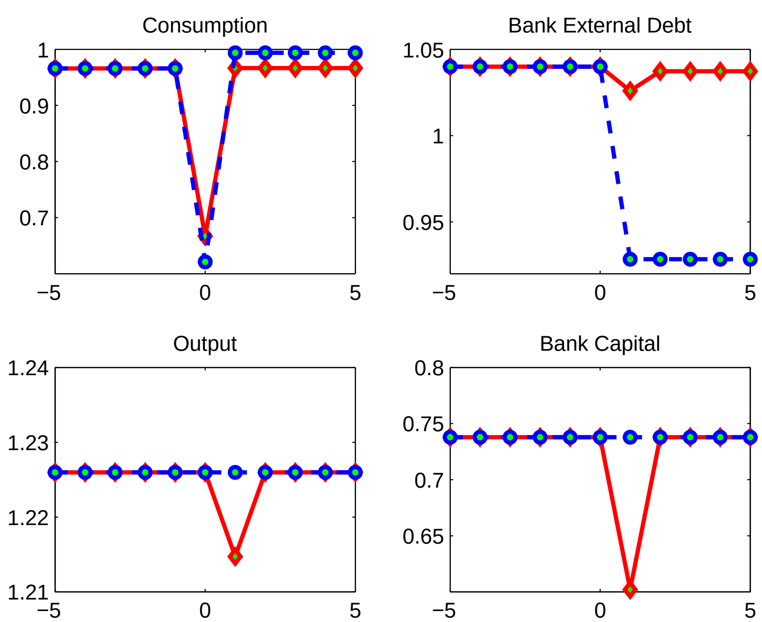
In order to solve the dynamic responses of key variables, we proceed as follows. We first guess that the dividend constraint binds only at $t = 0$ and numerically solve the model. Then we check that dividend constraint is indeed slack $\forall t \geq 1$ and Lagrangian multiplier $\mu_0 > 0$. The dynamic responses are shown in Figure 2.4.

Solid lines represent the dynamic responses with dividend constraint $\underline{\text{d}} = 0.5$. Upon

Table 2.1: Parameters

Parameter	Value	Note
β	0.75	Patience
A_b	1	Bank Productivity
A_h	0.5	Household Productivity
α	0.33	Capital Share
K	1	Normalized Aggregate Capital Stock
σ	1	Risk Aversion
$\underline{\text{d}}$	0.50	Minimum Dividend Requirement
b_0	1.04	Initial Steady State Debt
R	$\frac{1}{\beta}$	Steady State Interest Rate
$\hat{R}$	$\frac{1}{\beta}+0.8$	Interest Rate Shock

Figure 2.4: Role of Domestic Financial Frictions



Notes: this figure shows the dynamic responses under a one-time shock in period 0. Solid blue lines with circles are with domestic equity frictions; dashed red lines with diamonds are without domestic equity frictions.

the interest rate shock, as banks' borrowing cost is too high, they retreat debt position . [7] Due to the dividend constraint, despite that they would like to cut dividends, they find that they cannot do that so they have to sell part of its capital stock to the household sector. The appearance of the Lagrangian multiplier $\mu_0 > 0$ creates mis-allocation thus output drop in the economy in period 1, which means that the marginal products of capital are not equalized in the two sectors. In fact, from equilibrium conditions, we can derive

$$1 + \mu_0 = \frac{F'(K_{b1}) + q^*}{H'(K - K_{b1}) + q^*}, \tag{2.2.21}$$

so it is clear that the larger μ_0 is, the more severe the misallocation is. Consumption drops in period 0 because the interest rate is high so they choose to save instead of consume that much.

In comparison, in the case without dividend constraint, illustrated in dashed lines, there is no misallocation of capital and aggregate output is always at its maximum level. Banks also cut debt more, because with dividend constraint, even if borrowing cost soars, they don't decrease debt that much in order to pay the minimum dividend. As with consumption dynamics, the minimum dividend requirement not only distorts capital allocation, but also forces households to receive more dividends to be consumed given that we don't allow households to save.

In sum, an external interest rate shock brings about a banking crisis to the small open economy. Banks who are exposed to external borrowing have to reduce debt and sell its capital upon the shock. The consequent misallocation and intertemporal distortion of consumption highlight the inefficiencies caused by the financial frictions.

[7] It is well known that there are both wealth effect and substitution effect so the direction of debt depends on which force is stronger. In our simulation, substitution effect dominates wealth effect.

2.2.7 Simple Policy Analysis

We have seen that dividend constraints distort the economy to deviate from the first-best. We next deliver some simple policy analysis to have an idea of how policies can kick in and its interplay with the financial frictions.

2.2.7.1 Household-Bank Transfer

We first allow lump-sum transfer T_t directly from households to banks by the government.

Proposition 7. *With lump-sum transfer from households to banks, the economy can achieve first-best equilibrium.*

Proof. See Appendix. □

Proposition 7 is intuitive in the sense that the financial friction in the model is that banks have to pay shareholders, i.e., households, a minimum amount, then the transfer from households to banks effectively lowers the dividend requirement, until making it irrelevant. If the government has access to implementing the direct transfer from households to banks, there is no role of government external debt at all as the economy can already restore first-best.

2.2.7.2 Government-Bank Transfer

We then analyze another case that the government cannot do the lump-sum transfer from households at all. The transfer is only intertemporal between banks and government. Denote B_{gt} as government external debt and T_t as lump-sum transfer to banks. The budget constraint of the government is:

$$\frac{B_{g,t+1}}{R_t} = B_{gt} + T_t \tag{2.2.22}$$

Proposition 8. *With lump-sum transfer between banks and the government, the economy is equivalent to the competitive equilibrium.*

Proof. See Appendix. □

This result is a repeat of the famous *Ricardian Equivalence*. Banks understand that any transfer to them today will have to be paid by themselves in the future. Therefore, there is no improvement beyond the decentralized equilibrium.

So far we have considered two extreme cases. One is that we can do the direct transfer from households to banks, then the government external debt doesn't need to appear and we obtain first-best allocation. The other is that the government cannot touch the household and has to use external debt to do finance a transfer, then we cannot outperform the decentralized equilibrium. In the following Section, we shall introduce explicit government budget constraint to make sense the tradeoff of bank bailout policy.

2.3 Banking Crisis, Bailout and Government Debt

In this section, we introduce the above banking crisis into a model with explicit government balance sheet, where the government employs a fixed tax rate to output to pay for public good provision. To shed light on the role of financial frictions on the incentives to bailout, we deliberately set up the model so that without financial frictions (i.e., first-best), the balance sheets of private and public sectors are "parallel" thus no bailout is needed. But upon bad shocks, with financial frictions (i.e. decentralized equilibrium), the benevolent government find itself incentivized to do bailout transfer to banks. The optimal bailout scheme has implications for external debt dynamics in both private and public sectors.

We first let each agent in the economy take bailout policy ω_t as given to list the equilibrium conditions. Then the government selects the optimal bailout in period 0 to maximize a representative household's total welfare.

2.3.1 Households

We revise representative households' preferences to incorporate public good provision G_t, supplied by the benevolent government:

$$E_0\left[\sum_{t=0}^{+\infty}\beta^t[u(C_t)+v(G_t)]\right],$$

where $v(\cdot)$ is increasing and concave. Households take public good G_t as given. The government finances public good by taxing output. So households' budget constraint is changed to take into account a fixed tax rate τ to output:

$$C_t + x_{t+1}(e_t - div_t) = x_t e_t + Z_t(1-\tau)H(k_{ht}) + q_t(k_{ht} - k_{h,t+1}).$$

2.3.2 Banks

Representative banks objective is always to maximize their equity price:

$$e_0 = E_0\left[\sum_{t=0}^{+\infty}\beta^t\frac{\Lambda_t}{\Lambda_0}div_t\right], \tag{2.3.1}$$

subject to budget constraint

$$div_t = Z_t(1-\tau)F(k_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt} - k_{b,t+1}) + \omega_t, \tag{2.3.2}$$

and dividend constraint

$$(1-\underline{\mathrm{d}})(1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) + \omega_t \geq 0,$$

where $\omega_t \geq 0$ is bailout transfer to banks by the government and in the constraints, tax rate τ also appears. When we shut down the bailout transfer, $\omega_t = 0, \forall t$.

2.3.3 Government

Given bailout transfer, the benevolent government's problem is

$$\max_{B_{g,t+1},G_t} E_0\left[\sum_{t=0}^{+\infty}\beta^t[u(C_t)+v(G_t)]\right], \tag{2.3.3}$$

subject to budget constraint

$$G_t + B_{gt} = \frac{B_{g,t+1}}{R_t} + \tau\left(H(K-K_{bt})+F(K_{bt})\right) - \omega_t, \tag{2.3.4}$$

where private consumption C_t is not directly selected by the government but by the households.

Denoting Λ_{gt} as the Lagrangian multiplier of the budget constraint, we have the following first order conditions with respect to G_t and $B_{g,t+1}$:

$$\Lambda_{gt} = v'(G_t), \tag{2.3.5}$$

$$\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{g,t+1}}{\Lambda_{gt}}\right). \tag{2.3.6}$$

2.3.4 Equilibrium Conditions

A competitive equilibrium with public good is defined as a set of sequences $\{C_t, \Lambda_t, G_t, \Lambda_{gt}, b_{t+1}, B_{g,t+1}, K_{b,t+1}, q_t, \mu_t \geq 0\}$ satisfying

$$C_t = Z_t(1-\tau)F(K_{bt}) + Z_t(1-\tau)H(K-K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + \omega_t, \tag{2.3.7}$$

$$\Lambda_t = u'(C_t), \tag{2.3.8}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}(1-\tau)H'(K-K_{b,t+1}) + q_{t+1})], \tag{2.3.9}$$

$$(1+\mu_t)\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right), \tag{2.3.10}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}(1-\tau)F'(K_{b,t+1})+q_{t+1})(1+\mu_{t+1}) - \underline{\text{d}}\mu_{t+1}Z_{t+1}(1-\tau)F'(K_{b,t+1})]\right), \tag{2.3.11}$$

$$\mu_t\left((1-\underline{\text{d}})Z_t(1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt}-K_{b,t+1}) + \omega_t\right) = 0, \tag{2.3.12}$$

$$(1-\underline{\text{d}})Z_t(1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt}-K_{b,t+1}) + \omega_t \geq 0, \tag{2.3.13}$$

$$G_t = \tau F(K_{bt}) + \tau H(K-K_{bt}) - b_{gt} + \frac{b_{g,t+1}}{R_t} - \omega_t, \tag{2.3.14}$$

$$\Lambda_{gt} = v'(G_t), \tag{2.3.15}$$

$$\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{g,t+1}}{\Lambda_{gt}}\right). \tag{2.3.16}$$

2.3.5 Steady State

We assume that in steady state there is no bailout and confirm it is indeed optimal given the relationship between initial government debt and bank debt. The private sector steady state is very similar to the case in Section 2.5 thus omitted. The public sector steady state is:

$$G = \tau F(K_b^*) + \tau H(K-K_b^*) - B_g + \frac{B_g}{R}, \tag{2.3.17}$$

$$\Lambda_g = v'(G). \tag{2.3.18}$$

2.3.6 Initial State

We further assume that the economy starts with $B_{g0} = \frac{\tau}{1-\tau}b_0$ and $u(X) = \frac{X^{1-\sigma}-1}{1-\sigma}$ and $v(X) = \left(\frac{\tau}{1-\tau}\right)^{\sigma} u(X)$. Then in the steady state, there is no incentive to do any bailout transfer because in any time t, $u'(C) = v'(G)$. Note it is also true that if we exclude the financial frictions (no banking crisis), even we have stochastic $\{Z_t, R_t\}$, there is no incentive for the government to do any bailout transfer either, because $u'(C_t) = v'(G_t)$ is always true, $\forall t$. Now what we are interested in is that if there is an interest rate shock at time 0 in the frictional decentralized equilibrium and we allow the government to do a bailout transfer $\omega_0 \geq 0$ in period 0, will the government optimally step in to recapitalize banks and what are the consequences for debt dynamics.

2.3.7 One Time Interest Rate Shock

Let the economy experience an interest rate shock $\hat{R}$ in period 0. We first solve the equilibrium given a one-time bailout transfer to banks $\omega_0 \geq 0$. We keep assuming that the shock will let banks' dividend constraint bind only in period 0 and then we verify numerically. The detailed equilibrium conditions in private and public sector with given bailout $\omega_0 \geq 0$ is in the Appendix.

2.3.7.1 Bailout Transfer ω_0

After obtaining the equilibrium with a given ω_0, we next proceed to pick up the optimal ω_0. The problem of the benevolent government is

$$\max_{\omega_0} \frac{C_0^{1-\sigma}-1}{1-\sigma} + \frac{\beta}{1-\beta}\frac{C_1^{1-\sigma}-1}{1-\sigma} + \left(\frac{\tau}{1-\tau}\right)^{\sigma}\left[\frac{G_0^{1-\sigma}-1}{1-\sigma} + \frac{\beta}{1-\beta}\frac{G_1^{1-\sigma}-1}{1-\sigma}\right].$$

Note that we have used the fact that $C_t = C_{t-1}$ and $G_t = G_{t-1}$, $\forall t \geq 2$. We will select the optimal bailout ω_0 numerically.

2.3.7.2 Parameterization

Since we have introduced tax rate to output, we will adjust total factor productivity $A_b = 1$ and $A_h = 0.5$ to $A_b = \frac{1}{1-\tau}$ and $A_h = \frac{0.5}{1-\tau}$ so that without bailout transfer, the private sector's debt b_t and capital stock K_{bt} remain the same dynamics as in Section 2.6.2. We will keep everything else the same in Table 2.1. New parameter values are summarized in Table

2.2.

Table 2.2: Parameters (continued)

Parameter	Value	Note
β	0.75	Patience
τ	0.35	Tax Rate to Output
A_b	$\frac{1}{1-\tau}$	Bank Productivity
A_h	$\frac{0.5}{1-\tau}$	Household Productivity
α	0.33	Capital Share
K	1	Normalized Aggregate Capital Stock
σ	1	Risk Aversion
$\underline{\text{d}}$	0.50	Minimum Dividend Requirement
b_0	1.04	Initial Steady State Bank Debt
B_{g0}	$\frac{\tau}{1-\tau}b_0$	Initial Steady State Government Debt
R	$\frac{1}{\beta}$	Steady State Interest Rate
$\hat{R}$	$\frac{1}{\beta}+0.8$	Interest Rate Shock

2.3.7.3 Dynamic Responses

We first consider the case where bailout option is not available for the government, i.e. $\omega_0 = 0$. In Figure 2.5 dashed lines, we can confirm that bank capital and bank debt are exactly the same as in Figure 2.4. In addition, increasing borrowing cost culminates in government debt drop.

In order to highlight the role of financial frictions, we also consider the optimal bailout transfer without dividend constraints in the private sector. In Figure 2.6, we can see that the optimal bailout transfer is indeed 0. This result is by design. We set a specific relationship between utility functions of private and public good, and also between the initial debts of them carefully, to make sure that without financial frictions, marginal utilities of public and private good are always equalized.

After we consider optimal bailout transfer, exhibited in Figure 2.5 solid lines, we can see that optimal bailout transfer is positive and as a consequence, government debt goes up instead of drops. Due to the bailout transfer, bank' external debt also reduces more. Bank capital drops less and mis-allocation is alleviated. Figure 2.7 does show that welfare function is hump shaped in bailout transfer in the region $\omega_0 \geq 0$. The intuition is that at $\omega_0 = 0$, the presence of binding financial friction in the private sector makes one more unit transfer to banks more valuable than spending it in public good from the benevolent government's standpoint. But as the transfer increases, the marginal value of transfer will decrease and also marginal cost will increase because after all the transfer has to be born by the reduction of public good today and in the future. When the optimal bailout transfer package is large enough, government debt has to increase instead of decrease.

Proposition 9. *In the above decentralized economy, the marginal value of positive bailout transfer at point $\omega_0 = 0$ is strictly positive as long as the Lagrangian multiplier μ_0 is a decreasing function of the amount of bailout at point $\omega_0 = 0$.*

Proof. See Appendix. □

Intuitively, less tightening dividend constraint will first raise aggregate output in period 1 and also mute the intertemporal distortions of consumption. These two forces are the values of bank bailout and are in fact presented in the details of the proof.

Proposition 10. *A sufficiently small transfer $\omega_0 = \epsilon > 0$ strictly decreases μ_0.*

Proof. We prove by contradiction. Suppose the reverse is true, $\mu_0(\epsilon) \geq \mu_0(0)$.

Combining equations (B.4.1) and (B.4.2), and combining (B.4.2) and (B.4.4) show that when μ_0 goes up, $K_{b1} < K_b^*$ goes down and then q_0 goes up. Therefore, equations (B.4.3) and (B.4.5) gives that C_0 drops. According to the lifetime budget constraint for the private sector, a transfer to them must either increase C_0 or C_1 or both. Given that C_0 declines, it must be that C_1 increases.

However, if the right hand side of equation (B.4.4) must drop, then μ_0 has to drop as well. It constitutes a contradiction. Therefore, $\mu_0(\epsilon) < \mu_0(0)$ □

It makes sense that effectively with less debt on burden, the dividend constraint will be less binding, as confirmed in the numerical exercises. On the other hand, the transfer should have an upper bound as when we reduce public sector's available resources further, the public welfare diminishes more sharply in the end due to the limiting property of the utility function of public good provision.

2.3.8 Differential Shocks to Private and Public Sector

2.3.8.1 Debt Inelastic Interest Rate

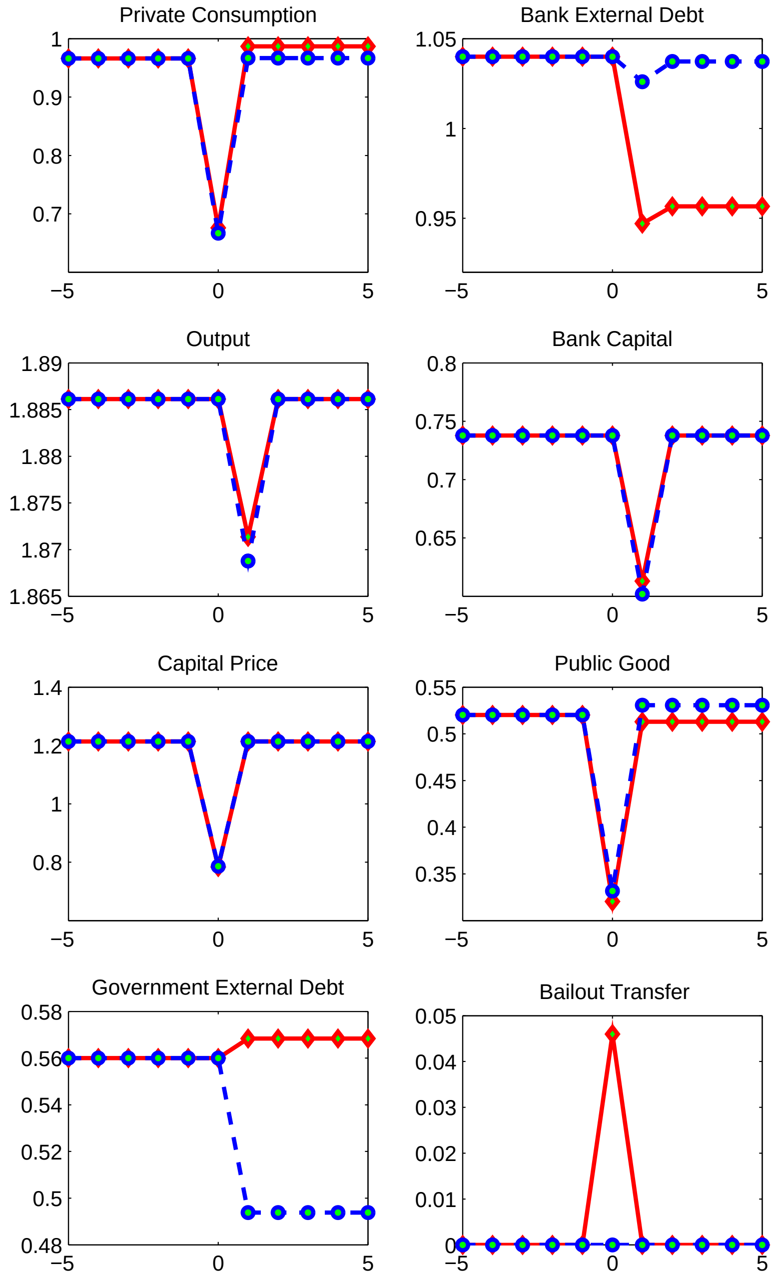
To highlight the role of financial frictions for banks in impelling the government's bailout, we have assumed that banks and the government face the same interest rate. Nevertheless, in reality, the government usually borrows in cheaper terms than the private sector. The interest rate gap between public and private debt is particularly high in bad times. footnoteSee e.g., Acharya, Drechsler and Schnabl (2014) evidence on Ireland bank and sovereign spread. If we set the interest rate shock to the government in period 0 only equal to, say, $R + 0.5$, which is smaller than the shock $R + 0.8$ which banks have to pay. Figure 2.8 shows the results. Not surprisingly, less borrowing cost for the government transfers into more incentives to bailout thus higher increase in government debt and lower bank external debt. Correspondingly, bank capital cut is lower and inefficient output loss becomes smaller.

2.3.8.2 (Internal) Debt Elastic Interest Rate

We have considered interest rate shock to the government debt, where borrowing cost is insensitive to the quantity she borrows. In sovereign default literature, when representative agent increases debt, debt price drops dramatically especially during crisis time. In order to capture this elastic price response, in stead of setting interest rate in period 0 as $R + 0.5$, I add an debt elastic term $p(b_1 - b_0)$, where $p(\cdot)$ is an increasingly convex function and $p(0) = 0$. We parameterize following Schmitt-Grohé and Uribe (2003)

$$p(x) = \psi_1(e^x - 1), \tag{2.3.19}$$

Figure 2.5: Dynamics under Optimal Bailout and No Bailout



Notes: this figure shows the dynamic responses under a one-time shock in period 0. Solid blue lines with circles are with optimal bailout; dashed red lines with diamonds are without bailout.

Figure 2.6: Optimality of No Bailout without Domestic Financial Frictions

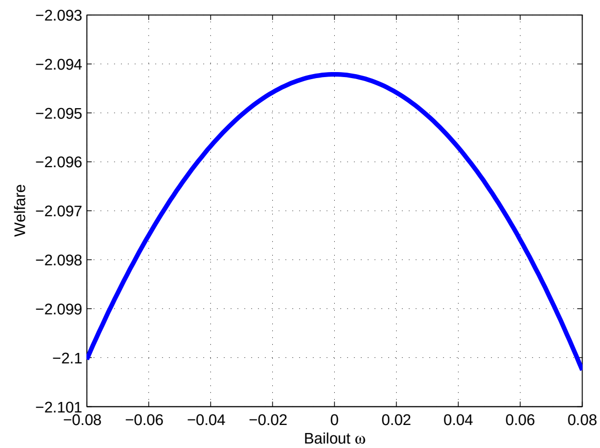
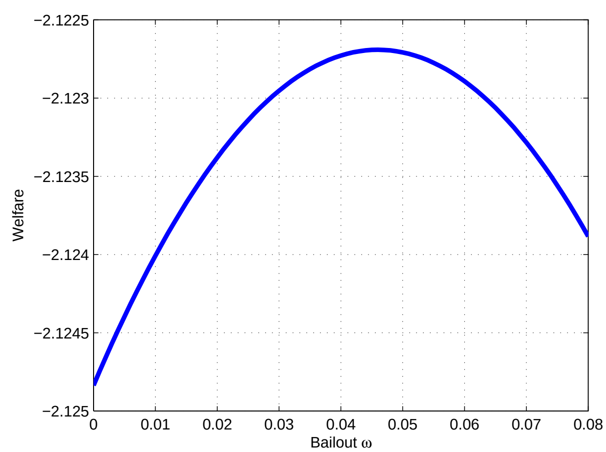


Figure 2.7: Optimality of Bailout with Domestic Financial Frictions



The larger ψ_1 is, the higher elasticity of interest rate in response to debt increase. When $\psi_1 = 0$, we return to the debt inelastic interest rate. we will set $\psi_1 = 0.5$ to make comparisons.

Figure 2.9 illustrate the dynamics of key variables under no bailout and optimal bailout. The optimal bailout transfer here is less than the debt inelastic interest rate case, as we have put the debt elastic part as additional borrowing cost, disincentiving the government to borrow from abroad. In consequence, government debt increases less, and the private sector's misallocation is more severe.

2.3.9 Debt Limit Shocks

We have imposed only equity market frictions so far. The literature has largely constrained agents to debt market frictions by contrast, typically debt ceiling constraints, e.g., Uribe (2006) and Bianchi, Hatchondo and Martinez (2012). We will also consider those frictions. To be precise, in addition to the previous equity market frictions, banks are subject to the following frictions:

$$b_{t+1} \leq \bar{b}_{t+1},$$

where $\bar{b}_{t+1}$ is exogenously given. We will introduce shocks to debt limit. The definition of competitive equilibrium with debt limit shocks is given in Appendix.

2.3.10 One Time Interest Rate and Debt Limit Shock

We will still do a one-time shock experimentation. The economy starts with steady state without binding dividend constraints and binding debt limit constraints. In period 0, the economy is hit by an interest rate shock as before, plus a debt limit shock. To make the debt limit shock relevant, we set the debt limit in period 0 low enough to let the debt ceiling constraint be binding. The dual shocks immediately fade away after period 0. The description of equilibrium conditions are in Appendix.

2.3.10.1 Dynamic Responses

Set debt limit $\bar{b}_1 = 0.9$. As the debt limit constraint is going to be binding one period, we shall see $b_1 = \bar{b}_1$. In comparison with section 3.7.5., where banks can adjust both through external debt and capital, here banks are also debt constrained, so the only way they adjust is to get rid of capital good more upon the shock, creating larger output drop. That brings more incentives for the government to revive the banking sector, i.e. optimal bailout is larger, as shown in Figure 2.10. In this case, government debt jumps more to finance the desired bailout package. As with bank external debt, the long run equilibrium exhibits less debt burden for the banking sector. The bailout also prevents capital good price from plunging and enlarges the wedge between private good consumption and public good consumption. In the following Sections, we shall keep both interest rate shock and debt limit shock. We take a position that during crises not only banks face higher interest rate but they can hardly borrow to the amount they would like to given any interest rate.

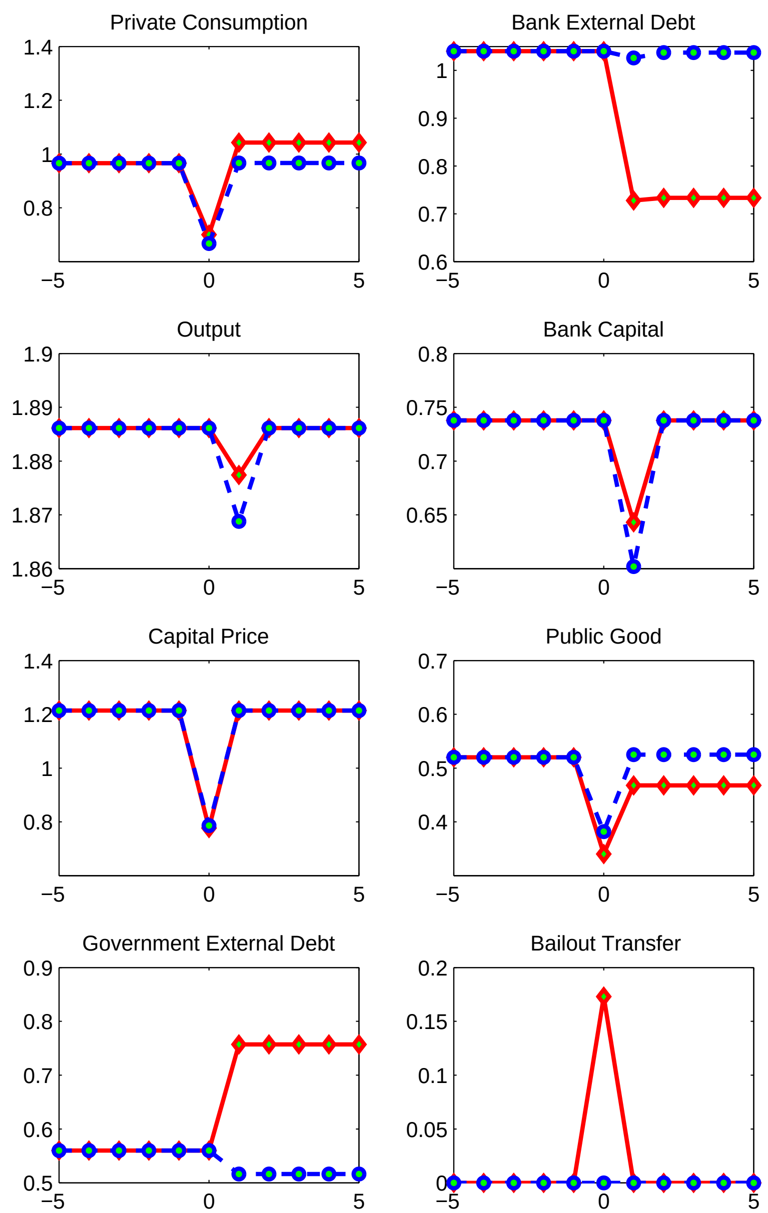
2.4 Sovereign Debt Default

In the previous sections, we have assumed government external debt is default-free. We now extend our model to include sovereign default risk. We introduce productivity shocks. We assume that in addition to R_0 and $\bar{b}_1$ shock unexpectedly arrives in period 0 to the private sector, there is also aggregate productivity shock Z_0 and all agents understand that there is aggregate productivity shock Z realized in period 1, which lasts to all future periods. The government can choose to default in period 1 with punishment of exclusion from international debt market forever[8] and default incurs a permanent cost to productivity such that productivity drops to $\phi < 1$ fraction of the original productivity.

Denote the cumulative distribution function of Z as $\theta(Z)$ and default threshold as

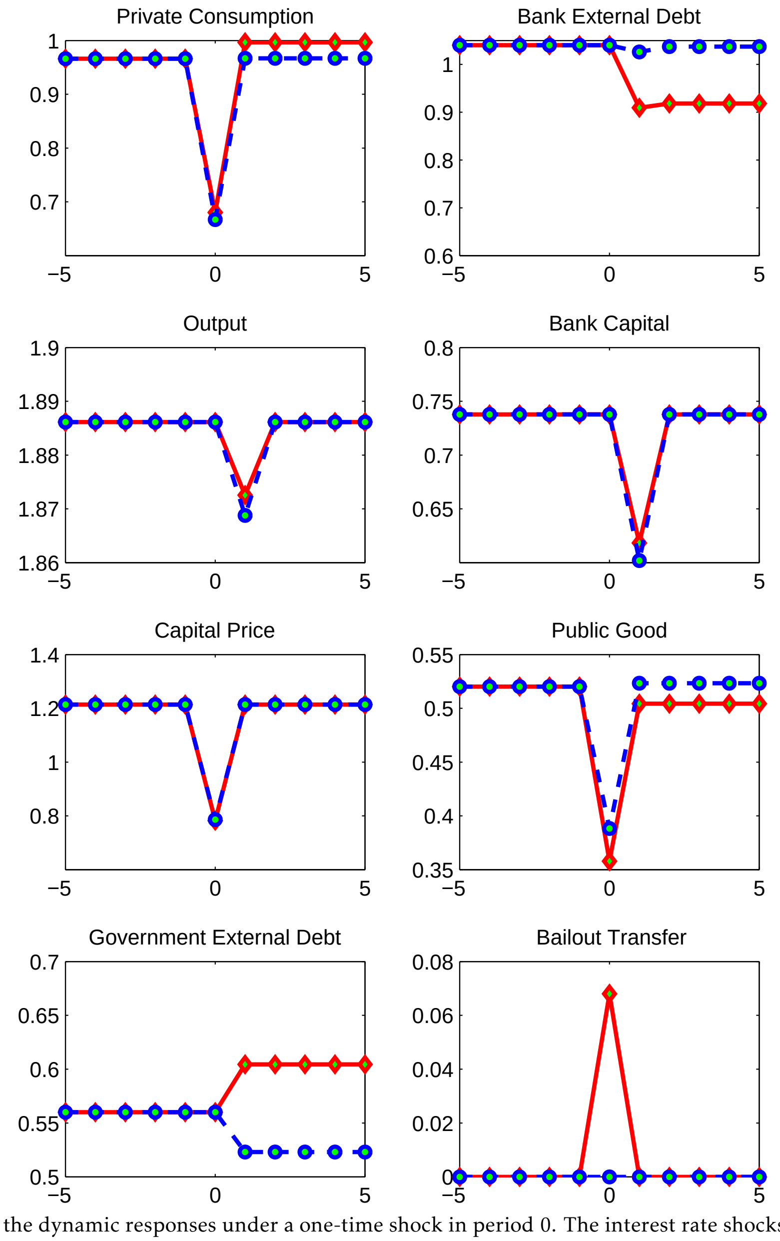
[8]This assumption is not essential as if the government starts with 0 debt and $\beta R = 1$, government debt level will stay at 0 afterwards.

Figure 2.8: Dynamics under Optimal Bailout and No Bailout with Differential Interest Rate (1)



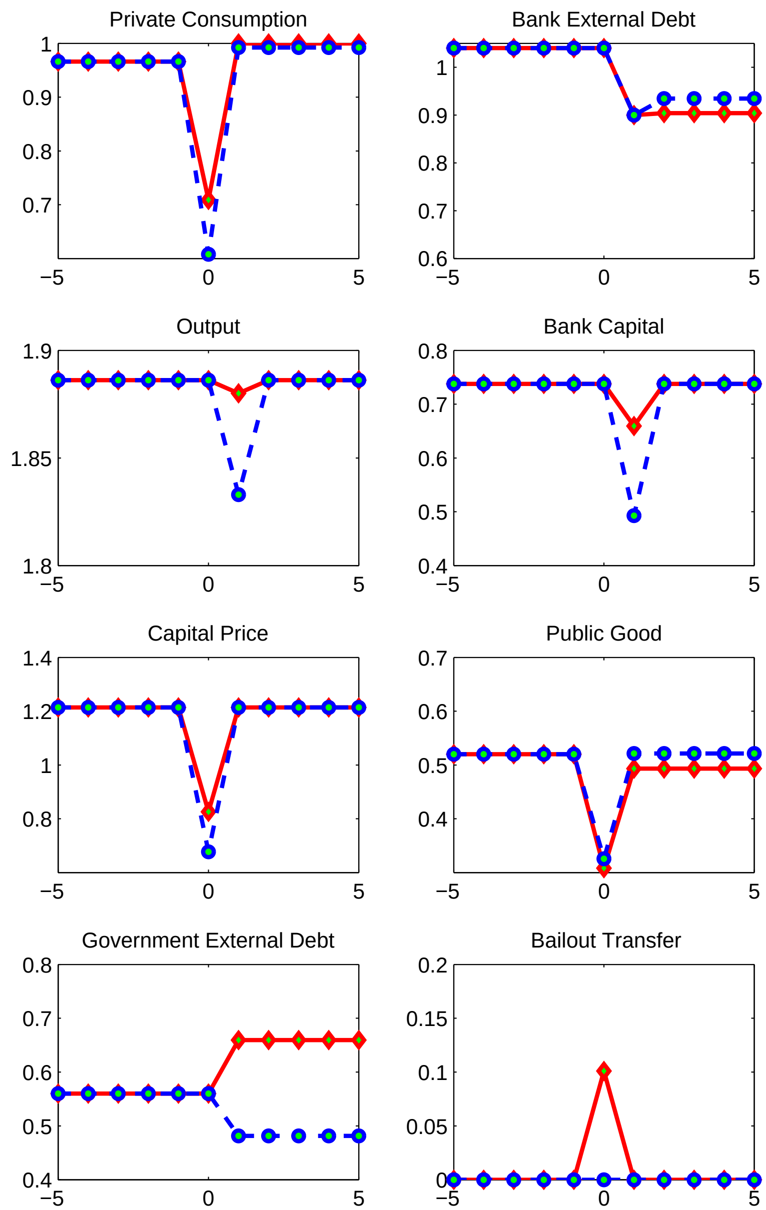
Notes: this figure shows the dynamic responses under a one-time shock in period 0. The interest rate shocks to the private sector and public sector are set to be different. Solid blue lines with circles are with optimal bailout; dashed red lines with diamonds are without bailout.

Figure 2.9: Dynamics under Optimal Bailout and No Bailout with Differential Interest Rate (2)



Notes: this figure shows the dynamic responses under a one-time shock in period 0. The interest rate shocks to the private sector and public sector are set to be different and government faces **debt elastic interest rate**. Solid blue lines with circles are with optimal bailout; dashed red lines with diamonds are without bailout.

Figure 2.10: Dynamics under Optimal Bailout and No Bailout with Borrowing Constraint Shock



Notes: this figure shows the dynamic responses under a one-time shock in period 0. There is also borrowing constraint shock to the private sector. Solid blue lines with circles are with optimal bailout; dashed red lines with diamonds are without bailout.

Z^*. Risk neutral pricing implies that government borrowing cost in period 0 is

$$R_0^g = \frac{R}{1-\theta(Z^*)}. \tag{2.4.1}$$

In period 1, given B_{g1} and K_{b1} and realized shock Z, the government chooses whether to default to maximize households' lifetime utility from public good consumption from period 1:

$$V^g(B_{g1}, K_{b1}, Z) = max\{V^{gd}(B_{g1}, K_{b1}, Z), V^{gc}(B_{g1}, K_{b1}, Z)\},$$

where d means default and c means no default (continue).

Write $y_1 = \tau Z[F(K_{b1}) + H(K - K_{b1})]$ and $y^* = \tau Z[F(K_b^*) + H(K - K_b^*)]$. Under no default choice, government spending is

$$G_t^c = \frac{R-1}{R}(y_1 - B_{g1}) + \frac{y^*}{R}, t \geq 1.$$

While with default, government spending is

$$G_t^d = \frac{R-1}{R} y_1 \phi + \frac{y^*}{R}\phi, t \geq 1.$$

Therefore, when

$$B_{g1} > (1-\phi)(y_1 + \frac{y^*}{R-1}),$$

the government will default. This equation illustrates that government defaults in bad times, as in Arellano (2008): high debt and low income. The cutoff Z^* is given by

$$Z^* = \frac{B_{g1}}{1-\phi} \frac{1}{\tau[F(K_{b1}) + H(K-K_{b1})] + \tau[F(K_b^*) + H(K-K_b^*)]/(R-1)}. \tag{2.4.2}$$

In period 0, government's problem is to pick up the size of bailout ω_0 and government debt B_{g0} to maximize representative household's welfare

$$\frac{C_0^{1-\sigma}-1}{1-\sigma}+\frac{\beta}{1-\beta}E_0\left[\frac{C_1^{1-\sigma}-1}{1-\sigma}\right]+\left(\frac{\tau}{1-\tau}\right)^{\sigma}\left[\frac{G_0^{1-\sigma}-1}{1-\sigma}+E_0[V^g(B_{g1},K_{b1},Z)]\right].$$

We notice that the government is subject to debt pricing equation given by equation (2.4.1) and (2.4.2). The amount of debt the government can raise in period 0 is

$$\frac{B_{g1}}{R_0^g}=\frac{B_{g1}}{R}[1-\theta(Z^*)],$$

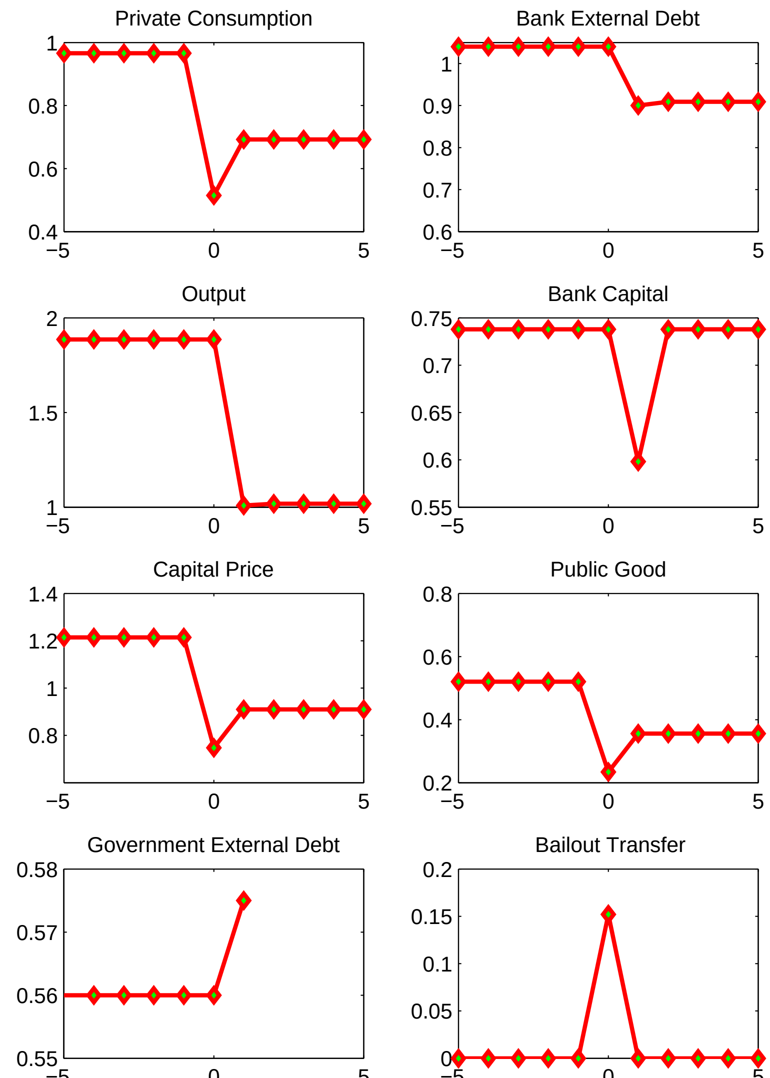
where Z^* is given by equation (2.4.2).

In Figure 2.11, we conduct a numerical experiment to illustrate that it is possible that despite the increased default risk and thus borrowing cost, the government still would like to increase government debt due to the need to bail out banks. Furthermore, Figure 2.12 shows the government debt Laffer curve given the bailout size is fixed at the above optimal level. The logic of the existence of a Laffer curve is also similar to Arellano (2008). When government debt issuance is very high, foreign lenders price in the high default risk, making the debt price very low.

2.5 Ex-ante Prudential Policies

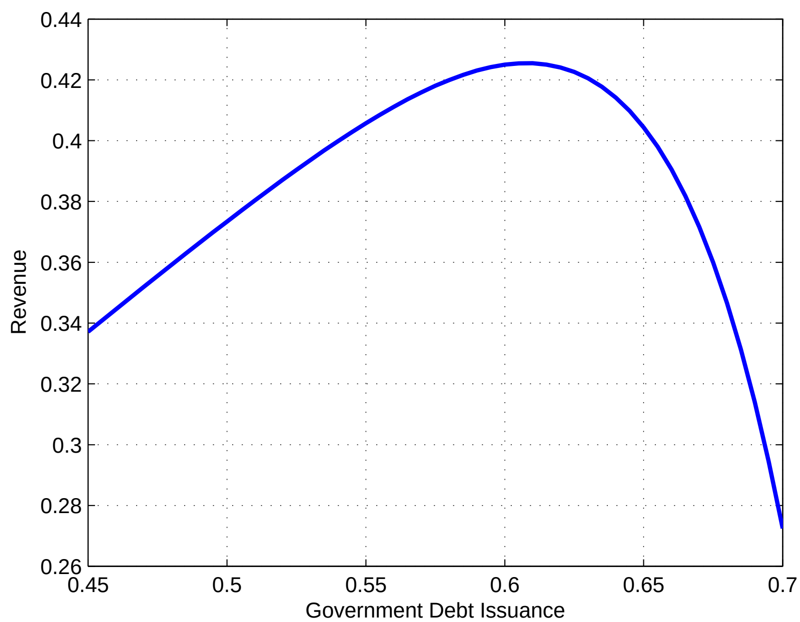
Analyzing the economy's response's to an unanticipated shock is a study of ex-post policy intervention. A natural question is whether there is also scope for ex-ante policy intervention. To mimic the boom-bust cycles in European countries, we introduce pre-crisis favorable interest rate shock and the economy understands that bad shocks (high interest rate and tightening borrowing constraint) can come next period. We assume that in period -1, there is a good interest rate shock $R_{-1}<\frac{1}{\beta}$. At the same time, all agents understand that with probability $p_B>0$, the interest rate and debt limit shock will arrive in period 0, while with $p_G=1-p_B$, the economy will revert back to steady state interest rate

Figure 2.11: Dynamics under Optimal Bailout with Government Default



Notes: this figure shows the dynamic response with government debt default. In this simulation, parameters $Z_0 = 0.8$, $\phi = 0.72$, and $1/Z$ follows Pareto distribution with support [1,5] and pareto parameter is 14. The realized Z is 0.75 and the government defaults under optimal policies.

Figure 2.12: Government Debt Laffer Curve



Notes: this figure shows government debt Laffer curve. The x-axis is debt issuance which is the amount government needs to repay next period. The y-axis is the debt issuance multiplied by debt price.

$R_t = \frac{1}{\beta}, \forall t \geq 1$. We set $p_B = 0.2$. To simplify analysis, we will still assume that government debt is risk-free.

2.5.1 Fire-sale Externalities

In face of interest rate or tighter borrowing constraint shocks, when the dividend constraint begins to bind, banks need to sell its capital stock to the household sector, which depresses capital good price q_t. The decline in capital good price in turn tightens each bank's dividend constraint because dividend is given by

$$div_t = (1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(k_{bt} - k_{b,t+1}).$$

If q_t drops, each bank has to sell more of its capital stock to satisfy the dividend constraint. The extent to which q_0 drops in bad times depends on debt b_0. However, each individual bank fails to internalize this pecuniary externality on other banks when choosing b_0. We shut down bailout so that $\omega_t = 0$ so as to isolate the role of fire-sale externalities.

In the decentralized case, in period -1, we have Euler equation

$$\Lambda_{-1} = \beta R_{-1} E_{-1}[\Lambda_0]$$

where $E_{-1}[\Lambda_0] = p_B \Lambda_0^B + p_G \Lambda_0^G$ and $\Lambda_t = u'(C_t)$. Consumption in period -1 is given by

$$C_{-1} = (1-\tau)Z_{-1}\left(F(K_b^*) + H(K - K_b^*)\right) - b_{-1} + \frac{b_0}{R_{-1}}$$

We guess and verify when the bad state happens, dividend constraint binds, while when good state happens, dividend constraint will not bind. Then we solve the model by letting a planner pick up b_0 for banks.

The planner's objective is to maximize private welfare. She solves the following problem

$$\max_{b_0} u(C_{-1}) + \beta E_{-1}[W(b_0)]$$

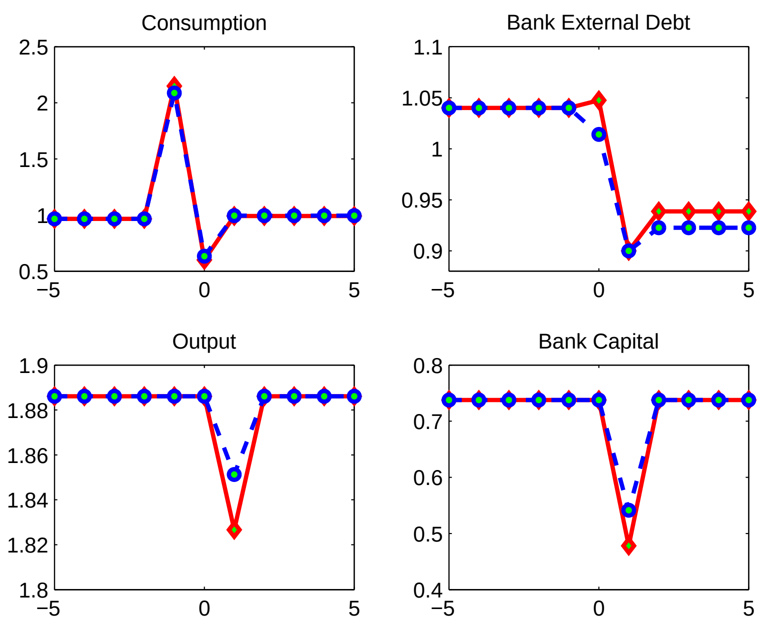
s.t.

$$C_{-1} = (1-\tau)Z_{-1}\left(F(K_b^*) + H(K - K_b^*)\right) - b_{-1} + \frac{b_0}{R_{-1}}$$

where $W(b_0)$ denotes the welfare of the representative household, given initial b_0 in the decentralized economy. We label this economy as "second best".

We expect the planner selects a lower b_0 so that when the bad shock arrives, fire-sale of capital will be less. Figure 2.13 shows that this is indeed the case. The social planner's choice also makes the economy less volatile as in crises, with less debt on burden, banks fire-sale less capital. Output loss is alleviated.

Figure 2.13: Pecuniary Externalities



Notes: this figure shows dynamics under planner's choice of ex-ante bank debt and decentralized choice of ex-ante bank debt (both under no bailout). Solid blue lines with circles are planner's choice; dashed red lines with diamonds are decentralized economy.

2.5.2 Moral Hazard

We also investigate the case with government bailout ex-post. To simplify the analysis, we assume that the government only has option to bailout when bad shock happens. It could be rationalized by a non-monetary cost to implement bank bailout. Therefore, banks have the expectation that when bad shock arrives, the government will optimally choose to implement a bailout transfer.

In the decentralized case, in period -1, we still have Euler equation

$$\Lambda_{-1} = \beta R_{-1} E_{-1}[\Lambda_0]$$

where $E_{-1}[\Lambda_0] = p_B \Lambda_0^B + p_G \Lambda_0^G$ and $\Lambda_t = u'(C_t)$. Consumption in period -1 is given by

$$C_{-1} = (1-\tau) Z_{-1} \left(F(K_b^*) + H(K - K_b^*) \right) - b_{-1} + \frac{b_0}{R_{-1}}$$

At the same time, for the public good, we obtain similar expressions

$$\Lambda_{g,-1} = \beta R_{-1} E_{-1}[\Lambda_{g0}]$$

where $E_{-1}[\Lambda_{g0}] = p_B \Lambda_{g0}^B + p_G \Lambda_{g0}^G$ and $\Lambda_{gt} = v'(G_t)$. Public good in period -1 is given by

$$G_{-1} = \tau Z_{-1} \left(F(K_b^*) + H(K - K_b^*) \right) - B_{g,-1} + \frac{B_{g0}}{R_{-1}}$$

Ex-post, when the bad shock happens, government optimally selects $\omega_0 \geq 0$ to maximize total welfare of the representative households. The equilibrium choice of b_0 and B_{g0} is a fixed point problem.

Then we solve the model with social planner helps pick up b_0 and B_{g0} to maximize total welfare starting from period −1. The social planner select b_0 and B_{g0} to

$$\max_{b_0, B_{g0}} u(C_{-1}) + v(G_{-1}) + E_{-1}[W(b_0, B_{g0})]$$

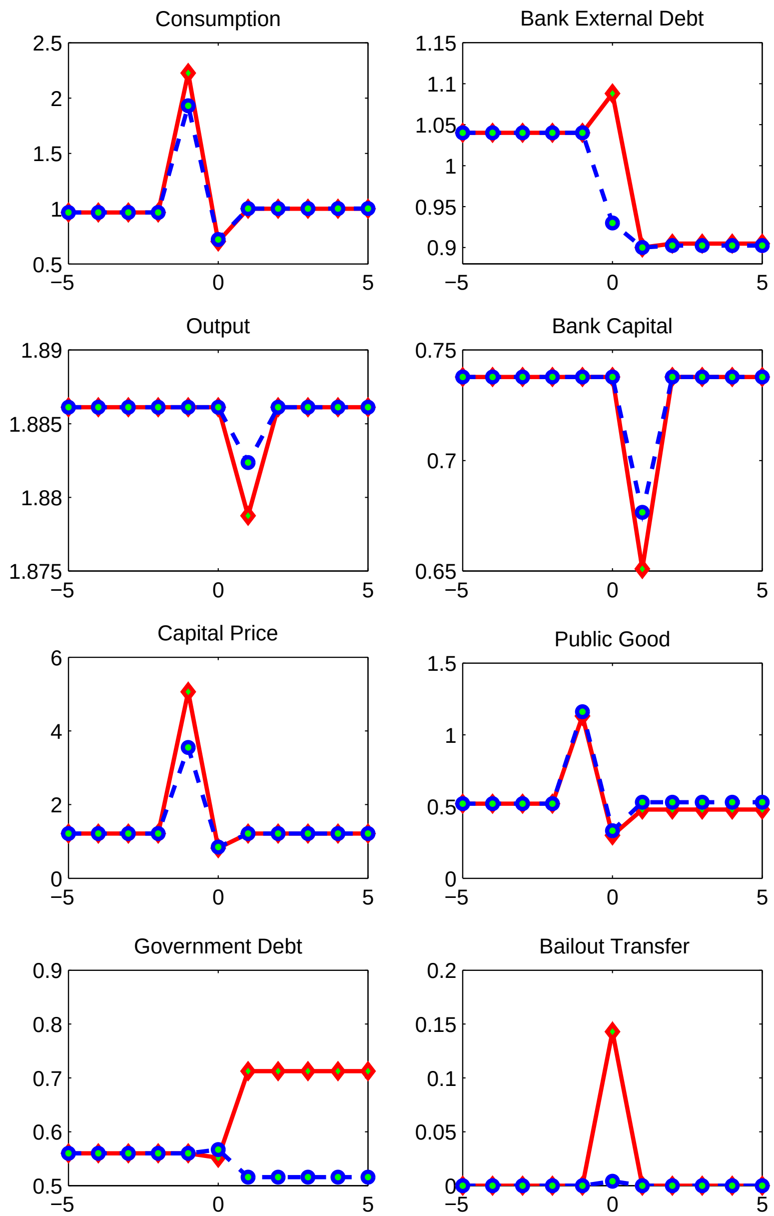
where $W(b_0, B_{g0})$ denotes the total welfare starting from period 0 with bank debt b_0 and B_{g0}, taking into account that when bad shock arrives, the government optimally intervenes to improve banks' balance sheet. We label this economy as "second best".

Figure 2.14 shows dynamic responses of the decentralized economy and the second-best economy. First, comparing with Figure 2.13, we see that in decentralized economy, banks become more aggressive in choosing b_0 in the boom phase when anticipate future bailout. Besides, in the planner's comparisons, the government prefers to select a more conservative debt b_0 as they want to reduce the bailout cost, which is borne by households' reduction in welfare and taken care by the government. As expected, with social planner's choice of b_0, the severity of crises is reduced. As a result, there is little need for bailout. What's more impressive is that the government debt doesn't need to increase during crises. In a word, if the social planner has directly picked up bank debt in the boom phase, a severe twin external crises might have been avoided.

2.6 Conclusion

This paper explores the external debt dynamics of both private and public sector. We start with some data patterns. In the recent European experience, during the crises, private debt and public debt move in opposite directions. Before the crises, most countries experience private debt boom while public debt GDP ratio remains stable or slightly declines. One salient fact during crises is that the government usually steps in to bailout its banking system. Motivated by the bailout connection between bank balance sheet and government balance sheet, we build up a small open economy model with both bank external debt and sovereign external borrowing.

Figure 2.14: Moral Hazard



Notes: this figure shows dynamics under planner's choice of ex-ante bank debt and decentralized choice of ex-ante bank debt (both under bailout). Solid blue lines with circles are planner's choice; dashed red lines with diamonds are decentralized economy.

In the private sector, banks face equity market frictions despite that they can borrow from abroad. When adverse shocks arrive, like interest rate shock or borrowing constraint shock, banks have to fire-sale capital, creating misallocation and output drop. The government optimally intervenes by trading off the benefit of relaxing banks' financial frictions and the cost of cut in (current and future) public good spending. When the optimal bailout package is large enough, in order to smooth public good provision, the government increases intertemporal debt. Banks' debt decrease is driven jointly by foreign shocks and the bailout transfer.

Finally, we do ex-ante policy analysis. We gauge into two rationales why prudential policies are desirable ex-ante. The first one is fire-sale externalities between banks. When banks borrow ex-ante, high debt level shall affect the amount of asset they need to sell during crises, driving down asset prices. Lower asset prices tighten other banks' financial frictions. However, banks don't internalize this price effect and instead take asset price as given. The second one is moral hazard problem by banks. Anticipation of bailout encourages ex-ante aggressive debt position of banks. Banks don't internalize that bailout comes at the cost of public good spending cut for households. If ex-ante prudential policies, say bank leverage restrictions had been implemented, the severity of crises will be alleviated and even possibly change the direction of government debt from increase to decrease.

While the current paper is intended to qualitatively assess the joint dynamics of public and private external debt, a potential exploration is to quantitatively study a sovereign debt crisis ignited by bailout policies. We also have not allowed private borrowing to be defaultable and simplified the role of domestic financial frictions on banks to be only creating inefficient misallocation. Deeper understanding and richer modeling of the role of financial frictions and the financial sector are possibly fruitful research topics in open economies.

Chapter 3

Intrinsic Openness and Endogenous Institutional Quality

3.1 Introduction

Institutional quality (e.g., level of bureaucratic corruption, political risk premium, quality of government service, and risk of expropriation) varies widely across countries. It has been regarded as a crucial determinant of a country's economic performance. Mauro (1995) finds that corruption lowers investment, thus growth rate. Murphy, Shleifer and Vishny (1991) argue that rent-seeking activities are detrimental to growth rate. Institutional quality can also affect how economic gains are distributed. Chong and Calderon (2000) find a negative relationship between institutional quality and income inequality. With open economy consideration, Wei (2000) empirically shows that corruption reduces a country's inward FDI. Tamirisa and Wei (2002) show that corruption also deters international trade significantly. Besides, institutional quality is found to affect international trade patterns. Costinot (2009), Levchenko (2007) and Vogel (2007) consider institutional quality as an independent source of comparative advantage. Ju and Wei (2011) conclude that institutional quality affects patterns of both capital flows and trade.

Given the significance of institutional quality, it is important to understand its determinants. We argue in this paper that a country's "intrinsic openness", as given by its population size and geography, is a determinant of institutional quality. The central story is as follows. The amount of resources that a society devotes to building good institutions is endogenous; and depends on a comparison of marginal cost and marginal benefit. Since international traders and investors are more footloose (i.e., have better outside options) than domestic ones, bad governance and bureaucratic corruption in a country reduces international trade and investment more than domestic trade and investment. As a result, a country that is intrinsically more open – based on its population size, geography, and other factors outside its control – would find it more costly if they suffer from bad institutions so they optimally devote more resources to building good institutions. Such economies will display, for example, less corruption and a higher quality of government than intrinsically less open economies.

We will check the plausibility of some key assumptions in our story. For example, do bad institutions reduce international trade more than domestic trade? This would require a way to estimate a country's trade with itself. By using gross output decomposition data from the recent literature on the measurement of global value chains, we can perform such a test and find supportive evidence. We also empirically confirm that, across countries, intrinsic openness (smaller size, shorter distance to the world market, not landlocked, or longer coastline length/area) does lead to greater actual trade openness (trade/GDP).

Importantly, we test and find strong support for the key proposition of our theory: An increase in a country's intrinsic openness indeed reduces corruption, improves government quality, and decreases political risk. In the same exercise, we also find some support for the notion that colonial settlers' mortality rate in the 18th and 19th century, and abundance of natural resources tend to be associated with worse institutions. We do not find robust support for a role of legal origins in determining institutional quality.

Because institutional quality is a slow-moving variable, much of our results will be based on cross-country variations in a given year (2005 is our base year, though we have verified that the same results hold for other years). By necessity, one cannot control for country fixed effects in pure cross-country regressions. This is not unusual for the literature on this topic. For example, Acemoglu, Johnson and Robinson (2001) and Leite and Weidmann (1999) report only cross-sectional results in testing their theories of settler mortality and natural resource endowment, respectively, as determinants of institutional quality. Since our measures of a country's intrinsic openness are geographic features (such as distance to major economic centers of the world, or coastal length relative to area size) and population size, they are unlikely to be endogenous outcomes of institutional quality. There is therefore less need to worry about endogeneity in our setting than a typical cross-country regression.

Nonetheless, we will also attempt a long-difference exercise by exploring exogenous variations in the level of intrinsic openness experienced by small and medium-sized countries during 2000-2006. A major shock to the global trading environment during that period was China's accession to the World Trade Organization in 2001, and a dramatic and unilateral reductions in China's trade barriers on imports from the rest of the world. While China's GDP roughly doubles once every seven years, China's trade roughly doubles once every four years. Given the size of the Chinese market, its cut in import tariff implies a significant and exogenous change in many countries' overall trading opportunities. Importantly, the changes to intrinsic openness are uneven across countries, partly because of differences in geography (e.g., countries near China might benefit more than those that are far away), and partly because of differences in comparative advantage (e.g., a big reduction in Chinese tariff on automobiles means different things for car-exporting countries versus non-car-exporting countries).

While changes in the Chinese tariff rates were the primary shock, changes in tariffs by other major economies during the same period could matter as well. In our long-difference exercise, we employ changes in import tariffs by big trading nations (China + G7) from 2000 to 2006 as a source of exogenous shock to other countries' intrinsic openness. A key finding will be that greater improvement in governance quality (greater reduction in political risks) is found in those countries that experienced greater relative increase in intrinsic openness. Various robustness checks such as excluding outliers, using 3-year averages, and implementing placebo-tests confirm robustness of our conclusions.

A third type of empirical exercise we do explores cross-product heterogeneity in the reliance on governance institutions. Nunn (2007) makes the point that the same improvement in public institutions might have a greater salubrious effect on the production and trade of what he calls "contract-intensive" products (which are empirically proxied by differentiated goods such as numerically controlled machines) than on "less contract intensive" goods (which are empirically proxied by relatively "homogeneous" goods such as iron, steal, and oil). We build on this insight and ask the reverse question: do countries whose comparative advantage is in contract intensive products respond more in governance quality to a given change in intrinsic openness? We find that the answer is a resounding yes, and take it as a further confirmation of our theory.

We compare our story with the existing literature on the determinants of institutional quality. Acemoglu, Johnson and Robinson (2001) propose that the mortality rate of the European colonizers in the past is a key determinant of a developing country's institutional quality today. By their logic, a higher colonial mortality rate translates into a stronger incentive to set up extractive institutions with less protection for property rights during the colonial years, and the nature of institutions tends to live on even after independence. Sokoloff and Engerman (2000) use the initial factor endowment as an explanation for the difference in institutional quality in the Americas. La Porta, Lopez-de Silanes and Shleifer (2008) hypothesize that a common law origin is more protective of outside investors than the civil law tradition. Leite and Weidmann (1999) argue that natural resource abundance is related to more rent seeking behavior, resulting in lower economic growth. None of these explanations is based explicitly on open economy concerns.

At least three other papers make a connection between trade and institutional quality. Ades and Di Tella (1999) argue that greater trade openness reduces the amount of rent associated with being in the government and hence reduces the level of corruption. In their theory, the sign of competitiveness' effect on corruption is ambiguous. In their empirical part, they find that a higher import/GDP ratio reduces the level of corruption. Our cross sectional results will show that, after controlling for the import/GDP ratio, there is still ample evidence supporting the role of intrinsic openness in affecting institutional quality. In our framework, it is the intrinsic openness not the actual openness (trade/GDP) that can affect institutional quality. When we let intrinsic openness and residual openness - the part of import/GDP that is not related to geography and country size - compete in explaining institutional quality, intrinsic openness dominates residual openness. In addition, we will explore a natural experiment in which institutional quality responds to changes in export opportunities due to policy changes of partner countries rather than in import competition.

Acemoglu, Johnson and Robinson (2005) attribute part of Western Europe's development after 1500 to institutional improvement after the increase of the Atlantic trade. Because the Atlantic trade enriched merchants, their political demand - stronger protection of property rights - became better met. In comparison, while we also look at the role of trade globalization, we do not rely on changes in political power but differential sensitivity between international and domestic trade to a given change in institutional quality.

For Levchenko (2012), the mechanism for institutional changes is a "race to the top": when the technology difference between two countries is small, after opening to trade, countries upgrade institutional quality in order to specialize in institutionally intensive sectors to extract rents in that sector. But when the technology difference is large enough, the opposite pattern happens - institutional quality deteriorates in order to extract more rents. Therefore, trade openness helps institutional quality only locally. In comparison, we regard bad institutional quality as a tax on trade, and endogenous upgrading of institutional quality is driven by the difference in the effects of institutional quality on international versus trade. In addition, while Levchenko (2012) provides only cross sectional regressions, this paper will also conduct long-difference analysis (that differences out country fixed effects).

The current paper is also related to a growing literature on a "China shock" in trade. Autor, Dorn and Hanson (2013), Acemoglu et al. (2016) and Pierce and Schott (2016) study effects of increased China's import competition during 2000-2007 on US local labor markets. Bloom, Draca and Van Reenen (2016) show that offshoring to China may have benefited European firms and their workers by enhancing firms' productivity and innovation activities. Autor et al. (2016) analyze the role of growing imports from China during 2000-2007 in shaping the polarization of U.S. politics. Wang and Zhu (2017) suggest, once using a supply chain perspective, the negative effects on the US labor market of a China trade shock could be reversed.

Similar to other papers on the China trade shock, some of the empirical exercises in this paper also take advantage of the changes in global trading environment during 2000-2006 that was related to China's accession to the WTO. Different from the existing literature on the China trade shock, we focus on its effect on institutional changes in other countries. Our results suggests an indirect but important beneficial channel for China's rise in word trade: by responding to the changes in the global trading environment by improving their public institutions, many countries' growth prospect in the long run may be brightened. This could be especially important for countries with a low initial level of institutional quality.

The rest of the paper is organized as follows. In Section 2, we propose a simple theory clarifying the logic behind the story. In Section 3, we supply cross-sectional evidence on the relationship between a country's intrinsic openness and its institutional quality. In Section 4, we conduct a long-difference analysis exploring exogenous changes in intrinsic openness experienced by small and medium sized economies during 2000-2006 due to changes in trade barriers by China and G7 countries. We will also explore cross-product heterogeneity in the reliance on public governance institutions. Finally, in Section 5, we provide concluding remarks and suggest some possible future research. A set of five appendices provide more information on data sources, supplementary empirical work verifying some key assumptions of the theory, and an extension of the model.

3.2 The Model

3.2.1 Model Setup

Consider a world with N countries. Country i has a population of L_i and a technology level denoted by A_i. This yields total units of effective labor $E_i = A_i L_i$. Each unit of effective labor produces one unit of good (either a homogeneous or a differentiated good).

A representative consumer in country i has the following logarithmic utility[1]:

$$u_i = \log H_i$$

with H_i denoting the consumption of the final good, which comes from

$$H_i = Y_i^{\alpha} X_i^{1-\alpha} \tag{3.2.1}$$

where $0 < \alpha < 1$. Y_i is an internationally traded homogeneous good, and X_i is an Armington aggregate of differentiated goods from each country described as below:

$$X_i = (\sum_{j \in N} N_j X_{ij}^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$$

where X_{ij} is the consumption of a differentiated good produced by country j and consumed in country i, and N_j the number of varieties produced in country j. We assume N_j is positively related to the producing country's population: $N_j = M(L_j)$[2]. Parameter $\sigma > 1$ is the elasticity of substitution.

The homogeneous good is taken as the numeraire thus $p_Y = 1$. Since it is tradable

[1] The logarithmic utility is for ease of exhibition. All theoretical results apply as long as utility is an increasing function of final good consumption, as one can always equivalently transform the objective function for welfare by a monotonic increasing function.

[2] This shares a feature with the Krugman (1979) model in which the (endogenous) number of varieties is proportional to the population size. For simplicity, we assume a competitive good market. However, our theoretical predictions are preserved if we adopt the monopolistic competition framework of Krugman (1979).

across countries, the wage rate of a unit of effective labor is pinned down by $w_i = 1$[3]. Assuming a complete competitive market for each variety, the fob price of each variety must be $p_i = w_i = 1$. Denoting the final good price as P_i, the profit maximization problem of final good producers is

$$\max_{\{Y_i, X_{ij}\}} P_i Y_i^{\alpha}[(\sum_{j\in N} N_j X_{ij}^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}]^{1-\alpha} - p_Y Y_i - \sum_{j\in N} p_i N_j X_{ij}\tau_{ij} \tag{3.2.2}$$

where τ_{ij} is an iceberg cost to be specified later. The final good price index is derived as

$$P_i = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}[[\sum_{j\in N} N_j \tau_{ij}^{1-\sigma}]^{\frac{1}{1-\sigma}}]^{(1-\alpha)} \tag{3.2.3}$$

The indirect utility for a representative agent in country i is, therefore,

$$v_i = \log\frac{A_i}{P_i} = \log(\alpha^{\alpha}(1-\alpha)^{1-\alpha}) + \log(A_i) + \log(\sum_{j\in N} T_{ij})^{\frac{1-\alpha}{\sigma-1}} \tag{3.2.4}$$

with $T_{ij} = N_j \tau_{ij}^{1-\sigma}$.

The iceberg trade cost for a given country pair (i, j), τ_{ij}, is assumed to depend on the quality of institutions in the two countries, as well as geographic distance d_{ij}. The assumption is meant to capture the idea that bad institutions (e.g. corruption) add to the cost of clearing the customs or uploading or offloading cargos. We specify the following separable functional form for the iceberg cost:

$$\tau_{ij} = d_{ij} f(q_i, q_j) \tag{3.2.5}$$

where the first term d_{ij} reflects physical distance and (bilateral) trade policy, and the second term (q_i, q_j) captures the role of the two countries' institutional qualities.

Note that bad institutional quality negatively impacts both domestic and interna-

[3]In country i, GDP per capita, i.e. the wage rate of each worker is $A_i w_i = A_i$.

tional trade.

Assumption 1. for $i \neq j$, $\frac{\partial f(q_i,q_j)}{\partial q_i} < 0$, $\frac{\partial f(q_i,q_j)}{\partial q_j} < 0$ and for $i = j$, $\frac{\partial f(q_i,q_i)}{\partial q_i} \leq 0$[4].

We further make the following assumption to capture the idea that international traders are more "mobile" than domestic traders.

Assumption 2. $-\frac{\partial \log f(q_i,q_j)}{\partial q_i} > -\frac{\partial \log f(q_i,q_i)}{\partial q_i}$.

That is to say, international trade is more sensitive to domestic institutional quality compared to domestic trade.

The above two assumptions are crucial for the theoretical predictions. In an appendix, we empirically verify these assumptions using an augmented gravity framework. A key ingredient is to measure a country's trade with itself. See Appendix C2 for details.

3.2.2 Institutional Cost

We now investigate the endogenous determination of institutional quality. To capture the idea that improving institutional quality requires costly investment, we specify a cost function in per capita terms such that the per capita income in the economy net of investment in public institutions is:

$$A_i^e = [1 - \phi(q_i)]A_i$$

where $\phi\prime(q_i) > 0$ so that it is costly to upgrade institutional quality[5].

The indirect utility is then

$$\begin{aligned} v_i &= \log(\alpha^\alpha (1-\alpha)^{1-\alpha} A_i^e (\sum_{j\in N} T_{ij})^{\frac{1-\alpha}{\sigma-1}}) \\ &= \log(\alpha^\alpha (1-\alpha)^{1-\alpha}) + \log([1-\phi(q_i)]) + \log(A_i) + \log[\sum_{j\in N} N_j d_{ij}^{1-\sigma} f^{1-\sigma}(q_i, q_j)]^{\frac{1-\alpha}{\sigma-1}} \end{aligned} \tag{3.2.6}$$

[4]Without risk of confusion, the expression $f(q_i, q_i)$ is always taken as a function of only one variable q_i.

[5]Note that the requirement investment in public institutions is assumed to exhibit no scale effect. In Appendix C4, we use cross-country data to confirm that neither general government expense per capita nor total government employee compensation per capita exhibits a scale effect. One reason might be that, as a country becomes larger, the number of layers of goverments tends to increase as well.

This implies a tradeoff for any country: on one hand, better institutional quality leads to less resource spent on consumption; on the other hand, it reduces transaction costs in trade.

3.2.3 Optimal Institutional Quality

The optimal institutional quality can be solved from the viewpoint of a social planner, who faces the following problem:

$$\max_{q_i} v_i(q_i)$$

i.e.

$$\max_{q_i} \log \alpha^{\alpha}(1-\alpha)^{1-\alpha} + \log A_i + \log[1-\phi(q_i)] + \frac{1-\alpha}{\sigma-1}\log[\sum_{j\in N} N_j d_{ij}^{1-\sigma} f^{1-\sigma}(q_i,q_j)] \quad (3.2.7)$$

The first order condition of the above problem is

$$\frac{\phi\prime(q_i)}{1-\phi(q_i)} = (1-\alpha)\frac{\sum_{j\in N} N_j d_{ij}^{1-\sigma} f^{1-\sigma}(q_i,q_j)[-\frac{\partial \log f(q_i,q_j)}{\partial q_i}]}{\sum_{j\in N} N_j d_{ij}^{1-\sigma} f^{1-\sigma}(q_i,q_j)} \quad (3.2.8)$$

The left hand side is the marginal cost of increasing one unit of institutional quality while the right hand side is the marginal benefit. To guarantee uniqueness, we assume that the left hand side is increasing in q_i (convex cost of increasing institutional quality), while the right hand side is decreasing in q_i (diminishing returns to institutional quality). At least one of the two is assumed to be strictly monotonic. For example, $\phi(q) = 1-e^{-\gamma q}$, $f(q_i,q_j) = e^{\frac{\pi_i}{q_i}} e^{\frac{\pi_j}{q_j}}$, $f(q_i,q_i) = e^{\frac{\pi}{q_i}}$, where $\pi_i > \pi$.

Following the existing trade literature, and for notational convenience, we set $d_{ii} = 1$. The first order condition can be re-written as

$$\frac{1}{1-\alpha}\frac{\phi\prime(q_i)}{1-\phi(q_i)} = -\frac{\partial \log f(q_i,q_i)}{\partial q_i}$$

$$+\frac{\sum_{j\neq i}\frac{N_j}{N_i}d_{ij}^{1-\sigma}[\frac{f(q_i,q_j)}{f(q_i,q_i)}]^{1-\sigma}[-\frac{\partial\log f(q_i,q_j)}{\partial q_i}-(-\frac{\partial\log f(q_i,q_i)}{\partial q_i})]}{1+\sum_{j\neq i}\frac{N_j}{N_i}d_{ij}^{1-\sigma}[\frac{f(q_i,q_j)}{f(q_i,q_i)}]^{1-\sigma}} \tag{3.2.9}$$

Before we proceed to the role of intrinsic openness in determining institutional quality, we note that if institutional quality were to affect international trade and domestic trade equally: $-\frac{\partial\log f(q_i,q_j)}{\partial q_i}=-\frac{\partial\log f(q_i,q_i)}{\partial q_i}$, then the second term of the right hand side is 0, and population and distance would have been irrelevant for determining institutional quality.

Assume that $f(q_i,q_j)$, $i\neq j$ is separable (log-additive[6], or in a two-country setting: home and rest of the world, we don't need this assumption.)

$$f(q_i,q_j)=f_1(q_i)f_2(q_j).$$

Then we have the following

$$\frac{1}{1-\alpha}\frac{\phi\prime(q_i)}{1-\phi(q_i)}=-\frac{\partial\log f(q_i,q_i)}{\partial q_i}$$

$$+\frac{\sum_{j\neq i}\frac{N_j}{N_i}d_{ij}^{1-\sigma}[\frac{f(q_i,q_j)}{f(q_i,q_i)}]^{1-\sigma}}{1+\sum_{j\neq i}\frac{N_j}{N_i}d_{ij}^{1-\sigma}[\frac{f(q_i,q_j)}{f(q_i,q_i)}]^{1-\sigma}}[-\frac{\partial\log f(q_i,q_j)}{\partial q_i}-(-\frac{\partial\log f(q_i,q_i)}{\partial q_i})] \tag{3.2.10}$$

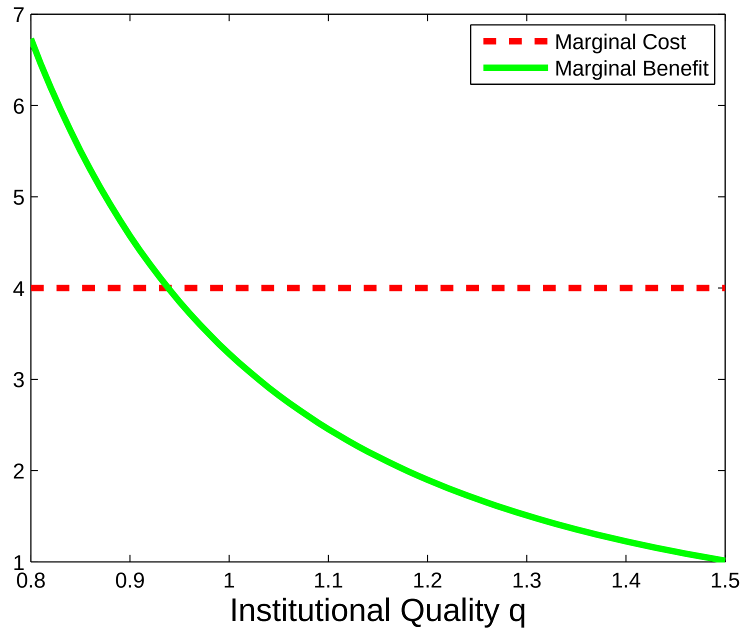
See Figure 3.1 for a numerical example of equilibrium determination. Conducting comparative statics offers the following insights.

Proposition 11. ***(Population)*** *Holding everything else equal, a smaller country (smaller N_i) chooses to invest in better institutional quality.*

Proof. The second term of the right hand side increases when N_i decreases. Therefore, the marginal return from better institutional quality goes up. In equilibrium, smaller N_i country displays higher institutional quality q_i. □

[6] In the Appendix, when we test gravity equation with institutional quality, if we include an interaction term $q_i * q_j$, it is hard to reject the coefficient before the interaction term is 0.

Figure 3.1: Determination of Institutional Quality - Numerical Example



Notes: this figure displays a numerical example of the equilibrium determination of institutional quality. Consider home country i, and the rest of the world$j$. Institutional quality$q \in (0, +\infty)$. For simplicity, set foreign $q_j = +\infty$.

$$\phi(q) = 1 - e^{-\gamma q}, \ f(q_i, q_j) = e^{\frac{\pi_i}{q_i}} e^{\frac{\pi_j}{q_j}}, \ f(q_i, q_i) = e^{\frac{\pi}{q_i}}$$

where $\pi_i > \pi$ to ensure **Assumption 2** is satisfied. The first order condition is then read as

$$\frac{\gamma}{1-\alpha} = e^{\frac{\pi_i}{q_i}} \frac{\pi_i}{q_i^2} + \frac{\frac{N_j}{N_i} d_{ij}^{1-\sigma} e^{\frac{\pi_i - \pi}{q_i}(1-\sigma)}}{1 + \frac{N_j}{N_i} d_{ij}^{1-\sigma} e^{\frac{\pi_i - \pi}{q_i}(1-\sigma)}} [e^{\frac{\pi_i}{q_i}} \frac{\pi_i}{q_i^2} - e^{\frac{\pi}{q_i}} \frac{\pi}{q_i^2}]$$

The left hand side is a constant. The right hand side is strictly decreasing if $\frac{N_j}{N_i} d_{ij}^{1-\sigma} e^{\frac{\pi_i - \pi}{q_i}(1-\sigma)}$ or $[e^{\frac{\pi_i}{q_i}} \frac{\pi_i}{q_i^2} - e^{\frac{\pi}{q_i}} \frac{\pi}{q_i^2}]$ is small enough so that the monotonicity of the first term of the right hand side dominates. Parameter values are $\alpha = 0.5, \gamma = 2, \pi_i = 1.05, \pi = 1; N_j = 100, N_i = 1, \sigma = 1.5, d_{ij} = 1.1$.

Proposition 12. ***(Geography)*** *Holding everything else equal, a country that is nearer to the rest of the world economy (smaller d_{ij}) tends to choose better institutional quality.*

Proof. The second term of the right hand side increases when d_{ij} decreases. Therefore, the marginal return from better institutional quality goes up. In equilibrium, smaller d_{ij} country displays higher institutional quality q_i. □

The intuition of the above two propositions is as follows: the welfare of an intrinsically more open country (with either a smaller N_i or a smaller d_{ij}) has a larger part coming from international trade. As international trade is more sensitive to institutional quality compared to domestic trade, bad institutional quality will do more damage to such a country. Therefore, an intrinsically more open economy has a stronger incentive to improve institutional quality.

Corollary (**Globalization**) Trade liberalization facilitates institutional quality upgrading.

Proposition 13. ***(Complementarity)*** *Improvement in foreign institutional quality induces improvement in domestic institutional quality.*

Proof. County j institutional upgrading decreases $f(q_i, q_j)$ thus also increases the second term of the right hand side. In equilibrium, higher q_j increases q_i. □

Since those foreign countries that are geographically close have a bigger weight in a country's trade, the above proposition would generate spatial correlation in institutional quality. That is, one tends to see a cluster of adjacent countries with similar quality of institutions.

The assumption that international trade is more sensitive to institutional quality compared to domestic trade is crucial. If we were to reverse this assumption, Proposition 1-3 would have been reversed too. As we show in Appendix C2, data supports the assumption that international trade is more sensitive to institutional quality than domestic trade.

3.2.4 Political Economy Considerations

The previous propositions are derived from a social planner's optimization problem. Without heterogeneity across agents in a country, everyone would make the same choice as the social planner. To highlight the potential conflict of interest across agents in selecting the quality of institutions, we now introduce capital (as another exogenous element of endowment, in the spirit of the Heckscher-Ohlin model of trade) and inequality of capital endowment. Inequality of capital among individuals or households has been emphasized in the Piketty (2014) book on income inequality.

Suppose the economy has total capital K_i where agent s in country i holds k_i^s and is endowed with a unit of labor as before. Household utility is still assumed to be

$$u_i = \log H_i$$

where H_i is the consumption of final good. The final good consumption is revised to

$$H_i = Y_i^{\alpha} M_i^{1-\alpha}$$

with Y_i the consumption of freely traded homogeneous good and M_i produced by using domestic capital K_i and differentiated good X_{ij} from country j. A continuum of M_i producers master the following production technology

$$M_i = K_i^{\beta}[(\sum_{j \in N} N_j X_{ij}^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}]^{1-\beta} \tag{3.2.11}$$

Since Mauro (1995) finds that corruption reduces investment rate, we interpret it as evidence that bad institutions damage capital returns, although we do not model explicitly capital accumulation. To represent this idea, we assume that bad institutional quality imposes a tax on capital income. Formally, good M_i producer's profit maximization problem is

$$\max_{\{K_i, X_{ij}\}} P_{Mi} K_i^{\beta} [(\sum_{j \in N} N_j X_{ij}^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}]^{1-\beta} - R_i K_i \tau_i^K - \sum_{j \in N} N_j X_{ij} \tau_{ij} \tag{3.2.12}$$

where R_i is the return to capital owners but $\tau_i^K R_i \geq R_i$ is the cost to capital users. τ_i^K will be a function of institutional quality just as τ_{ij}.

The total income of the economy is the sum of capital income and labor income

$$R_i K_i + A_i L_i \tag{3.2.13}$$

Due to the Cobb-Douglas properties, we know that $(1-\alpha)\beta$ fraction of nominal income is spent on total capital input, so

$$(1-\alpha)\beta[R_i K_i + A_i L_i] = R_i K_i \tau_i^K \tag{3.2.14}$$

which solves capital return

$$R_i = \frac{(1-\alpha)\beta A_i}{\tau_i^K - (1-\alpha)\beta} \frac{L_i}{K_i}. \tag{3.2.15}$$

Intuitively, when capital is scarce (large $\frac{L_i}{K_i}$ ratio), capital return is high. On the other hand, if the iceberg cost (i.e. τ_i^K) is high, the capital return is low.

It follows that the price index of the final good in this economy is now changed to

$$P_i = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}\{\beta^{-\beta}(1-\beta)^{-(1-\beta)}(R_i \tau_i^K)^{\beta}[\sum_{j \in N} N_j \tau_{ij}^{1-\sigma}]^{\frac{1-\beta}{1-\sigma}}\}^{(1-\alpha)} \tag{3.2.16}$$

Therefore, if to obtain a given level of institutional quality q_i, each agent needs to contribute $1-\phi(q_i)$ of her income, agent s' utility after paying for the investment in institutional quality is

$$v_i^s = \log \frac{(R_i k_i^s + A_i)(1-\phi(q_i))}{P_i} = const + \log(1-\phi(q_i)) + \log(R_i k_i^s + A_i)$$

$$-\beta(1-\alpha)\log(R_i\tau_i^K)+\frac{(1-\alpha)(1-\beta)}{\sigma-1}\log(\sum_{j\in N}N_j\tau_{ij}^{1-\sigma}) \tag{3.2.17}$$

Note that if $\beta = 0$, we go back to the benchmark model without capital. The first order condition with respect to q_i is

$$\frac{\phi\prime(q_i^s)}{1-\phi(q_i^s)}=(1-\alpha)(1-\beta)\frac{\sum_{j\in N}N_jd_{ij}^{1-\sigma}f^{1-\sigma}(q_i^s,q_j)[-\frac{\partial\log f(q_i^s,q_j)}{\partial q_i^s}]}{\sum_{j\in N}N_jd_{ij}^{1-\sigma}f^{1-\sigma}(q_i^s,q_j)}$$

$$-\beta(1-\alpha)\frac{\partial\log[\frac{\tau_i^K}{\tau_i^K-(1-\alpha)\beta}]}{\partial q_i^s}+\frac{\partial\log(1+\frac{(1-\alpha)\beta}{\tau_i^K-(1-\alpha)\beta}\frac{k_i^s}{K_i/L_i})}{\partial q_i^s} \tag{3.2.18}$$

Inspecting the last term of the equation above reveals that a larger $\frac{k_i^s}{K_i/L_i}$ means a higher marginal return from improving institutional quality. This translates into a preference for better institutional quality.

Because lower institutional quality reduces capital returns, agents with a higher level of capital endowment suffer more from a given level of poor institutional quality. Suppose institutional quality is determined by the median voter, then higher inequality of capital endowment across individuals reduces the median voter's capital endowment, which leads to worse institutional quality. Formally,

Proposition 14. ***(Capital Inequality)*** *Holding everything else equal, a country with a smaller ratio of median voter capital to average capital* $\frac{k_i^m}{K_i/L_i}$*, displays worse institutional quality chosen by the median voter.*

Proof. The decrease in the ratio of median voter capital to average capital shifts down the marginal benefit line of institutional quality. □

3.3 Cross-Sectional Evidence

We now turn to empirical evidence, staring with cross-country data patterns. We first look at whether the intrinsic openness explains the institutional quality across countries. These are the key predictions of our story. In this part, we also add various controls which are shown to help explain institutional quality in the existing literature.

We also add inequality of income (Gini coefficient) as a regressor. This is meant to serve two purposes: (a) to check if the data patterns are consistent with the prediction of the political economy extension of the model, and (b) to check if the relationship between intrinsic openness and institutional quality survives after one controls for income inequality. An important caveat is that we do not have an instrumental variable for the Gini coefficient, so this part of the evidence should be treated only as suggestive.

3.3.1 Data Description

For cross-sectional evidence, we choose the values of institutional quality and other variables in 2005. In general, institutional quality is persistent (the relative ranks across countries exhibit strong persistence). Thus, for cross sectional regressions, it does not matter much which specific year one takes. Year 2005 is chosen so that the key variables are available for a relatively large number of countries.

We drop countries with fewer than 0.5 million population because data quality is often poor for very small countries and measurement errors could be large[7]. We also use two different thresholds: 0.2 million or 1 million, and find that our main results are robust.

Table 3.1 reports the summary statistics of the variables used in the regressions. We are left with 150 economies although not every country has data for all variables. We

[7]We further drop Serbia, Kosovo, Montenegro, East Timor, and North and South Sudan, as these relatively new countries have a short history and potentially less reliable data. We drop West Bank and Gaza Strip because of a lack of reliable data.

explain the data in detail below.

3.3.1.1 Institutional Quality Measures

We use five measures of institutional quality: (1) political risk index from International Country Risk Guide, abbreviated as ICRG, (2) the corruption perception index from Transparency International, abbreviated as TI, (3) control of corruption from the World Bank's World Governance Indicators, abbreviated as WGI, and (4) government effectiveness from WGI[8], (5) expropriation risk, which is the Investment Profile component of the political risk index. All indices are constructed in such a way that a higher score means better institutional quality.

The political risk index takes on a value between 0 and 100, and is meant to capture eleven aspects of a country's institutional quality: (A) Government Stability, a maximum of 12 points; (B) Socioeconomic Conditions, 12 points; (C) Investment Profile, 12 points; (D) Internal Conflict, 12 points; (E) External Conflict, 12 points; (F) Corruption, 6 points; (G) Military in Politics, 6 points; (H) Religious Tensions, 6 points; (I) Law and Order, 6 points; (J) Ethnic Tensions, 6 points; (K) Democratic Accountability, 6 points; (L) Bureaucracy Quality, 4 points[9]. The political risk index is the sum of these 11 sub-indices, and covers 140 countries in 2005.

The corruption perception index, constructed by Transparency International, a Berlin-based non-profit organization devoted to fight corruption worldwide, is derived by combining information from polls on corruption by a variety of reputable institutions. For an economy to be included in the CPI data, it needs to be included in a minimum of three data sources[10]. The CPI index in 2005 covers 159 countries.

[8] WGI has 6 measures of institutional quality. Other measures such as rule of law and regulatory quality suggest similar empirical results, and are omitted to save space.

[9] See the following link for a more detailed description, including the sub-components of each component https://www.prsgroup.com/wp-content/uploads/2012/11/icrgmethodology.pdf

[10] Please refer to the link below for more details:
http://www.transparency.org/research/cpi/cpi_2005/0/

Table 3.1: Summary Statistics on Intrinsic Openness and Institutional Quality

Variable	Obs	Mean	Std. Dev.	Min	Max	Median
PR Index	122	66.79	12.55	26	93.5	66.5
CPI	140	3.83	2.03	1.7	9.6	3
ctr corrupt	150	-0.21	0.97	-1.68	2.35	-0.44
gvnment	150	-0.20	0.98	-2.17	2.16	-0.88
exprop risk	122	8.80	2.36	1.5	12	8.75
log(population)	150	16.06	1.38	13.31	20.84	16.02
remoteness	150	8.98	0.30	7.96	9.55	8.98
landlock dummy	150	0.22	0.42	0	1	0
coastline length/area	150	0.038	0.094	0	0.91	0.0059
common law dummy	150	0.26	0.44	0	1	0
mortality rate	59	0.26	0.49	0.00086	2.94	0.078
import/GDP (%)	148	47.32	28.57	9.54	211.27	42.72
fuel export fraction	120	18.56	27.89	0	98.03	5.40
Gini	62	38.93	9.74	16.64	59.51	38.41
GDP per capita	147	10535.98	16398	205.07	88519.09	3517.75
trade/GDP (%)	148	45.22	26.29	13.54	211.17	40.86

Notes: This table reports relevant variables' summary statistics for the sample we use in the cross sectional regressions. It utilizes year 2005 data. PR index is political risk index which falls into [0,100]; CPI is Corruption Perception Index which falls into [0,10]; ctr corrupt is control of corruption which falls into [-2.5,+2.5], gvnment is government effectiveness which falls into [-2.5,2.5]; exprop risk is expropriation risk (investment profile item in Political Risk Index) which falls into [0, 12]; remoteness' unit is km; coastline length/area's unit is km/sq. km^2. Mortality rate (per person) is taken from Acemoglu, Johnson and Robinson (2001). Fuel export fraction is with respect to total merchandise export, computed in WDI using Comtrade data. Gini index is income Gini. GDP per capita is measured at constant 2010 US dollars. We don't find Korea, D.P.R. and Somalia GDP data in year 2005 or around 2005 from WDI, and import/GDP, trade/GDP and GDP per capita data are also missing for these two countries. There is no Syrian GDP per capita in terms of 2010 US dollars data in WDI. Another note is Myanmar import/GDP and export/GDP data experience a more than 100 times jump from before 2011 to after 2012 in World Bank database. The import/GDP and export/GDP are too low before 2011. For example, in 2005, import/GDP is 0.95% and export/GDP is 0.18%. We suspect there is a data error and contact World Bank staff. The problem lies in the fact that they take Myanmar trade data from IMF but there is a huge difference in the exchange rate between the World Bank measure and the IMF measure for Myanmar. In the IMF data, there is a more than around 100 times jump in exchange rate from 2011 to 2012. So here we simply multiply Myanmar import/GDP and export/GDP by 100 in year 2005 as a rough estimate (the minimum of trade/GDP in the table is Myanmar even after we multiply its number by 100.) All our results remain virtually unchanged by excluding Myanmar directly.

Control of corruption reflects the extent to which public power is perceived to be exercised for private gains. According to the World Bank Institute, the notion of corruption here includes both petty and grand forms of corruption, as well as “capture" of the state by elites and private interests. This index is also constructed from a variety of available indices[11], and covers 207 economies in 2005.

Government effectiveness by the World Bank Institute is meant to measure quality of public services, quality of the civil service, and the degree of civil services' independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The WGI builds the index from various data sources and covers 208 economies in 2005 (the broadest country coverage among all indices).

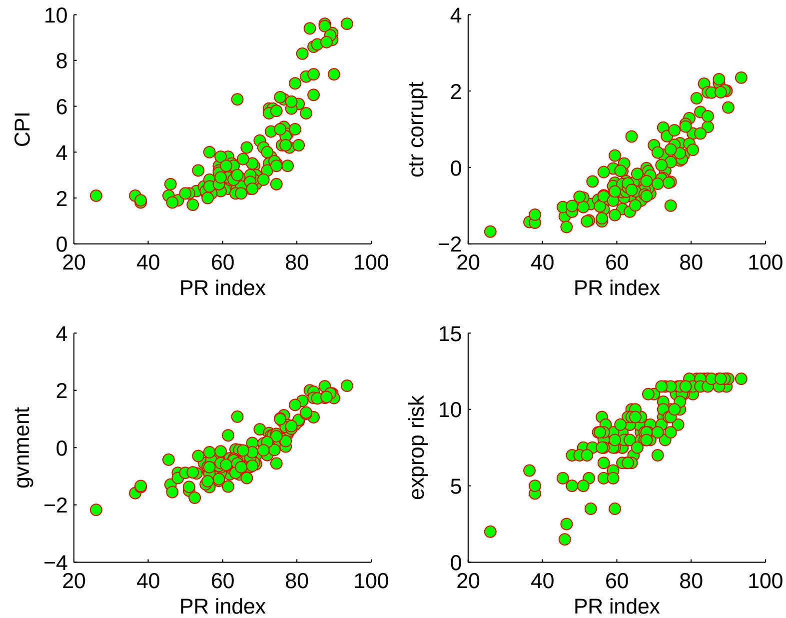
Besides these broad indices, we will also examine the role of a narrower indicator - expropriation risk - which is a component of the political risk index. It assigns 12 points to 3 sub-components: (1) Contract Viability/Expropriation, 4 points; (2) Profits Repatriation, 4 points; and (3) Payment Delays, 4 points.

These measures are, unsurprisingly, highly correlated. At the same time, the correlation is less than perfect, reflecting some non-overlapping dimensions of institutional quality that each index aims to capture. Table 3.2 reports the pairwise correlations among the 5 measures. The lowest correlation is 0.7. In Figure 2, we visualize the relationship among these measures. Each graph plots other institutional quality measures against political risk index.

All measures are potentially relevant for our story. At the same time, since the political risk index is most comprehensive in capturing different aspects of institutional quality, we will use it as the baseline measure of institutional quality.

[11] The link below describes the World Governance Indicators:
http://info.worldbank.org/governance/wgi/#doc

Figure 3.2: The Political Risk Index and Other Institutional Quality Measures



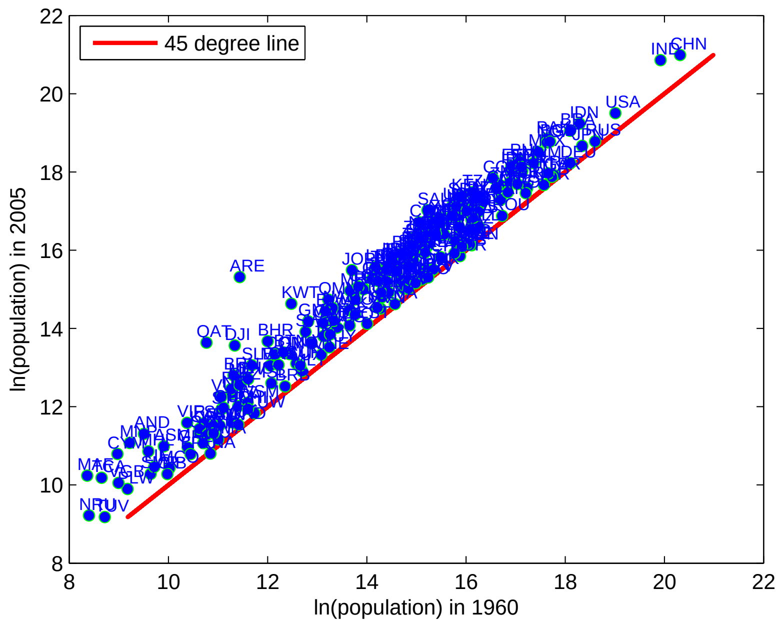
Notes: this figure displays the raw data of other measures of institutional quality against political risk index (year 2005). Each point represents a country. From left to right, top to down, the order is Corruption Perception Index, Control of Corruption, Government Effectiveness and Expropriation Risk, all against Political Risk Index.

3.3.1.2 Intrinsic Openness Variables

We consider four aspects of intrinsic openness. The first one is population. Frankel and Romer (1999) document that a larger population reduces actual openness (trade/GDP ratio). One may be concerned about whether population size is "sticky" enough to work as a characteristic of a country. In Figure 3.3, we plot log(population) in year 2005 against the value in year 1960; one can see a high degree of correlation (>0.97) over this span of 50 years. In other words, the country ranking in terms of population tends to persistent.

The second one is remoteness to the world market (see Wei, 1996, for an early exposition of the concept). We take G7 countries (Canada, France, Germany Italy, Japan, United Kingdom, United States) and China as the world market. The remoteness of a small open

Figure 3.3: Ln(population) in 2005 versus 1960



Notes: this figure displays the raw data of ln(population) in year 2005 against that in year 1960. The red line is the 45 degree line. The correlation between ln(population) in year 2005 and 1960 is 0.978. Our cross sectional regressions' results remain valid if we drop the two outliers ARE (United Arab Emirates) and QAT (Qatar) in the above figure.

economy i is defined as follows:

$$remoteness_i = \sum_{j=1}^{8} w_j \log(d_{ij})$$

where j denotes G7 countries and China. $w_j = \frac{trade_j}{\sum_{k=1}^{8} trade_k}$ is the international trade share of big country j in total international trade volume of G7 and China, where $trade_j = \frac{import_j + export_j}{2}$ and d_{ij} is the great-circle distance between country i and j. Finally, variable landlock dummy=1 if the country is landlocked, otherwise, it takes value 0. Variable coast/area is constructed as coastline length divided by land area. There are overlaps in landlock dummy and coastline length/area as they by and large capture similar geographic characteristics. We also notice that there are only 22 landlocked countries in the sample. Table 3.3 shows the pairwise correlation matrix between different dimensions of intrinsic openness. The correlations between intrinsic openness variables are in general very low.

3.3.1.3 Other Control Variables

Following the existing literature, we identify and control for other variables that might affect institutional quality. Legal origin, and having a common law tradition in particular, is said to be associated with stronger protection of property rights than other legal traditions (La Porta, Lopez-de-Silanes, and Shleifer, 2008). We include a dummy for countries with a common law system, which essentially are former British colonies.

Acemoglu, Johnson and Robinson (2001) argue that the mortality rate of European settlers more than a century ago is a key determinant of institutional quality today. So we include mortality rate (its logarithm as they do) as a second control variable. Note that the AJR sample size is small. In order not to lose too much information when we include mortality rate, we define a variable called dummy mortality rate availability which takes value 1 if there exists mortality rate data, otherwise it takes value 0.

Ades and Di Tella (1999) suggest that a higher import/GDP ratio of an economy means more competition and fewer rent seeking opportunities. We will include the import/GDP ratio as a control.

One version of the "natural resource curse" theory hypothesizes that abundance of natural resources provides a strong incentive for "strong men" to seize power and hold onto power via undemocratic means in order to benefit from the wealth associated with the sale of natural resources. Sachs and Warner (1995) confirm a robustly negative association between natural resource abundance and growth. Leite and Weidmann (1999) provide evidence that natural resource abundance induces more rent seeking behavior. We use fuel exports as a fraction of total merchandise exports, “fuel export frac," to capture the dominance of natural resources in an economy.

In our theory, both institutional quality and income level (GDP per capita) are determined by intrinsic openness. (We know institutional quality and income are highly

Table 3.2: Pairwise Correlation Matrix: Institutional Quality

	PR index	CPI	ctr corrupt	gvnment	exprop risk
PR index	1.0000				
CPI	0.8072	1.0000			
ctr corrupt	0.8592	0.9556	1.0000		
gvnment	0.8857	0.9163	0.9454	1.0000	
exprop risk	0.8622	0.7040	0.7679	0.8099	1.0000

Notes: this table reports the summary statistics of pairwise correlation between 5 institutional quality measures. Variables PR index, CPI, ctr corrupt, gvnment, and exprop risk represent five measures of institutional quality by order: Political Risk index, Corruption Perception Index, Control of Corruption, Government Effectiveness and Expropriation Risk.

Table 3.3: Pairwise Correlation Matrix: Intrinsic Openness

	log(population)	remoteness	landlock	coast/area
log(population)	1.0000			
remoteness	-0.1181	1.0000		
landlock	-0.1144	0.0274	1.0000	
coast/area	-0.2137	-0.1470	-0.2129	1.0000

Notes: this table reports the summary statistics of pairwise correlation between 4 intrinsic openness measures. Variable remoteness is weighted log distance to G7 and China, landlock is landlock dummy, and variable coast/area is coastline length divided by land area.

correlated.) We decompose income into a component that is a linear function of intrinsic openness and a second component that is orthogonal to intrinsic openness. We will use the orthogonal component of income as a control variable as well.

3.3.2 Evidence on the Key Predictions

We start with cross-sectional evidence, and our main regressions use the following specification:

$$\begin{aligned} q_i &= \beta_0+\beta_1 \log(population_i) + \beta_2 remoteness_i+\beta_3 landlock\_dummy_i \\ &\quad +\beta_4 coast/area_i+\delta X_i'+\epsilon_i \end{aligned} \tag{3.3.1}$$

where q_i is institutional quality and X' is a set of controls. Tables 3.4 - 3.6 report the estimation with 5 institutional quality measures.

In Column 1 of Table 3.4, we have population and remoteness as the only regressors. Both coefficients on these regressors are negative and statistically significant at the 1% level. A negative coefficient on log population indicates that a larger population is associated with poorer quality of public institutions (or a higher political risk). (Recall that a higher value of the political risk index means a lower level of political risk.). The coefficient on log distance means that a decrease in a country's distance to the world market by one percent is associated with an improvement in political risk by 0.15 percent. For example, should Paraguay (whose remoteness value is 9.48) be relocated to where Republic of Korea is (whose remoteness is 7.96), its political risk index would improve by 23 points, roughly to the level of Spain.

In Columns 2-4 of Table 3.4, we add a landlock dummy or (and) the ratio of coastline length/area. The signs of the new coefficients are always as expected from the theory, namely, being landlocked is associated with worse institutional quality, and a longer coastline for a given area size is associated with higher institutional quality. While the ratio of coastline length/area is significant at the 10% level, the landlock dummy is not.

In Columns 5-8, we add a common law dummy, mortality rate (or earlier European settlers), import/GDP ratio, and fuel exports (as a fraction of total merchandise exports) as controls. We find that both mortality rate and fuel exports are significantly detrimental to institutional quality (consistent with the arguments in Acemoglu, Johnson, and Robinson, 2001, and Leite and Weidmann, 1999). On the other hand, the common law dummy, suggesting that the legal origin hypothesis is not robustly supported by the data in the context of institutional quality. The ratio of import/GDP is not significant either. Indeed, the negative sign on the import/GDP ratio is not consistent with the prediction of Ades and Di Tella (1999), once a set of measures of a country's intrinsic openness is included.

In Column 9, we include all four control variables together, along with four intrinsic openness variables. Three of the intrinsic openness measures (population size, remoteness, and the landlock dummy) are statistically significant, and all four measures have signs that are consistent with the theoretical predictions. As an illustration of the magnitude of the estimates, if Zambia were not landlocked, its political risk index would have been improved to Romania's score. In this expanded specification, both mortality rate and fuel exports remain significant.

Because intrinsic openness could raise income by improving institutions in our theory, we attempt to extract a part of per capita GDP that is not explained by our intrinsic openness measures and include it as a control variable. In particular, we first regress log GDP per capita on the four measures of intrinsic openness, and denote the residuals from the regression as $e\_log(GDPC)$. We then add this to the list of control variables in the political risk regression, and report the results in Column 10. A positive sign on $e\_log(GDPC)$ suggests that income has an independent influence on the quality of public institutions. Perhaps as a country becomes richer, it can better afford to invest in public institutions, including paying civil servants better.

In Tables 3.5 and 3.6, we substitute the left hand side variable, the political risk index, by the corruption perception index, control of corruption, government effectiveness, and expropriation risk, respectively. We draw similar conclusions on intrinsic openness measures. Both population and remoteness have the expected signs, and are robustly significant in almost all the columns. The landlock dummy and the ratio of coastline length/area are not always significant, though they almost always have the expected signs. Note that landlocked economies are often small economies with data problems. Among the 22 landlocked economies in the world, 13 of them lack data on institutional quality to be included in our regressions.

When we use control of corruption and government effectiveness as institutional quality measures where we have full coverage of 150 countries, in the columns with a full set of control variables (with or without $e\_log(GDPC)$), both landlock dummy and coastline length/area are statistically significant.

Finally, in Table 3.5 and Table 3.6, common law dummy is not robust but its sign is always positive and it sometimes becomes significant. Mortality rate and fuel export fraction decreases institutional quality. But there is no evidence that larger import/GDP ratio improves institutions.

3.3.3 Income Inequality and Institutional Quality

In the second part of the theory in Section 2, we presented a political economy extension of the basic model that features heterogeneity in capital endowment (which might be proxied by income or wealth equality). The prediction of the model is that higher inequality leads to worse institutional quality. We now add income inequality as measured by a Gini coefficient of income distribution to the model. (We are not able to use wealth inequality due to a lack of data.)

The results are reported in Table 3.7. The coefficient on the Gini variable is negative and significant. This is consistent with the theoretical prediction that inequality leads the society to invest less in institutional building. Since inequality could be endogenous and we do not have an instrumental variable strategy for it, this result should only be regarded as suggestive.

Note that the four dimensions of intrinsic openness (population, remoteness, ratio of coastal length/area size, and a landlock dummy) have essentially the same signs and significance levels as before. We thus conclude that the effects of intrinsic openness on institutional quality are not qualitatively affected by the control of income inequality or political economy considerations.

3.4 Long Differences: Exogenous Changes in Intrinsic Openness

The results reported previously are cross-sectional evidence. By necessity, such analysis cannot control for country fixed effects. This is not unusual in the literature on this topic,

Table 3.4: Intrinsic Openness and Political Risk Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(
	PR index	PR index	PR index	PR index	PR index	PR index	PR index	PR index	PR index	PR
log(population)	-3.041***	-3.103***	-2.792***	-2.858***	-2.882***	-2.792***	-3.190***	-3.105***	-3.192***	-2.
	(0.627)	(0.618)	(0.636)	(0.626)	(0.630)	(0.625)	(0.650)	(0.578)	(0.591)	(0
remoteness	-15.268***	-15.156***	-13.977***	-14.007***	-14.882***	-10.843**	-16.759***	-12.303***	-10.426**	-12
	(3.980)	(3.994)	(4.089)	(4.094)	(4.417)	(5.016)	(3.598)	(3.113)	(4.425)	(3
landlock dummy		-2.683		-1.927	-1.958	-1.838	-2.506	-4.380*	-4.595**	-6.
		(2.353)		(2.380)	(2.374)	(2.547)	(2.254)	(2.460)	(2.317)	(1
coast/area			17.051*	15.578*	12.989	8.835	17.990**	11.813	13.832	10
			(8.840)	(8.307)	(9.033)	(8.445)	(8.658)	(7.263)	(8.999)	(5
common law dummy					1.966				0.988	1
					(2.456)				(2.236)	(1
log(mortality rate)						-4.022***			-3.195**	-(
						(1.188)			(1.243)	(1
import/GDP							-0.045		-0.061*	0
							(0.035)		(0.031)	(0
fuel export frac								-0.042*	-0.061**	-0.
								(0.025)	(0.025)	(0
e_log(GDPC)										5.
										(0
mortality rate avail						-11.518***			-11.204***	-1
						(3.602)			(3.385)	(3
fuel export frac avail								16.351***	11.902***	6.
								(3.212)	(3.128)	(2
Observations	122	122	122	122	122	122	120	122	120	
R^2	0.232	0.238	0.248	0.251	0.256	0.328	0.314	0.427	0.498	0

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of political risk index against intrinsic openness measures. Variable mortality rate avail equals 1 if there is mortality rate data and equals 0 otherwise. Variable fuel export frac avail equals 1 if there is fuel export fraction (of total merchandise export) data and equals 0 otherwise. Variable $e\_log(GDPC)$ is the residual after projecting log(GDP per capita) on four intrinsic openness variables.

Table 3.5: Intrinsic Openness and Corruption Perception Index, Control of Corruption

	(1) CPI	(2) CPI	(3) CPI	(4) CPI	(5) ctr corrupt	(6) ctr corrupt	(7) ctr corrupt	(8) ctr corrupt
log(population)	-0.392***	-0.320***	-0.409***	-0.233**	-0.159***	-0.121***	-0.173***	-0.127***
	(0.093)	(0.092)	(0.112)	(0.090)	(0.044)	(0.045)	(0.048)	(0.042)
remoteness	-2.048***	-1.566**	-1.355**	-1.717***	-0.864***	-0.708**	-0.726**	-0.848***
	(0.646)	(0.628)	(0.655)	(0.488)	(0.313)	(0.305)	(0.299)	(0.224)
landlock dummy		-0.430	-0.513	-0.633**		-0.173	-0.289*	-0.329***
		(0.344)	(0.355)	(0.259)		(0.169)	(0.165)	(0.126)
coast/area		6.429***	5.765***	5.131***		2.753***	2.181***	2.149***
		(2.103)	(2.088)	(1.282)		(0.827)	(0.801)	(0.470)
common law dummy			0.297	0.241			0.186	0.142
			(0.312)	(0.225)			(0.151)	(0.114)
log(mortality rate)			-0.600**	-0.112			-0.255**	-0.016
			(0.230)	(0.162)			(0.101)	(0.071)
import/GDP			-0.011	0.002			-0.004	0.001
			(0.007)	(0.004)			(0.003)	(0.002)
fuel export frac			-0.010*	-0.015***			-0.006**	-0.008***
			(0.005)	(0.004)			(0.002)	(0.002)
e_log(GDPC)				1.029***				0.485***
				(0.111)				(0.048)
mortality rate avail			-1.618***	-0.289			-0.681***	-0.047
			(0.494)	(0.391)			(0.228)	(0.175)
fuel export frac avail			1.393***	0.409			0.867***	0.393**
			(0.285)	(0.315)			(0.161)	(0.152)
Observations	140	140	139	138	150	150	148	147
R^2	0.141	0.241	0.386	0.672	0.107	0.189	0.389	0.697

Standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of corruption perception index and control of corruption against intrinsic openness measures. Variable mortality rate avail equals 1 if there is mortality rate data and equals 0 otherwise. Variable fuel export frac avail equals 1 if there is fuel export fraction (of total merchandise export) data and equals 0 otherwise. Variable $e\_log(GDPC)$ is the residual after projecting log(GDP per capita) on four intrinsic openness variables.

Table 3.6: Intrinsic Openness and Government Effectiveness, Expropriation Risk

	(1) gvnment	(2) gvnment	(3) gvnment	(4) gvnment	(5) exprop risk	(6) exprop risk	(7) exprop risk	(8) exprop risk
log(population)	-0.095**	-0.060	-0.128***	-0.080**	-0.474***	-0.431***	-0.543***	-0.396***
	(0.043)	(0.043)	(0.044)	(0.034)	(0.128)	(0.126)	(0.133)	(0.119)
remoteness	-1.122***	-0.975***	-1.150***	-1.265***	-2.227***	-1.947**	-2.159**	-2.590***
	(0.327)	(0.324)	(0.279)	(0.194)	(0.754)	(0.774)	(0.990)	(0.877)
landlock dummy		-0.198	-0.338**	-0.381***		-0.359	-0.715	-1.079**
		(0.165)	(0.153)	(0.101)		(0.572)	(0.565)	(0.475)
coast/area		2.578***	1.606*	1.564***		3.496**	2.997	2.342
		(0.913)	(0.864)	(0.504)		(1.441)	(2.181)	(1.733)
common law dummy			0.293**	0.247***			0.561	0.577*
			(0.137)	(0.088)			(0.420)	(0.346)
log(mortality rate)			-0.269***	-0.030			-0.353*	0.203
			(0.086)	(0.053)			(0.201)	(0.187)
import/GDP			-0.004	0.001			-0.013*	0.000
			(0.003)	(0.001)			(0.008)	(0.006)
fuel export frac			-0.007***	-0.009***			-0.008	-0.010
			(0.002)	(0.002)			(0.008)	(0.008)
e_log(GDPC)				0.482***				1.042***
				(0.037)				(0.148)
dummy mortality rate			-0.615***	0.008			-1.036	0.703
			(0.211)	(0.149)			(0.649)	(0.721)
dummy fuel export frac			0.963***	0.492***			1.664**	0.671
			(0.154)	(0.132)			(0.716)	(0.543)
Observations	150	150	148	147	122	122	120	119
R^2	0.124	0.199	0.468	0.778	0.149	0.174	0.317	0.545

Standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of government effectiveness and expropriation risk against intrinsic openness measures. Variable mortality rate avail equals 1 if there is mortality rate data and equals 0 otherwise. Variable fuel export frac avail equals 1 if there is fuel export fraction (of total merchandise export) data and equals 0 otherwise. Variable *e_log*(*GDPC*) is the residual after projecting log(GDP per capita) on four intrinsic openness variables.

Table 3.7: Gini and Institutional Quality

	(1) PR index	(2) PR index	(3) CPI	(4) CPI	(5) ctr corrupt	(6) ctr corrupt	(7) gvnment	(8) gvnment	(9) exprop risk	(10) exprop risk
log(population)		-2.412***		-0.230**		-0.126***		-0.076**		-0.393***
		(0.499)		(0.089)		(0.044)		(0.034)		(0.115)
remoteness		-9.851***		-1.198**		-0.652***		-1.046***		-2.062**
		(3.371)		(0.477)		(0.242)		(0.200)		(0.819)
landlock dummy		-6.542***		-0.602**		-0.308**		-0.359***		-1.105**
		(1.579)		(0.259)		(0.123)		(0.104)		(0.472)
coast/area		11.121**		5.253***		2.140***		1.641***		2.308
		(4.700)		(1.320)		(0.479)		(0.513)		(1.682)
common law dummy		0.054		0.040		0.067		0.204**		0.327
		(1.966)		(0.227)		(0.116)		(0.092)		(0.370)
log(mortality rate)		-0.446		-0.148		-0.036		-0.054		0.179
		(1.074)		(0.151)		(0.065)		(0.050)		(0.188)
import/GDP		0.008		0.002		0.001		0.001		0.001
		(0.020)		(0.004)		(0.002)		(0.001)		(0.006)
fuel export frac		-0.076***		-0.015***		-0.008***		-0.009***		-0.011
		(0.022)		(0.004)		(0.002)		(0.002)		(0.007)
Gini	-0.627***	-0.320***	-0.093***	-0.057***	-0.044***	-0.025***	-0.048***	-0.023***	-0.103***	-0.063***
	(0.130)	(0.092)	(0.028)	(0.020)	(0.013)	(0.008)	(0.012)	(0.007)	(0.024)	(0.023)
e_log(GDPC)		5.582***		1.026***		0.486***		0.474***		1.079***
		(0.555)		(0.112)		(0.049)		(0.038)		(0.134)
mortality rate avail		-0.859		-0.128		0.021		0.043		0.954
		(3.338)		(0.376)		(0.167)		(0.144)		(0.713)
fuel export frac avail		7.151***		0.474		0.416***		0.473***		0.820
		(2.597)		(0.316)		(0.149)		(0.130)		(0.588)
Gini avail		11.532***		2.055**		0.892**		0.922***		2.105**
		(3.779)		(0.855)		(0.373)		(0.300)		(0.912)
Observations	58	119	62	138	62	147	62	147	58	119
R^2	0.292	0.742	0.173	0.694	0.186	0.716	0.237	0.793	0.245	0.572

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of institutional quality measures against Gini coefficients. Variable mortality rate avail equals 1 if there is mortality rate data and equals 0 otherwise. Variable fuel export frac avail equals 1 if there is fuel export fraction (of total merchandise export) data and equals 0 otherwise. Variable Gini avail equals 1 if there is income Gini data and equals 0 otherwise.

since institutional quality does not change at a high frequency. For example, the well-cited work of Acemoglu et al. (2003) does not control for country fixed effects. In our case, most dimensions of intrinsic openness are also slow-moving variables, which make it hard to obtain meaningful variations over time. Nonetheless, if we could produce some evidence on time series variations, we could control for country fixed effects and produce a useful complement to the cross-sectional evidence.

We identify changes in the external trading environment during 2000-2006 as a plausible natural experiment. During this period, a significant event is China's accession to the World Trade Organization in 2001. From 2000 to 2006, China's tariffs and non-tariff trade barriers were dramatically slashed according to the terms of its WTO accession (which mandated trade liberalization according to a time schedule). Since policy changes mandated on China are essentially unilateral liberalization (with no required changes in trading partners' policies), this represents an exogenous and watershed shock for most other economies. Indeed, trade between China and the rest of the world exploded afterwards (doubling once every four years on average).

Importantly, the same China trade shock implies heterogeneous effects on the trading opportunities of different countries. For example, a given increase in China's total imports implies greater benefits to countries that are geographically close to China e.g, Republic of Korea) than those that are far away (e.g., Mexico). Similarly, holding geographic distance constant, reductions in China's trade barriers also translate into different opportunities for different countries depending on how well their export baskets match with China's import need.

The China trade shock has been employed in a booming recent literature to study the effects of international trade on local US labor markets (Autor, Dorn and Hanson (2013); Wang and Zhu (2017)), US electoral politics (Autor et al. (2016)), and productivity and innovation in Europe (Bloom, Draca and Van Reenen (2016)). Note that, for many of the papers in this literature, the period that covers the year before China joined the WTO (e.g., 2000) to the year before the Global Financial Crisis (e.g., 2006 or 2007) is used.

While changes in China's trade barriers were a major source of the change in global trading environment during 2000-2006, policy changes in other major economies during this period such as the United States and the European Union also matter.

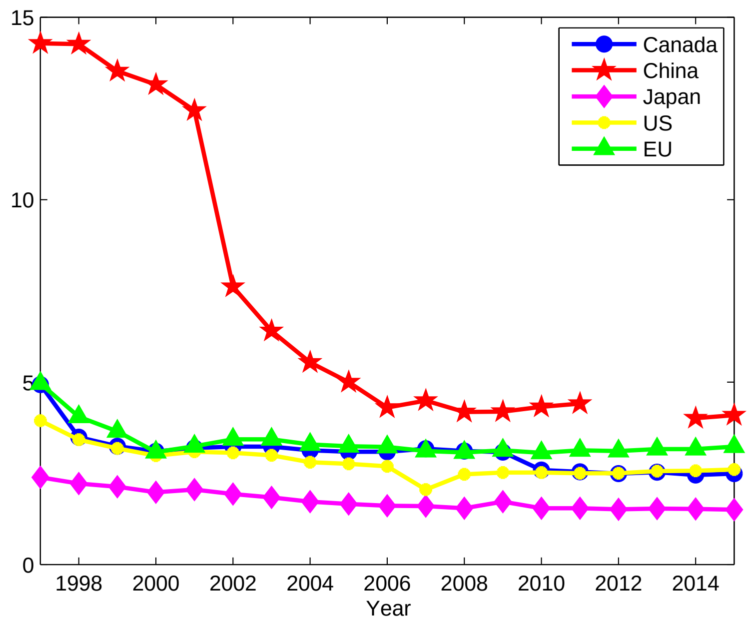
We now turn to long-difference evidence exploring exogenous changes in intrinsic openness faced by small and medium sized countries during 2000-2006. We first describe the construction of key variables.

3.4.1 Data Description

As a measure of the change in institutional quality over 2001-2007, we use the change in the political risk index for this period. The political risk index by its nature captures many dimensions of institutional quality such as corruption, impartiality of the legal system, government discretion, and policy uncertainty, and is therefore regarded as a comprehensive measure of public governance. We have a consistent source of the political risk measure for this period. In comparison, other measures of institutional quality (the corruption perception index, control of corruption, and government effectiveness) often change the underlying sources of surveys and the number of underlying surveys in different years, which makes comparisons over time less meaningful. Indeed, the world governance indicators including control of corruption and government effectiveness, for example, warn readers from making comparisons in different years. (In any case, in any given year, the political risk index and other proxies of institutional quality are highly correlated. This is confirmed in Figure 2, which presents the scatter plots on the pairwise relations for these variables in 2005.)

We use changes in tariff rates by China's and G-7 advanced economies during 2000-2006 as exogenous shocks to intrinsic openness of other economies. Figure 4 plots the trade weighted average of MFN (most favored nation) import tariff rates by each of these economies (all EU member states have identical tariff rates). Clearly, reductions in China's tariffs in this period dominate tariff changes in other big economies. At the same time, other big economies also have some changes in their tariff rates.

Figure 3.4: The MFN Import Tariff Rates (%) of Big Economies 1997-2015



Notes: Source: TRAIN Database

We will relate changes in the institutional quality of a (small and medium sized) country over 2001-2007 to changes in its intrinsic openness during 2000-2006 that were triggered by changes in trade policies of China or G7.

3.4.1.1 Weighted Tariff: Country Level

A key component of Country i's external trading environment in year t is the weighted average of the tariff rates of China plus G7 in that year, with weights proportional to the large countries' relative importance in Country i's export bundles:

$$weighted\ tariff_{it} = \sum_{j=1}^{8} w_{ij,t-1} \log(1 + tariff_{jt}) * 100 \tag{3.4.1}$$

where $tariff_{jt}$ is country j MFN import tariff[12] in year t and

$$w_{ijt} = \frac{export_{ijt}}{\sum_{j=}^{8} export_{ijt}} \tag{3.4.2}$$

where $export_{ijt}$ is country i (merchandise) exports to country j in year t. Index j denotes either China or one of the G7 economies. A change in this measure for country i from 2000 to 2006 represents a change in the external trading opportunity for the country over this period.

In our regression analysis, we will exclude EU member countries from our sample, partly because four EU countries are part of the G7 group, and partly because some of the changes in institutional quality in many new EU members from Central and Eastern Europe are mandated by the EU accession requirement, unrelated to intrinsic openness.

We also exclude Yemen and Mongolia as potential outliers. The shares of exports to China in total exports are the highest for these countries (89% for Yemen, and 67% for Mongolia, respectively). Both predominantly export natural resources to China (oil and oil products for Yemen, and copper ore, gold, and coal for Mongolia, respectively). The Chinese tariff rates on natural resources products were relatively low (4.2% on average in 2000), and did not change much during 2000-2006 (3.3% on average in 2006)[13].

Table 3.8 Panel A reports summary statistics on changes in key variables over 2000-2006 (tariff variables) or 2001-2007. 102 countries have data on both weighted tariffs and political risk index. One can see that the median change in the weighted tariff is negative (-0.21), suggesting an improvement in intrinsic openness for most countries. In fact, out of 102 countries, 70 countries experienced an improvement in intrinsic openness. The largest drop (minimum in the table) is 3.45 percentage points deduction in

[12] We also look at effectively applied tariff rates instead of the MFN rates, and find our results to be robust.

[13] The average tariff rate over all HS codes for natural resources (ores, slag and ash; and mineral fuels, mineral oils, and products of their distillation, bituminous substances, mineral waxes) is 4.2% in 2000, compared to 17%, the equally weighted average across all HS 6-digit products.

Table 3.8: Summary Statistics

Panel A: Using Country Level Tariff						
Variable	Obs	Mean	Std. Dev.	Min	Max	Median
diff political risk	102	0.06	5.74	-16	16.5	0
diff weighted tariff	102	-0.34	0.66	-3.49	0.71	-0.21
diff import/GDP	97	0.07	0.24	-0.37	2.05	0.05
diff fuel export frac	86	1.79	8.09	-36.33	25.09	0.95
diff log(GDP per capita)	99	0.20	0.20	-0.52	1.00	0.20

Panel B: Using HS6 Product Level Tariff						
Variable	Obs	Mean	Std. Dev.	Min	Max	Median
diff political risk index	70	-0.70	5.97	-16	16.5	-1.25
diff weighted tariff	70	0.25	3.71	-7.07	21.07	-0.29
diff import/GDP	68	0.05	0.12	-0.34	0.61	0.05
diff fuel export frac	66	2.90	6.45	-9.93	25.09	1.28
diff log(GDP per capita)	70	0.21	0.17	-0.08	1.00	0.19

Notes: this table's Panel A and Panel B report the summary statistics of variables for "China shock" regressions where weighted tariff is constructed using G7+China country level and HS6 product level import tariff information, respectively. Korea, D.P.R., Somalia and Syria GDP per capita data is missing. The text "diff" means the difference between year 2007 and 2001, except variable diff weighted tariff means the difference of weighted tariffs between year 2006 and 2000.

the average of big partner countries' tariff rates. (However, there are also some countries that experienced an increase in partner countries' tariff rates, i.e., a deterioration in their intrinsic openness). Across countries, the mean and median changes in the tariff rates of big trading partners are a reduction by 0.34 and 0.21 percentage points, respectively.

3.4.1.2 Weighted Tariff: HS6 Level

As a robustness check, we also construct countries' weighted average of tariffs at the more disaggregated HS6 level:

$$weighted\ tariff_{it} = \sum_{j=1}^{8} \sum_{k} w_{ijk,t-1} \log(1 + tariff_{jkt}) * 100 \tag{3.4.3}$$

where $tariff_{jkt}$ is country j MFN import tariff in year t for product k and

$$w_{ijkt} = \frac{\exp ort_{ijt}}{\sum_{j=1}^{8} \sum_{k} \exp ort_{ijkt}} \tag{3.4.4}$$

where where $\exp ort_{ijt}$ is country i export to country j of product k in year t (merchandise export) where the data is from Comtrade. Index j denotes G7 countries and China.

Changes in intrinsic openness measured by big partners' product-level tariffs have the advantage of being more precise. On the other hand, since bilateral product level trade data, needed to compute the weights in the openness measure, are often missing, the new measure is available for a smaller sample of countries (70 countries now versus 102 for the previous measure).

We exclude agriculture products from our calculation since many agriculture products face quota constraints or receive domestic price support for which we do not have systematic data. As before, we also exclude EU countries, Mongolia, and Yemen.

Table 3.8 Panel B reports the summary statistics. The median in weighted average of big partners' tariff rate is 0.29 percentage points across all small and medium size countries. The largest drop in weighted tariff (minimum in the table) is 7.07 percentage points. 44 out of the 70 countries in the sample faced a reduction in partners' tariff (or an improvement in intrinsic openness). The improvement in intrinsic openness for most countries is driven by a massive reduction in tariff rates by China during this period.

However, some countries may experience a deterioration in their intrinsic openness. First, G7 countries or China may happen to have raised tariff rates on some products that are important for these countries during this period. For example, China raised import tariff on wool tops and combed wool (HS code 510529) from 15% in 2000 to 38% in 2006. This product happens to be an important export item for Uruguay, causing it to experience a decline in the measure of its intrinsic openness. Second, a country's comparative advantage could have shifted (say, due to differential productivity increases in different sectors) in such a way that the weights in their export bundles happen to have increased for products on which the big partners have a relatively high tariff rate. For example, for Guatemala, the United States is its dominant export destination. Its top two export items used to be candles and tapers, and soaps and soap products, respectively, in 2000, for which the United States had a zero tariff, but changed to women's or girls' cotton knitted blouses and shirts, and women's or girls' non-knitted cotton trousers for which the United States had relatively high tariff rates of 19.7% and 8.15%, respectively, in 2006.

The simple correlation between the two measures of changes in intrinsic openness is 0.35. While there is similarity between the two, they also carry somewhat information. Hence, results from the two measures can complement each other.

3.4.2 Long Differences

We perform long-difference regressions with variations of the following specification:

$$\Delta q_i = \beta_0 + \beta_1 \Delta weighted\ tariff_i + \Delta X_i' \delta + \varepsilon_i \tag{3.4.5}$$

where Δq_i is the change in country i's institutional quality from 2001 to 2007, $\Delta weighted$ $tariff_i$ is the change in weighted average of big trading partners' tariff rates facing the exports from country i from 2000 to 2006, $\Delta X_i'$ is changes in other control variables that may be relevant for the institutional quality of country i, such as its import/GDP ratio, and fuel exports as a fraction of total merchandise exports. Note that settler mortality rate in the 18th or 19th century and legal origins are not included since they do not change over time. We maintain that changes in big countries' tariff rates are exogenous to small and medium sized countries. This feature is important for assigning a causal interpretation to the regression estimates.

Table 3.9: Change in Weighted Tariff Using Country Level Tariff Information and Change in Political Risk Index

	(1)	(2)	(3)
Dependent variable: change in PR index			
change in weighted tariff	-1.868***	-2.539***	-2.536***
	(0.688)	(0.841)	(0.797)
change in import/GDP		-5.730	-3.036
		(6.595)	(6.718)
change in fuel export frac		-0.077	-0.160**
		(0.089)	(0.067)
e_change in log(GDP per capita)			5.878*
			(3.28)
Observations	102	84	83
R^2	0.046	0.081	0.172

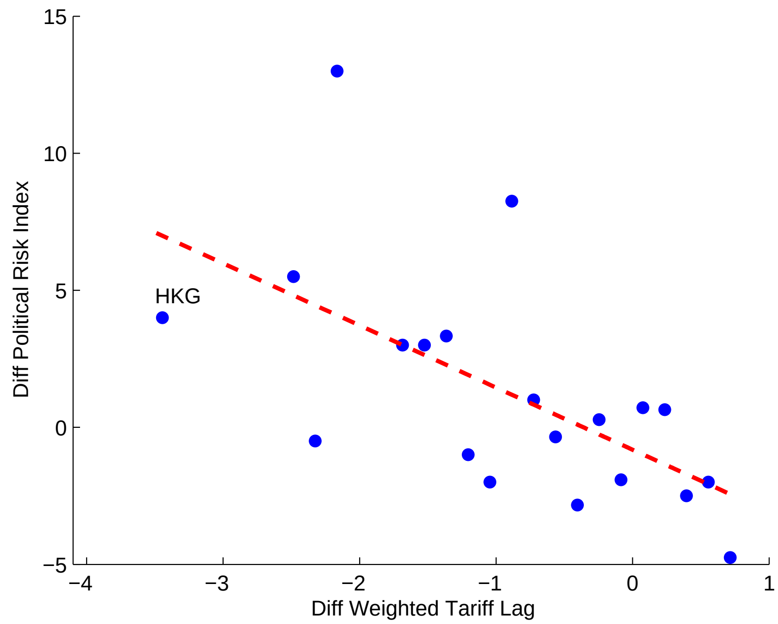
Robust standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of long difference in political risk index (year 2001-2007) against long difference of weighted tariff constructed using G7+China country level import tariff information (year 2000-2006). Variable *e_change* in log(GDP per capita) is the residual after projecting change in log(GDP per capita) on change in weighted tariff.

Table 3.9 reports the regression results. In Column 1, the coefficient on the change in the weighted average of big partners' tariff is negative and statistically significant (-1.87). This is consistent with the notion that greater intrinsic openness leads to better public institutions. A reduction in the average tariff rate of the big partners by 1 percentage point leads to an improvement in the political risk score by 1.87 points.

One can visualize the regression result via a bin scatter plot (Figure 3.5). All the observed changes in the partner's average tariff rates during 2000-2006 are divided into 30 equal-sized bins. Within each bin, there can be many observations corresponding to different changes in the political risk index during 2001-2007. (Some bins may be empty.) We plot the mean value of the political risk index across all observations within a bin (on the vertical axis), against the mean value of the change in the partner's tariff rate (on the horizontal axis). The bin scatter plot is a noise reduction technique used in applied microeconomic research. We can see a clear negative relationship between the two variables: a reduction in big partners' tariff is associated with an improvement in institutional quality. Moreover, we can see that removing one or two data points will not alter the negative slope (though the point estimate could change a bit).

Figure 3.5: Weighted Tariff and Political Risk Index: Long Difference



Notes: this figure displays the bin-scatter plot of long difference of political risk index and weighted tariff. We divide long difference of weighted tariff lag into 30 equal-width bins on the x axis. Within each box, we compute the mean value of long difference of political risk index. The resulting mean is plotted against the mid-value of long difference of weighted tariff lag for all boxes.

In Column 2, we add change in the import/GDP ratio and change in the fraction of fuel exports in total exports as control variables. The coefficients on the two new regressors are negative but not statistically significant. The coefficient on the change in the partner's tariff rate is still negative and becomes somewhat larger in absolute magnitude.

In Column 3, we also add change in income level as a control variable. The coefficient on change in income is positive and significant: becoming richer is associated with improvement in institutional quality (which is perhaps not surprising). This time, the coefficient on change in the fraction of fuel exports has also become statistically significant. This is consistent with the "natural resource curse" hypothesis: more resource abundance leads to more competition for rents, often associated with a worsening of public institutions. For the purpose of this paper, an important feature to note is that the coefficient on the change in partners' tariff remains negative and statistically significant. That is, our key result is robust - change in intrinsic openness leads to change in institutional quality. Based on the point estimate in Column 3, **a** reduction in the average tariff rate of partner countries by one standard deviation (0.66) leads to an improvement in the political risk score by 1.67 points (=2.536*0.66). (During this period, the average change in the political risk index for all countries in the sample is an improvement by 0.06 point, and the median change is zero. Against these statistics, an improvement in the political risk index by 1.67 points is economically significant.)

We do the same exercise with the second measure of intrinsic openness (with partner countries' product level tariff rates), and report the results in Table 3.10. The results are qualitatively similar as before. In particular, the coefficient on the change in the partner countries' weight tariff is negative and statistically significant in all three columns. This is again consistent with the notion that greater intrinsic openness leads to greater improvement in institutional quality. Using the point estimate in the last column as an illustration, a reduction in the average tariff rate of partner countries by one standard deviation (3.71) leads to an improvement in the political risk score by 1.00 point (=0.271*3.71).

Figure 3.6 is a bin scatter plot corresponding to Column 1 of the regression table. We can see clearly a negative relationship between the two variables. The bin on the far right contains a single country (Mali). If we remove that bin, the negative relationship is preserved, and the point estimate would become even bigger.

3.4.3 Excluding Potential Outliers

We investigate the robustness of our results to removing apparent outliers. When the first measure of intrinsic openness is used, Hong Kong appears to be an outlier in a scatter plot of a change in institutional quality against a change in intrinsic openness (not reported

Table 3.10: Change in Weighted Tariff Using HS6 Product Level Tariff Information and Change in Political Risk Index

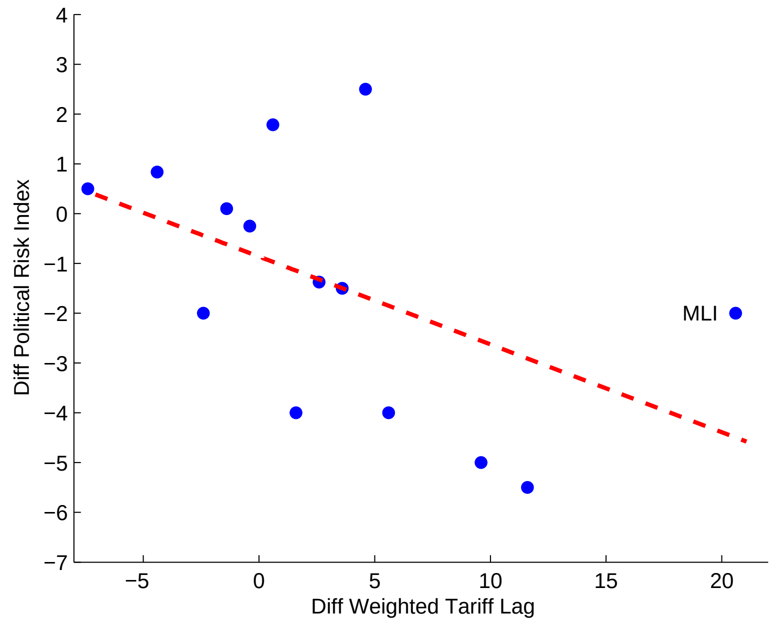
	(1)	(2)	(3)
Dependent Variable: change in PR index			
change in weighted tariff	-0.238*	-0.303 **	-0.271*
	(0.122)	(0.152)	(0.137)
change in import/GDP		-3.996	-1.540
		(8.233)	(7.466)
change in fuel export frac		-0.176*	-0.120
		(0.092)	(0.084)
e_change in log(GDP per capita)			11.079***
			(4.007)
Observations	70	64	64
R^2	0.022	0.064	0.151

Robust standard errors in parentheses

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

Notes: this table reports the regression results of long difference in political risk index against long difference of weighted tariff constructed using G7+China HS6 level import tariff information. Variable *e_change* in log(GDP per capita) is the residual after projecting change in log (GDP per capita) on change in weighted tariff.

Figure 3.6: Weighted Tariff and Political Risk Index: Long Difference, HS6



Notes: This bin scatter plot graphs the change in the political risk index from 2001 to 2007 (on the vertical axis) against the change in the weighted average of product-level tariff rates of big trading partners (on the horizontal axis). All changes in the weighted average tariff rate are placed in 30 equal-width bins on the x axis. The average value of the change in political risk index over all observations within a given bin is used in the plot.

to save space). We investigate the effect of excluding Hong Kong from the sample and report the new result in the first two columns Table 3.11. We find that the coefficient on the change in the weighted average tariff of the big trading partners is still negative and statistically significant at the 5% level. Indeed, the point estimate becomes bigger in absolute magnitude. This means that an even greater improvement in institutional quality is revealed in response to a given improvement in intrinsic openness, once Hong Kong is removed from the sample.

When the second measure of intrinsic openness is used, Mali appears as an outlier. We re-do the regressions after excluding Mali from the sample and report the results in the first two columns of Table 3.12. In this case, the coefficient on a change in trading partners' tariff rates is still negative and statistically significant at the 5% level, and the point estimate becomes larger in absolute magnitude as well. This suggests that removing

Table 3.11: Change in Weighted Tariff Using Country Level Tariff Information and Change in Political Risk Index: Robustness Checks

	(1)	(2)	(3)	(4)
Dependent Variable: change in PR index	Excluding Hong Kong		3-Year Average	
change in weighted tariff	-2.610**	-2.795***	-3.093 ***	-3.510***
	(0.985)	(0.908)	(0.986)	(0.900)
change in import/GDP	-5.322	-1.745	-4.744*	-5.546**
	(8.067)	(8.077)	(2.516)	(2.505)
change in fuel export frac	-0.078	-0.164**	-0.126	-0.181*
	(0.090)	(0.067)	(0.126)	(0.096)
e_change in log(GDP per capita)		6.019*		13.091***
		(3.313)		(3.563)
Observations	83	82	73	71
R^2	0.075	0.172	0.095	0.270

Robust standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports robustness checks of the regression results of long difference in political risk index against long difference of weighted tariff constructed using G7+China HS6 level import tariff information. The first two columns exclude Hong Kong in the sample and the last two columns use 3-year average of long difference in political risk index, and long difference of weighted tariff. Variable *e_change* in log(GDP per capita) is the residual after projecting change in log (GDP per capita) on change in weighted tariff.

Table 3.12: Change in Weighted Tariff Using HS6 Product Level Tariff Information and Change in Political Risk Index: Robustness Checks

	(1)	(2)	(3)	(4)
Dependent Variable: change in PR index	Excluding Mali		3-Year Average	
change in weighted tariff	-0.475**	-0.430**	-0.891***	-0.873***
	(0.193)	(0.197)	(0.264)	(0.197)
change in import/GDP	-4.265	-1.792	-4.267	-4.738
	(8.254)	(7.587)	(3.585)	(3.554)
change in fuel export frac	-0.174*	-0.121	-0.183	-0.149
	(0.089)	(11.213)	(0.144)	(0.126)
e_change in log(GDP per capita)		10.754**		18.164***
		(4.025)		(5.621)
Observations	63	63	54	54
R^2	0.074	0.155	0.149	0.311

Robust standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports robustness checks of the regression results of long difference in political risk index against long difference of weighted tariff constructed using G7+China HS6 level import tariff information. The fist two columns exclude Mali in the sample and the last two columns use 3-year average of long difference in political risk index, and long difference of weighted tariff. Variable *e_change* in log(GDP per capita) is the residual after projecting change in log (GDP per capita) on change in weighted tariff.

the most obvious outliers tends to strengthen rather than weaken the main conclusions.

3.4.4 Noise Reduction by Three Year Averages

The values of either institutional quality or tariff rates could be noisy in any given year. As a check for robustness, we implement another version of long difference regressions by using three year averages of all key variables at both ends of the interval. The dependent variable is now the difference between the average value of institutional quality over 2005-2007, and the average value of the same variable over 1999-2001. Similarly, the key regressor is now the difference between the average value of intrinsic openness over 2004-2006 and the average value of the same variable over 1998-2000.

We report the new regression results in the last two columns of Tables 3.11 and 3.12, respectively. In both cases, the noise reduction procedure makes the key point estimates

Table 3.13: Post-China Joining WTO Change in Weighted Tariff and Pre-China Joining WTO Change in Political Risk Index

	(1)	(2)
Dependent Variable: change in PR index (1995-2001)		
change in weighted tariff, country	0.953	
	(1.491)	
change in weighted tariff, HS6		-0.080
		(0.220)
Observations	94	63
R^2	0.005	0.002

Robust standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of long difference in political risk index (pre-China joining WTO: 1995-2001) against long difference of weighted tariff (post-China joining WTO: 2000-2006) using country level and HS6 product level tariff information in Column (1) and (2), respectively.

somewhat bigger, without altering their signs or statistical significance.

3.4.5 Checking for Pre-trend

Changes in institutional quality might simply follow a trend, and the correlation with changes in intrinsic openness (triggered largely by China's accession to WTO) could be a coincidence.

To check for the validity of this story, we substitute the dependent variable - a change in institutional quality change from 2001 to 2007 - by a change in the same variable from 1995 to 2001 (i.e., before China joined the WTO). Table 3.13 reports the results of this placebo test (omitting the reporting of other coefficients). The coefficients on the change in intrinsic openness over 2000-2006 are now not different from zero statistically. This suggests that our conclusion is unlikely to be driven by a coincidental correlation between differential trends in the improvement of institutional quality across countries and changes in intrinsic openness.

3.4.6 Industry-specific Sensitivity to Institutional Quality

The empirical exercise so far treats intrinsic openness in all industries equally. Nunn (2007) makes the point that different industries may have different degrees of sensitivity to institutional quality. Nunn (2007) pioneers two measures of contract intensity (relationship specificity) for each final good using U.S. I-O table. The first measure is the fraction of input that can neither be bought and sold on an exchange nor referenced priced. The second measure also includes reference priced inputs as being relationship-specific. For example, the same level of corruption may damage trade in differentiated goods more than it does trade in homogeneous goods. Combining this insight with our theory on endogenous institutional quality, one might expect intrinsic openness increase in the contract intensive industries will increase institutional quality while intrinsic openness increase in the non-contract intensive industries will not increase institutional quality significantly.

To test this additional prediction, we first group all HS6 products into two categories. One group is contract intensive products, and the other is non-contract intensive products, separated by the median of relationship specificity (or contract intensive) measure across all industries provided in Nunn (2007)[14]. We will employ his first measure of contract intensity in our benchmark regressions and leave the second measure as robustness check. For each product group, we obtain the long difference in weighted tariff as before. We then compute each country's export share (year 2000, 2001 and 2002 three years' average) of contract intensive products Ψ_i and non-contract intensive products $1-\Psi_i$, where i denotes country i. Multiplying the long difference in weighted tariff by the export share of each group, we have two variables $\Delta weighted\ tariff-ci_i$, and $\Delta weighted\ tariff-ni_i$ for contract intensive (abbreviated as "ci") products and non-contract intensive (abbreviated as "ni") products respectively.

[14] We use concordance provided by BEA to convert the relationship specificity measure at the NAICS 6-digit level in Nunn (2007) to a corresponding measure at the HS 6 digit.

Table 3.14: Summary Statistics on Change in Weighted Tariff-Contract Intensive and Change in Weighted Tariff-non Contract Intensive

Variable	Obs	Mean	Std. Dev.	Min	Max	Median
diff weighted tariff-contract intensive	70	0.01	2.04	-3.30	6.03	-0.13
diff weighted tariff-non contract intensive	70	0.31	2.92	-6.96	21.16	-0.04
weight of contract intensive products	70	0.48	0.28	0.01	0.93	0.47

Notes: this table reports the summary statistics of variables for the "China Shock" regressions with industry-specific sensitivity to institutional quality. The text "diff" means the difference between year 2006 and 2000. Variable diff weighted tariff-contract intensive represents change in weighted tariff in contract intensive industries multiplied by export share of contract intensive industries. Variable diff weighted tariff-non contract intensive represents change in weighted tariff in non-contract intensive industries multiplied by export share of non-contract intensive industries.

Table 3.14 reports the summary statistics. One can see the median $\Delta weighted\ tariff - ci_i$ and $\Delta weighted\ tariff - ni_i$ are both negative and median Ψ_i is around 0.5. Among the 70 countries in the sample, the smallest three Ψ_i come from Algeria, Azerbaijan and Iran, which are natural resource exporters. The largest two Ψ_i come from Costa Rica and Singapore. Costa Rica's top exports are optical, technical, and medical apparatus. Singapore's main export products are integrated circuits refined petroleum, and computers.

We run the following regressions:

$$\Delta q_i = \beta_0 + \beta_1 \Delta weightedtariff - ci_i + \beta_2 \Delta weightedtariff - ni_i + \Delta X_i' \delta + \varepsilon_i.$$

Table 3.15 reports the results. In column (1), we only include $\Delta weighted\ tariff - ci_i$ and $\Delta weighted\ tariff - ni_i$ as regressors. The coefficient before $\Delta weightedtariff - ci_i$ is negative and statistically significant, while the coefficient before $\Delta weightedtariff - ni_i$ is not statistically different from zero. This means that improvement in intrinsic openness on contract intensive products helps to promote more investment in public institutions, leading to a higher quality of institutions. At the same time, improvement in intrinsic openness on products that are not contract intensive does not do much to alter the incen-

Table 3.15: Change in Weighted Tariff by Institutional Sensitivity (measure 1) and Change in Political Risk Index

	(1)	(2)	(3)
Dependent Variable: change in PR index			
change in weighted tariff-contract intensive	-0.674**	-0.643**	-0.585*
	(0.314)	(0.320)	(0.312)
change in weighted tariff-non contract intensive	-0.102	-0.158	-0.139
	(0.101)	(0.138)	(0.121)
change in import/GDP		-3.729	-1.260
		(8.103)	(7.435)
change in fuel export frac		-0.150*	-0.107
		(0.088)	(0.082)
e_change in log(GDP per capita)			11.221***
			(4.163)
Observations	70	64	64
R^2	0.030	0.061	0.147

Robust standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of long difference in political risk index against long difference of weighted tariff for contract intensive industries and non-contract intensive industries, constructed using G7+China HS6 level import tariff information and relationship specificity measure 1 in Nunn(2007). Variable change in weighted tariff-ci is change in weighted tariff in the contract intensive industry multiplied by export share of contract intensive industry. Variable change in weighted tariff-ni is change in weighted tariff in the non-contract intensive industry multiplied by export share of non-contract intensive industry. Variable *e*_change in log(GDP per capita) is the residual after projecting change in log (GDP per capita) on the first two regressors.

tive to improving institutions.

In colums (2) and (3), we add more control variables as in the previous section. Our results remain robust. In Table 3.16, we repeat the same exercise, using the second (broader) definition of contractive intensive products in Nunn (2007) in computing changes in intrinsic openness. Again, we see the same patterns on the coefficients, suggesting that our results are robust.

Table 3.16: Change in Weighted Tariff by Institutional Sensitivity (measure 2) and Change in Political Risk Index

	(1)	(2)	(3)
Dependent Variable: change in PR index			
change in weighted tariff-contract intensive	-0.902**	-0.918**	-0.864**
	(0.405)	(0.411)	(0.416)
change in weighted tariff-non contract intensive	-0.150	-0.195	-0.180
	(0.120)	(0.140)	(0.126)
change in import/GDP		-4.213	-1.644
		(8.080)	(7.564)
change in fuel export frac		-0.148*	-0.109
		(0.084)	(0.078)
e_change in log(GDP per capita)			10.765**
			(4.197)
Observations	70	64	64
R^2	0.038	0.074	0.151

Standard errors in parentheses

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regression results of long difference in political risk index against long difference of weighted tariff for contract intensive industries and non-contract intensive industries, constructed using G7+China HS6 level import tariff information and relationship specificity measure 2 in Nunn(2007). Variable change in weighted tariff-contract intensive is change in weighted tariff in the contract intensive industry multiplied by export share of contract intensive industry. Variable change in weighted tariff-non contract intensive is change in weighted tariff in the non-contract intensive industry multiplied by export share of non-contract intensive industry. Variable *e*_change in log(GDP per capita) is the residual after projecting change in log (GDP per capita) on the first two regressors.

3.5 Conclusion

We propose a theory that links endogenous institutional quality to a country's intrinsic openness, and provide several pieces of evidence.

Empirical tests confirm that intrinsically more open countries, i.e. countries with a smaller population, geographically closer to the world market, or endowed with a longer coastline, display better institutional quality.

Intrinsic openness is not immutable. Globalization, in particular, changes in trading partners' trade barriers could affect a country's external trading opportunities. Using big economies' import tariff change, especially those associated with China's accession to the WTO in 2001, as a source of variation in intrinsic openness for other economies, we also find evidence that improvement in intrinsic openness leads to improvement in institutional quality.

As Nunn (2007) points out, some products are more sensitive to the soundness of contractual institutions and legal environment than other products. We incorporate this insight to implement a refined test. In particular, we expect institutional improvement to respond more to changes in intrinsic openness triggered by partner countries' changes in trade barriers on contract intensive products, than to changes in tariffs on non-contract intensive products. Our empirical exercise confirms this idea.

One implication of our paper is that globalization can have an indirect but important channel to improve welfare. One country's trade liberalization might create a positive externality by inducing other countries to improving their public institutions. Investigating and quantifying such links might be a fruitful line of future research.

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Appendix A

Appendix of Chapter 1

A.1 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.[1] 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

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

A.2 Competitive Equilibrium with Given Exchange Rate Policy ϵ_t (No Bailout)

Definition 3. ***A competitive equilibrium with given exchange rate policy*** *ϵ_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 follow-*

[1] See Bolton (2016) for a similar way to introduce quantity theory of money.

ing equilibrium conditions

$$[c_t - \psi_h(1+\chi)^{-1}h_t^{1+\chi}]^{-\sigma}[a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}}a(c_t^T)^{-\frac{1}{\xi}} = \lambda_t \tag{A.2.1}$$

$$\psi_h h_t^\chi = [a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}}a(c_t^T)^{-\frac{1}{\xi}}w_t \tag{A.2.2}$$

$$p_t^N = \frac{1-a}{a}\left(\frac{c_t^N}{c_t^T}\right)^{-\frac{1}{\xi}} \tag{A.2.3}$$

$$(1+\mu_t)\left((\gamma-1)y_t^N p_t^N(1+\tau_y) - w_t h_t\frac{\gamma}{\alpha_h} + \psi(\pi_t^N-1)\pi_t^N\right) = \beta E_t\frac{\lambda_{t+1}}{\lambda_t}\psi(\pi_{t+1}^N-1)\pi_{t+1}^N(1+\mu_{t+1}) \tag{A.2.4}$$

$$(1+\mu_t)\frac{1}{1+r_t} - \frac{\nu_t}{1+r_t} = \beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}(1+\mu_{t+1})\right) \tag{A.2.5}$$

$$(1+\mu_t)\left(1+\phi(\frac{k_{t+1}}{k_t}-1)\right) = \beta E_t\frac{\lambda_{t+1}}{\lambda_t}\left\{\left[\left(1-\delta+\frac{\phi}{2}[(\frac{k_{t+2}}{k_{t+1}})^2-1]\right)+\frac{\alpha_k}{\alpha_h}\frac{w_{t+1}h_{t+1}}{k_{t+1}}\right](1+\mu_{t+1})+\kappa_{t+1}\nu_{t+1}\right\} \tag{A.2.6}$$

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t \tag{A.2.7}$$

$$(\kappa_t k_t - \frac{b_{t+1}}{1+r_t})\nu_t \geq 0 \tag{A.2.8}$$

$$p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \frac{\psi}{2}(\pi_t^N-1)^2 \geq \underline{d} \tag{A.2.9}$$

$$\mu_t\left(p_t^N y_t^N - w_t h_t - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2 k_t - b_t + \frac{b_{t+1}}{1+r_t} - \underline{d} - \frac{\psi}{2}(\pi_t^N-1)^2\right) \geq 0 \tag{A.2.10}$$

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2 k_t - \frac{\psi}{2}(\pi_t^N-1)^2 \tag{A.2.11}$$

$$y_t^N = c_t^N \tag{A.2.12}$$

$$y_t^N = k_t^{\alpha_k}(zh_t)^{\alpha_h} \tag{A.2.13}$$

$$i_t = k_{t+1} - (1-\delta)k_t + \frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2 k_t \tag{A.2.14}$$

$$c_t = [a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}]^{\frac{1}{1-\frac{1}{\xi}}} \tag{A.2.15}$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\epsilon_t} \tag{A.2.16}$$

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

A.3 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

$$b_{max}(k) = \max_{b',k',h} \Big(p^N y^N (1+\tau_y) - wh + t\Big) - \underline{\text{d}} + \frac{b'}{1+r_{max}} - k' + (1-\delta)k - \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k, \tag{A.3.1}$$

subject to

$$b' \leq \kappa_{min} \cdot k,$$

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

where

$$p^N = \frac{1-a}{a}\left(\frac{c^N}{c^T}\right)^{-\frac{1}{\xi}},$$

$$c^N = y^N$$

$$c^T = y_{min}^T - b_{max}(k) + \frac{b'}{1+r} - k' + (1-\delta)k - \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k,$$

$$t = -\tau_y p^N y^N.$$

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 (A.3.1). The above two equations also show that h is the solution to

$$\alpha_h(1-a)[k^{\alpha_k}(zh)^{\alpha_h}]^{1-\frac{1}{\xi}} = \frac{\psi_h h^{1+\chi}}{[ac^{T^{1-\frac{1}{\xi}}} + (1-a)c^{N^{1-\frac{1}{\xi}}}]^{\frac{1}{\xi-1}}}. \quad \text{(A.3.2)}$$

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

$$c^T = y^T_{min} - b_{max}(k) + \frac{b'}{1+r} - k' + (1-\delta)k - \frac{\phi}{2}(\frac{k'}{k} - 1)^2 k,$$

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

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

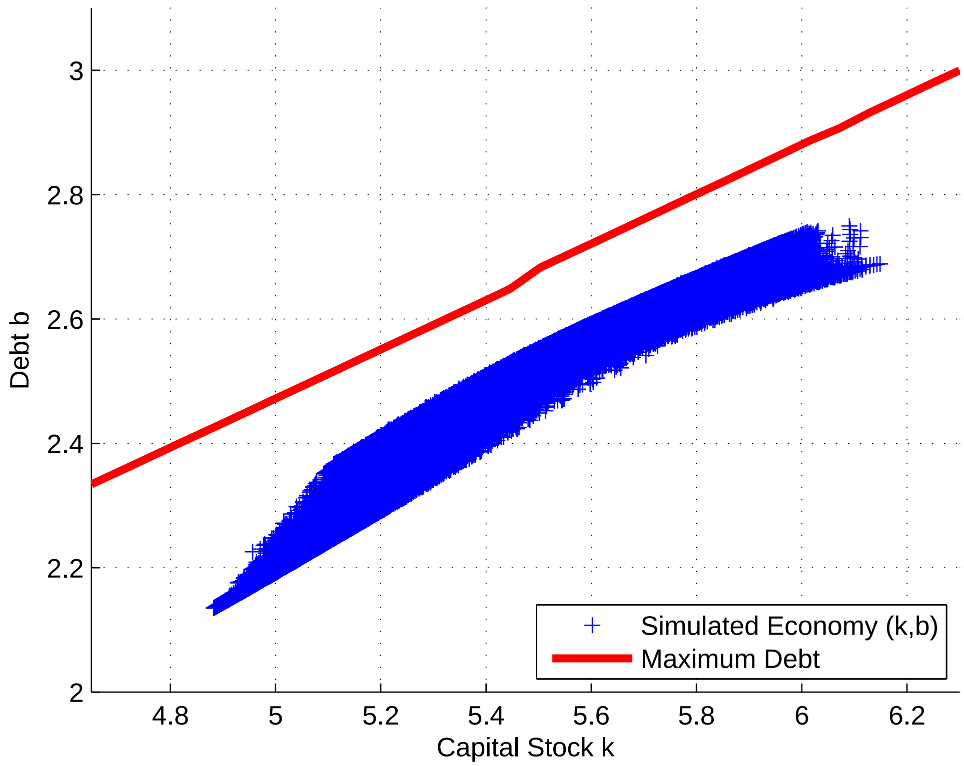
I define the feasible set as

$$\Theta = \{(b,k) \in \mathbb{R} \times \mathbb{R}_+, b \leq b_{max}(k)\}. \quad \text{(A.3.3)}$$

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.

Figure A.1: 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

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 Θ. Otherwise, set $s \rightarrow s+1$ and return to 2.

In Figure A.1, 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.

A.4 Exogenous Shocks: Transition Matrix of $(\ln(y^T), r, \kappa)$

To add exogenous κ_t, I take a practical stand to assume that the transition from κ_H to κ_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 $\Pi(i,5) = \Pi^0(i,5) - \Pi(i,6)$,[2] $i = 1,2,3,4,5$. As regard $\Pi(6,:)$, I first target the average duration of κ_L as 4 quarters, so $\Pi(6,6) = 0.75$. I assume that when the κ_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 Π of $(\ln(y^T), r, \kappa)$ and the transition matrix of $(\ln(y^T), r)$ will remain the same as Π^0 under Π. I report the transition matrix below

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

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 $(\ln(y^T)^l, r^h, \kappa^L)$.

A.5 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 cap-

[2] 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 $\Pi(i,5) = 0$.

ital 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

$$[\mathbb{C}(X)-\psi_h(1+\chi)^{-1}\mathbb{H}(X)^{1+\chi}]^{-\sigma}[a\mathbb{C}^T(X)^{1-\frac{1}{\xi}}+(1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}}a(\mathbb{C}^T(X))^{-\frac{1}{\xi}} = \Lambda(X) \quad (A.5.1)$$

$$\psi_h\mathbb{H}(X)^\chi = [a\mathbb{C}^T(X)^{1-\frac{1}{\xi}} + (1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{\xi-1}}a(\mathbb{C}^T(X))^{-\frac{1}{\xi}}\mathbb{W}(X) \quad (A.5.2)$$

$$\mathbb{P}^N(X) = \frac{1-a}{a}\left(\frac{\mathbb{C}^N(X)}{\mathbb{C}^T(X)}\right)^{-\frac{1}{\xi}} \quad (A.5.3)$$

$$(\gamma-1)\mathbb{Y}^N(X)\mathbb{P}^N(X)(1+\tau_y) = \mathbb{W}(X)\mathbb{H}(X)\frac{\gamma}{\alpha_h} \quad (A.5.4)$$

$$(1+\mathbb{M}(X))\frac{1}{1+r} - \frac{\mathbb{N}(X)}{1+r} = \beta E_t\left(\frac{\Lambda(X')}{\Lambda(X)}(1+\mathbb{M}(X'))\right) \quad (A.5.5)$$

$$(1+\mathbb{M}(X))\left(1+\phi(\frac{\mathbb{K}(X)}{k}-1)\right) = \beta E_t\frac{\Lambda(X')}{\Lambda(X)}\left\{\left[\left(1-\delta+\frac{\phi}{2}[(\frac{\mathbb{K}(X')}{\mathbb{K}(X)})^2-1]\right)+\frac{\alpha_k}{\alpha_h}\frac{\mathbb{W}(X')\mathbb{H}(X')}{\mathbb{K}(X)}\right](1+\mathbb{M}(X'))+\kappa'\mathbb{N}(X')\right\} \quad (A.5.6)$$

$$\frac{\mathbb{B}(X)}{1+r} \leq \kappa k \quad (A.5.7)$$

$$(\kappa k - \frac{\mathbb{B}(X)}{1+r})\mathbb{N}(X) \geq 0 \quad (A.5.8)$$

$$\mathbb{P}^N(X)\mathbb{Y}^N(X) - \mathbb{W}(X)\mathbb{H}(X) - \mathbb{K}(X) + (1-\delta)k - \frac{\phi}{2}(\frac{\mathbb{K}(X)}{k}-1)^2k - b + \frac{\mathbb{B}(X)}{1+r} \geq \underline{\mathrm{d}} \quad (A.5.9)$$

$$\mathbb{M}(X)\left(\mathbb{P}^N(X)\mathbb{Y}^N(X) - \mathbb{W}(X)\mathbb{H}(X) - \mathbb{K}(X) + (1-\delta)k - \frac{\phi}{2}(\frac{\mathbb{K}(X)}{k}-1)^2k - b + \frac{\mathbb{B}(X)}{1+r} - \underline{\mathrm{d}}\right) \geq 0 \quad (A.5.10)$$

$$\mathbb{C}^T(X) + b = y^T + \frac{\mathbb{B}(X)}{1+r} - \mathbb{K}(X) + (1-\delta)k - \frac{\phi}{2}(\frac{\mathbb{K}(X)}{k}-1)^2k \quad (A.5.11)$$

$$\mathbb{Y}^N(X) = \mathbb{C}^N(X) \quad (A.5.12)$$

$$\mathbb{Y}^N(X) = k^{\alpha_k}(z\mathbb{H}(X))^{\alpha_h} \quad (A.5.13)$$

$$\mathbb{I}(X) = \mathbb{K}(X) - (1-\delta)k + \frac{\phi}{2}(\frac{\mathbb{K}(X)}{k}-1)^2k. \quad (A.5.14)$$

$$\mathbb{C}(X) = [a\mathbb{C}^T(X)^{1-\frac{1}{\xi}} + (1-a)\mathbb{C}^N(X)^{1-\frac{1}{\xi}}]^{\frac{1}{1-\frac{1}{\xi}}} \quad (A.5.15)$$

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 Θ.

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 (A.5.7) and (A.5.9) 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 (A.5.7) 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 (A.5.9) 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 (A.5.7) and (A.5.9) 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 $j \to j+1$, return to 3.

A.6 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

A.7 Proofs

A.7.1 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

$$\max_{\{c_t^T, h_t, b_{t+1}, k_{t+1}\}} E_0 \sum_{t=0}^{+\infty} \beta^t u(\Omega(c_t^T, k_t^{\alpha_k}(zh_t)^{\alpha_h}) - v(h_t)), \tag{A.7.1}$$

subject to

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t, \tag{A.7.2}$$

$$\frac{b_{t+1}}{1+r_t} \leq \kappa_t k_t \tag{A.7.3}$$

Denoting λ_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}:

$$u'(c_t - v(h_t))\Omega_1(c_t^T, c_t^N) = \lambda_t \tag{A.7.4}$$

$$\Omega_2(c_t^T, c_t^N)\frac{\alpha_h c_t^N}{h_t} = \psi_h h_t^\chi \tag{A.7.5}$$

$$\frac{\lambda_t}{1+r_t} - \frac{\lambda_t \nu_t}{1+r_t} = \beta E_t \lambda_{t+1} \tag{A.7.6}$$

$$\lambda_t\left(1+\phi(\frac{k_{t+1}}{k_t}-1)\right)=\beta E_t\lambda_{t+1}\left[1-\delta+\frac{\phi}{2}[(\frac{k_{t+2}}{k_{t+1}})^2-1]\right]+\beta E_t u'(c_{t+1}-v(h_{t+1}))\Omega_2(c_{t+1}^T,c_{t+1}^N)\frac{\alpha_k c_{t+1}^N}{k_{t+1}}+\beta E_t\lambda_{t+1}\kappa_{t+1}\nu_{t+1} \tag{A.7.7}$$

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)

$$u'(c_t-v(h_t))\Omega_1(c_t^T,c_t^N)=\lambda_t \tag{A.7.8}$$

$$\Omega_1(c_t^T,c_t^N)w_t=\psi_h h_t^\chi \tag{A.7.9}$$

$$\frac{1}{1+r_t}-\frac{\nu_t}{1+r_t}=\beta E_t\frac{\lambda_{t+1}}{\lambda_t} \tag{A.7.10}$$

$$1+\phi(\frac{k_{t+1}}{k_t}-1)=\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\left[1-\delta+\frac{\phi}{2}[(\frac{k_{t+2}}{k_{t+1}})^2-1]\right]+\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\frac{\alpha_k p_{t+1}^N c_{t+1}^N}{k_{t+1}}+\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\kappa_{t+1}\nu_{t+1} \tag{A.7.11}$$

Now it is straightforward to see these equilibrium conditions coincide with the competitive equilibrium when $\mu_t=0$ ($\underline{d}=-\infty$) $\forall$ t.

A.7.2 Proof of Proposition 4

Set lump sum transfer $LT_t\geq\underline{d}-\{p_t^N y_t^N-w_t h_t-k_{t+1}+(1-\delta)k_t-\frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2k_t-b_t+\frac{b_{t+1}}{1+r_t}\}^{SP}$. 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

$$p_t^N y_t^N-w_t h_t-k_{t+1}+(1-\delta)k_t-\frac{\phi}{2}(\frac{k_{t+1}}{k_t}-1)^2k_t-b_t+\frac{b_{t+1}}{1+r_t}-\frac{\psi}{2}(\pi_t^N-1)^2=\underline{d}. \tag{A.7.12}$$

Market clearing condition for tradable good is

$$c_t^T + b_t = y_t^T + \frac{b_{t+1}}{1+r_t} - k_{t+1} + (1-\delta)k_t - \frac{\phi}{2}(\frac{k_{t+1}}{k_t} - 1)^2 k_t - \frac{\psi}{2}(\pi_t^N - 1)^2. \tag{A.7.13}$$

Combining the above two equations to arrive at

$$c_t^T = y_t^T + \underline{\mathrm{d}} - (p_t^N c_t^N - w_t h_t). \tag{A.7.14}$$

Since the non-tradable relative price is

$$p_t^N = \frac{1-a}{a}\left(\frac{c_t^N}{c_t^T}\right)^{-\frac{1}{\xi}}, \tag{A.7.15}$$

we obtain

$$p_t^N c_t^N = \left(\frac{a}{1-a}\right)^{-\xi} (p_t^N)^{1-\xi} c_t^T. \tag{A.7.16}$$

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

$$(\gamma - 1) y_t^N p_t^N (1+\tau_y) - w_t h_t \frac{\gamma}{\alpha_h} + \psi(\pi_t^N - 1)\pi_t^N = 0. \tag{A.7.17}$$

By substituting $p_t^N c_t^N$ and $w_t h_t$ in equation (A.7.14), we get

$$c_t^T = \frac{y_t^T + \underline{d}}{1 + [(1-\alpha_h) - \frac{\alpha_h}{\gamma}\psi(\pi_t^N - 1)\pi_t^N]\left(\frac{a}{1-a}\right)^{-\xi}(p_t^N)^{1-\xi}}. \tag{A.7.18}$$

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

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

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

$$\chi \hat{h}_t + \frac{(1-a)\left(\frac{ap_t^N}{1-a}\right)^{1-\xi}}{a+(1-a)\left(\frac{ap_t^N}{1-a}\right)^{1-\xi}} \hat{p}_t^N = \hat{w}_t, \tag{A.7.19}$$

$$\hat{p}_t^N = -\frac{1}{\xi}(\hat{c}_t^N - \hat{c}_t^T), \tag{A.7.20}$$

$$\frac{\psi}{\gamma}\hat{\pi}_t^N + \hat{p}_t^N + \hat{c}_t^N = \hat{w}_t + \hat{h}_t, \tag{A.7.21}$$

$$\hat{c}_t^T = \frac{w_t h_t}{c_t^T}(\hat{w}_t + \hat{h}_t) - \frac{p_t^N c_t^N}{c_t^T}(\hat{p}_t^N + \hat{c}_t^N), \tag{A.7.22}$$

$$\hat{c}_t^N = \alpha_h \hat{h}_t. \tag{A.7.23}$$

Finally, we also have

$$\hat{p}_t^N = \hat{\pi}_t^N - \hat{\epsilon}_t. \tag{A.7.24}$$

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

$$\begin{bmatrix} s_t - 1 & \frac{\chi+1}{\alpha_h} - 1 \\ \xi + \frac{p_t^N c_t^N}{c_t^T} - \frac{w_t h_t}{c_t^T} s_t & 1 + \frac{p_t^N c_t^N}{c_t^T} - \frac{w_t h_t}{c_t^T}\frac{1+\chi}{\alpha_h} \end{bmatrix} \begin{bmatrix} \hat{p}_t^N \\ \hat{c}_t^N \end{bmatrix} = \begin{bmatrix} \frac{\psi}{\gamma} \\ 0 \end{bmatrix} \hat{\pi}_t^N \tag{A.7.25}$$

Denote

$$B = \begin{bmatrix} s_t - 1 & \frac{\chi+1}{\alpha_h} - 1 \\ \xi + \frac{p_t^N c_t^N}{c_t^T} - \frac{w_t h_t}{c_t^T} s & 1 + \frac{p_t^N c_t^N}{c_t^T} - \frac{w_t h_t}{c_t^T} \frac{1+\chi}{\alpha_h} \\ & . \end{bmatrix} \tag{A.7.26}$$

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 $\hat{\epsilon}_t > 0$, then $\hat{p}_t^N < 0$, $\hat{\pi}_t^N > 0$ and according to equation (A.7.18), we further get $\hat{c}_t^T > 0$ thus $\hat{i}_t < 0$.

A.8 Robustness on FC Liability/GDP and Currency Devaluation

Table A.1: Foreign Currency Liability/GDP and Currency Devaluation (excluding sovereign debt crises)

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) devaluation
FC liability/GDP	0.151**	0.192***	0.199***	0.208***	0.217***
	(0.060)	(0.056)	(0.057)	(0.060)	(0.066)
LC liability/GDP	-0.289***	-0.306***	-0.323***	-0.261***	-0.278***
	(0.083)	(0.076)	(0.083)	(0.083)	(0.087)
control of corruption	-0.075**	-0.106***	-0.102***	-0.332**	-0.331**
	(0.036)	(0.034)	(0.036)	(0.126)	(0.128)
q GDP loss		-0.123		-0.133	
		(0.086)		(0.099)	
h GDP loss			-0.193		-0.315
			(0.220)		(0.396)
OECD dummy				0.615	0.628
				(0.382)	(0.387)
export/GDP				-0.077	-0.078
				(0.447)	(0.452)
broad money/reserves				-0.096	-0.111
				(0.148)	(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 A.2: Foreign Currency Liability/GDP and Inflation, Bailout (excluding sovereign debt crises)

	(1) inflation	(2) inflation	(3) inflation	(4) bailout	(5) bailout	(6) bailout
FC liability/GDP	0.076**	0.077**	0.083***	0.342**	0.488**	0.471**
	(0.030)	(0.028)	(0.026)	(0.150)	(0.172)	(0.184)
LC liability/GDP	-0.110**	-0.073*	-0.084**	-1.389***	-1.388**	-1.372**
	(0.041)	(0.038)	(0.035)	(0.399)	(0.514)	(0.542)
control of corruption	-0.057***	-0.134***	-0.135***	-0.671***	-1.195***	-1.180***
	(0.015)	(0.039)	(0.038)	(0.154)	(0.280)	(0.289)
q GDP loss		-0.046			-0.181	
		(0.032)			(0.455)	
h GDP loss			-0.244*			0.174
			(0.141)			(1.013)
OECD dummy		0.185	0.198*		1.157	1.141
		(0.114)	(0.113)		(0.796)	(0.802)
export/GDP		0.040	0.063		0.811	0.663
		(0.122)	(0.121)		(1.207)	(1.245)
broad money/reserves		-0.119	-0.164**		0.501	0.484
		(0.073)	(0.078)		(0.587)	(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(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(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 A.3: Foreign Currency Debt/GDP and Currency Devaluation

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) devaluation
FC liability/GDP	0.100	0.148**	0.151**	0.198***	0.201**
	(0.070)	(0.062)	(0.063)	(0.071)	(0.083)
LC liability/GDP	-1.073*	-1.217**	-1.216**	-1.552**	-1.701***
	(0.552)	(0.543)	(0.545)	(0.593)	(0.572)
control of corruption	-0.071	-0.099**	-0.101**	-0.181	-0.171
	(0.043)	(0.044)	(0.045)	(0.127)	(0.129)
q GDP loss		-0.046		0.026	
		(0.115)		(0.139)	
h GDP loss			0.080		0.377
			(0.312)		(0.415)
OECD dummy				0.306	0.294
				(0.360)	(0.365)
export/GDP				-0.701	-0.733*
				(0.416)	(0.396)
broad money/reserves				0.039	0.152
				(0.165)	(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 A.4: Foreign Currency Debt/GDP and Inflation, Bailout

	(1) inflation	(2) inflation	(3) inflation	(4) bailout	(5) bailout	(6) bailout
FC liability/GDP	0.071**	0.074**	0.073**	0.030	0.321	0.316*
	(0.029)	(0.031)	(0.028)	(0.244)	(0.234)	(0.177)
LC liability/GDP	-0.605***	-0.473**	-0.447**	-3.915	-6.700**	-7.016**
	(0.208)	(0.224)	(0.208)	(2.475)	(2.707)	(2.585)
control of corruption	-0.046***	-0.094**	-0.097**	-0.648***	-0.817**	-0.787**
	(0.015)	(0.038)	(0.038)	(0.196)	(0.334)	(0.338)
q GDP loss		-0.016			0.171	
		(0.038)			(0.547)	
h GDP loss			-0.093			1.589
			(0.130)			(1.020)
OECD dummy		0.112	0.117		0.315	0.269
		(0.108)	(0.107)		(0.807)	(0.812)
export/GDP		-0.088	-0.082		-1.225	-1.283
		(0.100)	(0.100)		(1.136)	(1.134)
broad money/reserves		-0.075	-0.097		2.379	2.633
		(0.068)	(0.074)		(1.748)	(1.734)
N	46	39	39	34	29	29
R^2	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(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(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 A.5: Foreign Currency Debt/GDP Held by Foreign Banks and Currency Devaluation (BIS-LBS data)

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) devaluation
FC liability/GDP	0.478***	0.440***	0.462***	0.439***	0.461***
	(0.163)	(0.112)	(0.115)	(0.122)	(0.128)
LC liability/GDP	-2.466***	-2.477***	-2.555***	-2.110**	-2.178**
	(0.840)	(0.776)	(0.789)	(0.838)	(0.848)
control of corruption	-0.101**	-0.097**	-0.094**	-0.099	-0.101
	(0.043)	(0.045)	(0.046)	(0.082)	(0.082)
q GDP loss		-0.056		-0.060	
		(0.097)		(0.099)	
h GDP loss			-0.182		-0.183
			(0.300)		(0.342)
OECD dummy				-0.023	-0.010
				(0.187)	(0.193)
export/GDP				-0.497**	-0.494**
				(0.244)	(0.241)
broad money/reserves				0.030	0.015
				(0.130)	(0.149)
N	61	49	49	48	48
R^2	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 A.6: Foreign Currency Debt/GDP Held by Foreign Banks and Inflation, Bailout (BIS-LBS data)

	(1) inflation	(2) inflation	(3) inflation	(4) bailout	(5) bailout	(6) bailout
FC liability/GDP	0.124**	0.110**	0.134***	0.812***	0.959***	0.763**
	(0.049)	(0.042)	(0.042)	(0.291)	(0.307)	(0.355)
LC liability/GDP	-0.650**	-0.566*	-0.624*	-10.234***	-9.771***	-9.452***
	(0.268)	(0.307)	(0.314)	(2.313)	(2.810)	(2.801)
control of corruption	-0.062***	-0.069**	-0.070**	-0.463**	-0.584*	-0.548*
	(0.016)	(0.029)	(0.029)	(0.195)	(0.307)	(0.304)
q GDP loss		-0.035			0.110	
		(0.035)			(0.513)	
h GDP loss			-0.174			1.352
			(0.132)			(1.156)
OECD dummy		0.014	0.024		-0.017	-0.058
		(0.072)	(0.073)		(0.661)	(0.653)
export/GDP		-0.002	0.008		-0.523	-0.584
		(0.104)	(0.098)		(0.824)	(0.853)
broad money/reserves		-0.076	-0.105*		0.923	1.052
		(0.055)	(0.060)		(0.677)	(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(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(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 A.7: Banks' Foreign Currency Debt/GDP Held by Foreign Banks and Currency Devaluation (BIS-LBS data)

	(1) devaluation	(2) devaluation	(3) devaluation	(4) devaluation	(5) devaluation
FC liability/GDP	0.362*	0.479***	0.499***	0.450***	0.462***
	(0.187)	(0.139)	(0.147)	(0.139)	(0.151)
LC liability/GDP	-2.464***	-2.982***	-3.059***	-2.494**	-2.554**
	(0.912)	(0.898)	(0.934)	(0.955)	(0.962)
control of corruption	-0.099**	-0.100**	-0.097**	-0.097	-0.099
	(0.042)	(0.044)	(0.045)	(0.085)	(0.086)
q GDP loss		-0.072		-0.071	
		(0.101)		(0.106)	
h GDP loss			-0.185		-0.154
			(0.308)		(0.353)
OECD dummy				-0.026	-0.014
				(0.196)	(0.203)
export/GDP				-0.479*	-0.471*
				(0.243)	(0.239)
broad money/reserves				0.055	0.058
				(0.142)	(0.156)
N	61	49	49	48	48
R^2	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 A.8: Banks' Foreign Currency Debt/GDP Held by Foreign Banks and Inflation, Bailout (BIS-LBS data)

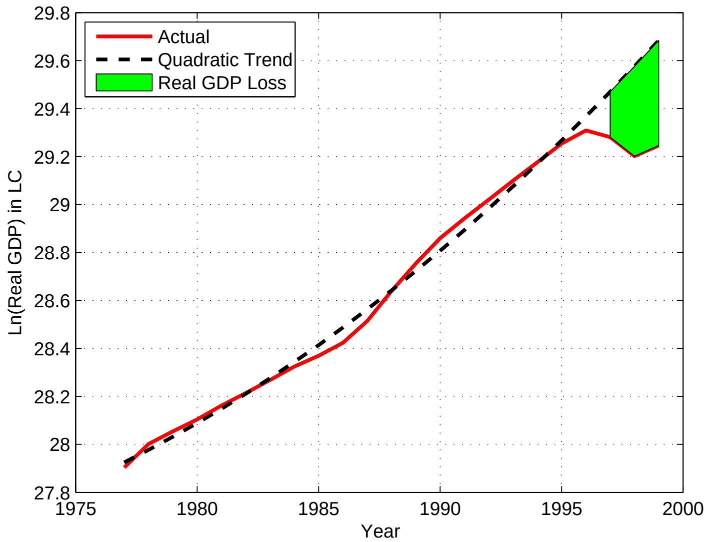
	(1)	(2)	(3)	(4)	(5)	(6)
	inflation	inflation	inflation	bailout	bailout	bailout
FC liability/GDP	0.147*	0.108	0.135*	0.999**	1.221***	0.929*
	(0.077)	(0.074)	(0.073)	(0.427)	(0.398)	(0.490)
LC liability/GDP	-0.819**	-0.667	-0.736*	-13.267***	-12.704***	-12.120***
	(0.377)	(0.400)	(0.405)	(3.045)	(3.395)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

Robust standard errors in parentheses

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

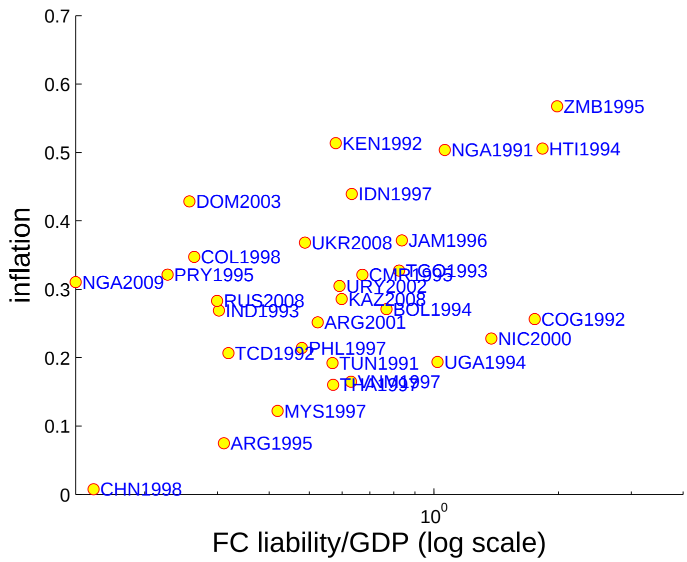
Notes: this table shows the relationship between domestic banks' foreign currency debt/GDP held by foreign banks before crises and inflation, bailout during crises. Each observation is a financial crisis. Dependent variable in the first 3 columns is inflation/(1+inflation), where inflation rate is ln(CPI) 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(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 A.2: Calculation of GDP Loss: Thailand 1997 Financial Crisis



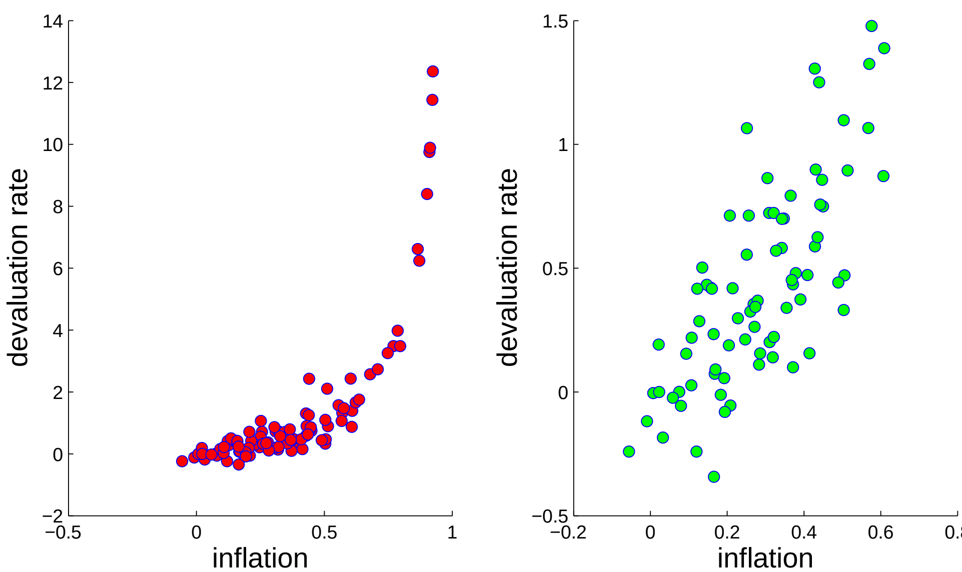
Notes: this figure illustrates the construction of 3-year GDP loss. Year 1997 is the crisis start year. I use year 1977-1996 real GDP to estimate a quadratic trend and predict year 19997-1999 real GDP. Real GDP loss is calculated as the cumulative gap between predicted $\ln(GDP)$ and actual $\ln(GDP)$ in year 1997-1999.

Figure A.3: Inflation and FC Liability/GDP (non-OECD)



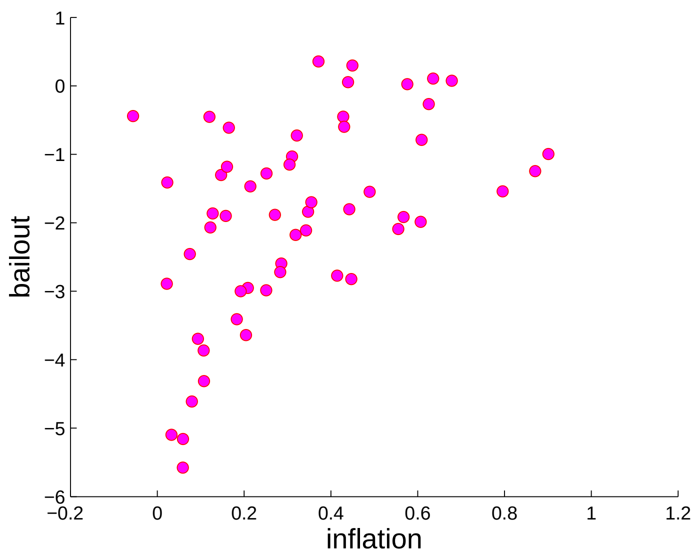
Notes: this figure shows the raw data of inflation in crises against FC (foreign currency) liability/GDP before crises for non-OECD group. Each dot is a financial crisis with country code and year on the right of each dot. Inflation is $\pi/(1+\pi)$ (for noise reducing purpose), where π is ln(CPI) change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

Figure A.4: 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 π is ln(CPI) change from T-2 to T+2 and T is crisis start year and devaluation is ln(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 A.5: 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 π is ln(CPI) change from T-2 to T+2 and T is crisis start year. Bailout is measured as ln(fiscal cost of restructuring financial sector/financial sector asset).

Appendix B

Appendix of Chapter 2

B.1 Data Sources

Figure 2.1 takes data from International Debt Statistics available in WDI. Public external debt refers to “public and publicly guaranteed external debt, including the national government, political subdivisions (or an agency of either), and autonomous public bodies, and external obligations of private debtors that are guaranteed for repayment by a public entity." Private external debt means“external obligations of private debtors that are not guaranteed for repayment by a public entity."

Figure 2.2 utilizes data from Lane and Milesi-Ferretti (2007), Merler, Pisani-Ferry et al. (2012) and WDI. Lane and Milesi-Ferretti (2007) provides data on debt asset, debt liability[1], GDP of nations in current US dollars, while Merler, Pisani-Ferry et al. (2012) contains information on foreign residents' holdings of a nation's government debt in terms of current Euros, which we take as public sector's (net) external debt. These holdings are then converted to US dollars by exchange rate data between US dollars and Euros from WDI. A nation's aggregate net external debt deducted by the government's external debt is regarded as private sector's net external debt. We look into sixteen EU27 countries. Germany, France, Italy and UK are excluded since they are big countries in the Europe. We also exclude advanced countries Belgium, Denmark, Finland, Netherland, Sweden and Luxembourg. Cyprus is further dropped as she is sometimes labeled as a “tax haven" which could mask its debt data. We keep Ireland (despite she is also sometimes labeled as a “tax haven") as she is explored in the literature that bailout ignites her sovereign debt crisis. However, one should not read its constructed private sector's net external debt in Figure 2.2 at its face value, either.

Figure 2.3 data are downloaded from each central bank's website.

[1]Here we don't use IIP (international investment position) asset and liability, as other international investment positions, for example, equity is contingent liability and FDI may involve technology transfer. However, as robustness check, if we use IIP instead, similar patterns in general preserve.

B.2 Discussions on Households' Access to External Saving

In the paper, we have forbid households to participate in the international debt market. Now we allow households to be able to save in international debt market with R_t^s, we derive the Euler equation for households:

$$\frac{1}{R_t^s} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}\right) \tag{B.2.1}$$

Denote b_{ht} as households' holding of foreign bonds. The system of equations for the competitive equilibrium includes

$$C_t = Z_t F(K_{bt}) + Z_t H(K - K_{bt}) - b_t - b_{ht} + \frac{b_{t+1}}{R_t} + \frac{b_{h,t+1}}{R_t^s} \tag{B.2.2}$$

$$\Lambda_t = u'(C_t) \tag{B.2.3}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}H'(K - K_{b,t+1}) + q_{t+1})] \tag{B.2.4}$$

$$(1+\mu_t)\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right) \tag{B.2.5}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}F'(K_{b,t+1}) + q_{t+1})(1+\mu_{t+1}) - \underline{\mathrm{d}}\mu_{t+1}Z_{t+1}F'(K_{b,t+1})]\right) \tag{B.2.6}$$

$$\mu_t\left((1-\underline{\mathrm{d}})Z_t F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1})\right) = 0 \tag{B.2.7}$$

$$(1-\underline{\mathrm{d}})Z_t F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) \geq 0 \tag{B.2.8}$$

given initial K_{b0}, b_0, $b_{h0} = 0$ and exogenous $\{Z_t, R_t\}$.

Proposition 15. *If $R_t^s = R_t$, the decentralized competitive equilibrium can replicate first-best economy.*

Proof. Set $b_{t+1} \geq -R_t\left((1-\underline{\mathrm{d}})Z_t F(K_b^*) - b_t\right)$ and $b_{h,t+1} = b_{t+1}^{FB} - b_{t+1}$, then the financial frictions don't bind and all the equilibrium conditions are satisfied as the first-best economy, taking $b_t + b_{ht}$ as the corresponding equivalence of b_t in the model without household access to foreign bond. □

The intuition behind the above proposition is that once households can save as much as possible with banks' borrowing cost, the marginal value of consumption becomes very high. The high marginal value of consumption translates into banks' incentives to pay more dividends, making the dividend constraints irrelevant. The key is to allow households have a saving technology with interest rate R_t. In other words, we just need household debt b_{ht} to be unbounded below, the above proposition still applies.

The interest rate shock R_t to banks in this paper could be understood as a spread shock during the crisis. Admittedly, I didn't introduce an endogenous default of banks or intermediation cost of foreign investors so as to produce an endogenous spread. Therefore, my banking crisis model's interest rate shock is a short-cut representation of spread hike. Suppose $R_t^s < R_t$, say, Ireland households can save in risk free German bonds with interest rate R_t^s and German bonds pay smaller interest rate than Ireland bonds. In this scenario, the next proposition establishes that dividend constraints would still matter when households in addition face borrowing constraint. As a matter of fact, we return to the decentralized competitive equilibrium without households' access to external saving.

Proposition 16. *In the one-time shock case, if $R_t^s < R_t$ and sufficiently small, and households are not allowed to borrow so that $b_{ht} \geq 0$, then households external debt would always be* 0.

Proof. Denote the Lagrangian multiplier of households' no borrowing constraint as ν_t. The Euler equation for households saving is

$$\Lambda_t = \beta R_t^s E_t \Lambda_{t+1} + \nu_t$$

In steady state, $R^s < R$, we get that $\nu_t > 0$, so $b_{ht} = 0$. While in period 0,

$$(1 + \mu_0)\Lambda_0 = \beta \hat{R} \Lambda_1$$

Therefore,

$$\nu_0 = \beta\Lambda_1(\frac{\hat{R}}{1+\mu_0} - \hat{R}^s)$$

It is also true that $\mu_0 > 0$ as long as $R^s < \frac{\hat{R}}{1+\mu_0}$. In my numerical example, $\frac{\hat{R}}{1+\mu_0} > \frac{1}{\beta} > R^s$, so as long as $R^s < \frac{1}{\beta}$, it is enough to guarantee that $b_{ht} = 0, \forall t$. □

From the small open economy's perspective, since households external saving pays less than banks' borrowing cost, when the economy is indebted, she doesn't want households' to save at all. One may wonder that not allowing households to access borrowing at all is too strict a precondition. However, if households are able to borrow but at a higher interest rate than banks, we can show that still $b_{ht} = 0\ \forall t$ holds.

Proposition 17. *In the one-time shock case, if $R_t^s < R_t$ and sufficiently small, and households' borrowing cost is $R_t^b > R_t$, then household saving/borrowing would always be* 0.

Proof. We only need to tackle with excluding the borrowing possibility now. We first add a pseudo constraint $b_{ht} \geq 0$. Denote the Lagrangian multiplier on this constraint as ν_{bt}. The Euler equation is

$$\Lambda_t = \beta R_t^b E_t \Lambda_{t+1} - \nu_{bt}$$

In steady state, $R^b > R$, we get that $\nu_{bt} > 0$, so that $b_{ht} = 0$. While in period 0, recall that the Euler equation for banks' debt is

$$(1+\mu_0)\Lambda_0 = \beta\hat{R}\Lambda_1$$

Therefore,

$$\nu_{b0} = \beta\Lambda_1(\hat{R}^b - \frac{\hat{R}}{1+\mu_0})$$

As long as $\hat{R}^b > \hat{R}$, we conclude that $\nu_{b0} > 0$, so households will not borrow. □

When households need to pay higher borrowing cost above banks', the economy would rather let banks borrow from abroad instead of households. In reality, this higher external borrowing cost could be a result of additional intermediation cost for households or more severe agency frictions of households beyond banks.

B.3 Solution Procedures in Section 2.2.6

Bank capital starts at $K_{b0} = K_b^*$. Upon that the interest rate shock arrives in period 0, financial constraint binds. Banks choose debt b_1 and capital K_{b1}. From period 1 on, the interest rate returns to $\frac{1}{\beta}$, the financial constraint no longer binds (as mentioned above, we guess and verify under some values of $\hat{R}$, this is true.) In other words, given b_1 and K_{b1}, we first solve the no-binding equilibrium for $t \geq 1$. Consumption in period 1 is

$$C_1 = F(K_{b1}) + H(K - K_{b1}) - b_1 + \frac{b_2}{R}$$

Since financial constraints will not bind for $t \geq 1$, we have $K_{bt} = K_b^*$, for $t \geq 2$, consumption in period 2 is

$$C_2 = F(K_b^*) + H(K - K_b^*) - b_2 + \frac{b_2}{R}$$

Recall that the Euler equation shows that

$$\Lambda_1 = \Lambda_2$$

So we obtain $C_1 = C_2$ thus

$$b_2 = b_1 + F(K_b^*) + H(K - K_b^*) - F(K_{b1}) - H(K - K_{b1})$$

We conclude that C_1 is a function of b_1 and K_{b1} in the following form:

$$C_1 = F(K_{b1}) + H(K - K_{b1}) - b_1 + \frac{b_1 + F(K_b^*) + H(K - K_b^*) - F(K_{b1}) - H(K - K_{b1})}{R}$$

It is also straightforward to see that capital price $q_t = q^*$ when $t \geq 1$.

Next we go back to period 0, the following equations hold:

$$C_0 = F(K_b^*) + H(K - K_b^*) - b_0 + \frac{b_1}{\hat{R}}$$

$$q_0 = \beta \frac{\Lambda_1}{\Lambda_0} \left(H'(K - K_{b1}) + q^* \right)$$

$$q_0(1 + \mu_0) = \beta \frac{\Lambda_1}{\Lambda_0} \left(F'(K_{b1}) + q^* \right)$$

$$(1 + \mu_0) \frac{1}{\hat{R}} = \beta \frac{\Lambda_1}{\Lambda_0}$$

$$(1 - \underline{\mathrm{d}}) F(K_b^*) - b_0 + \frac{b_1}{\hat{R}} + q_0 (K_b^* - K_{b1}) = 0$$

$$\Lambda_0 = u'(C_0)$$

$$\Lambda_1 = u'(C_1)$$

Remember that C_1 is in fact a function of b_1 and K_{b1}, so the last equation can be substituted by

$$\Lambda_1 = u' \left(F(K_{b1}) + H(K - K_{b1}) - b_1 + \frac{b_1 + F(K_b^*) + H(K - K_b^*) - F(K_{b1}) - H(K - K_{b1})}{R} \right)$$

We have in total 7 equations and 7 unknowns $\{q_0, \mu_0, \Lambda_0, \Lambda_1, C_0, b_1, K_{b1}\}$ given b_0 and $\hat{R}$, which will be solved numerically.

B.4 Equilibrium Conditions in Section 2.3.7

B.4.1 Private Sector

In order to avoid repeating the tedious procedures in Section 2.6, we directly write down the equilibrium conditions in the private sector:

$$q_0 = \beta \frac{\Lambda_1}{\Lambda_0} \left((1 - \tau) H'(K - K_{b1}) + q^* \right) \tag{B.4.1}$$

$$q_0(1+\mu_0) = \beta\frac{\Lambda_1}{\Lambda_0}((1-\tau)F'(K_{b1}) + q^*) \tag{B.4.2}$$

$$C_0 = (1-\tau)F(K_b^*) + (1-\tau)H(K-K_b^*) - b_0 + \frac{b_1}{\hat{R}} + \omega_0 \tag{B.4.3}$$

$$(1+\mu_0)\frac{1}{\hat{R}} = \beta\frac{\Lambda_1}{\Lambda_0} \tag{B.4.4}$$

$$(1-\underline{\mathrm{d}})(1-\tau)F(K_b^*) - b_0 + \frac{b_1}{\hat{R}} + q_0(K_b^* - K_{b1}) + \omega_0 = 0 \tag{B.4.5}$$

$$\Lambda_0 = u'(C_0) \tag{B.4.6}$$

$$\begin{aligned}\Lambda_1 =& u'((1-\tau)F(K_{b1}) + (1-\tau)H(K-K_{b1}) - b_1 \\ &+ \frac{b_1 + (1-\tau)F(K_b^*) + (1-\tau)H(K-K_b^*) - (1-\tau)F(K_{b1}) - (1-\tau)H(K-K_{b1})}{R})\end{aligned} \tag{B.4.7}$$

We have in total 7 equations and 7 unknowns $\{q_0, \mu_0, \Lambda_0, \Lambda_1, C_0, b_1, K_{b1}\}$.

B.4.2 Public Sector

At time 0, the government implements a transfer $\omega_0 \geq 0$ to banks.

$$G_0 = \tau F(K_b^*) + \tau H(K-K_b^*) - B_{g0} + \frac{B_{g1}}{\hat{R}} - \omega_0$$

$$G_1 = \tau F(K_{b1}) + \tau H(K-K_{b1}) - B_{g1} + \frac{B_{g2}}{R}$$

and

$$\frac{1}{\hat{R}} = \beta\frac{\Lambda_{g1}}{\Lambda_{g0}}$$

$$\Lambda_{g1} = v'(G_1)$$

$$\Lambda_{g0} = v'(G_0)$$

where we should notice that when interest goes back to steady state value, government debt $B_{g2} = B_{g1}$. So we have 6 equations and 6 unknowns $\{\Lambda_{g0}, \Lambda_{g1}, G_0, G_1, B_{g1}, B_{g2}\}$.

B.5 Competitive Equilibrium in Section 2.3.9

Denoting ν_t as the Lagrangian multiplier on the debt limit constraint. We again omit the long derivation procedures. Given bailout ω_t to banks, a competitive equilibrium with public good is defined as a set of sequences $\{C_t, \Lambda_t, G_t, \Lambda_{gt}, b_{t+1}, B_{g,t+1}, K_{b,t+1}, q_t, \mu_t \geq 0, \nu_t \geq 0\}$ satisfying

$$C_t = Z_t(1-\tau)F(K_{bt}) + Z_t(1-\tau)H(K-K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + \omega_t \tag{B.5.1}$$

$$\Lambda_t = u'(C_t) \tag{B.5.2}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}(1-\tau)H'(K-K_{b,t+1}) + q_{t+1})] \tag{B.5.3}$$

$$(1+\mu_t)\frac{1}{R_t} - \nu_t = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right) \tag{B.5.4}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}(1-\tau)F'(K_{b,t+1}) + q_{t+1})(1+\mu_{t+1}) - \underline{\text{d}}\mu_{t+1}Z_{t+1}(1-\tau)F'(K_{b,t+1})]\right) \tag{B.5.5}$$

$$\mu_t\left((1-\underline{\text{d}})Z_t(1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt}-K_{b,t+1}) + \omega_t\right) = 0 \tag{B.5.6}$$

$$(1-\underline{\text{d}})Z_t(1-\tau)F(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt}-K_{b,t+1}) + \omega_t \geq 0 \tag{B.5.7}$$

$$\nu_t(\bar{b}_{t+1} - b_{t+1}) = 0 \tag{B.5.8}$$

$$b_{t+1} \leq \bar{b}_{t+1} \tag{B.5.9}$$

$$G_t = \tau F(K_{bt}) + \tau H(K-K_{bt}) - b_{gt} + \frac{b_{g,t+1}}{R_t} - \omega_t \tag{B.5.10}$$

$$\Lambda_{gt} = v'(G_t) \tag{B.5.11}$$

$$\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{g,t+1}}{\Lambda_{gt}}\right) \tag{B.5.12}$$

Equilibrium Conditions in Section 2.3.10

Private Sector

The private sector equilibrium conditions carry a debt constraint with multiplier ν_0 as well:

$$q_0 = \beta \frac{\Lambda_1}{\Lambda_0}((1-\tau)H'(K-K_{b1}) + q^*) \tag{B.5.13}$$

$$q_0(1+\mu_0) = \beta \frac{\Lambda_1}{\Lambda_0}((1-\tau)F'(K_{b1}) + q^*) \tag{B.5.14}$$

$$C_0 = (1-\tau)F(K_b^*) + (1-\tau)H(K-K_b^*) - b_0 + \frac{b_1}{\hat{R}} + \omega_0 \tag{B.5.15}$$

$$(1+\mu_0)\frac{1}{\hat{R}} - \nu_0 = \beta \frac{\Lambda_1}{\Lambda_0} \tag{B.5.16}$$

$$(1-\underline{\mathrm{d}})(1-\tau)F(K_b^*) - b_0 + \frac{b_1}{\hat{R}} + q_0(K_b^* - K_{b1}) + \omega_0 = 0 \tag{B.5.17}$$

$$b_1 = \bar{b}_1, \nu_0 > 0 \tag{B.5.18}$$

$$\Lambda_0 = u'(C_0) \tag{B.5.19}$$

$$\begin{aligned} \Lambda_1 =& u'((1-\tau)F(K_{b1}) + (1-\tau)H(K-K_{b1}) - b_1 \\ &+ \frac{b_1 + (1-\tau)F(K_b^*) + (1-\tau)H(K-K_b^*) - (1-\tau)F(K_{b1}) - (1-\tau)H(K-K_{b1})}{R}) \end{aligned} \tag{B.5.20}$$

B.5.1 Public Sector

The public sector equilibrium conditions don't change compared to Section 2.7.3.2.

B.6 Proofs

B.6.1 Proof of Proposition 7

With lump-sum transfer from household to banks, the equilibrium conditions are as follows:

$$C_t = Z_t F(K_{bt}) + Z_t H(K-K_{bt}) - b_t + \frac{b_{t+1}}{R_t} \tag{B.6.1}$$

$$\Lambda_t = u'(C_t) \tag{B.6.2}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}H'(K - K_{b,t+1}) + q_{t+1})] \tag{B.6.3}$$

$$(1+\mu_t)\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right) \tag{B.6.4}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}F'(K_{b,t+1}) + q_{t+1})(1+\mu_{t+1}) - \underline{\mathrm{d}}\mu_{t+1}Z_{t+1}F'(K_{b,t+1})]\right) \tag{B.6.5}$$

$$\mu_t\left((1-\underline{\mathrm{d}})Z_tF(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) + T_t\right) = 0 \tag{B.6.6}$$

$$(1-\underline{\mathrm{d}})Z_tF(K_{bt}) - b_t + \frac{b_{t+1}}{R_t} + q_t(K_{bt} - K_{b,t+1}) + T_t \geq 0 \tag{B.6.7}$$

Set $T_t \geq -\left((1-\underline{\mathrm{d}})Z_tF(K_b^*) - b_t^{FB} + \frac{b_{t+1}^{FB}}{R_t}\right)$, we can see that the first-best allocations satisfy all the equilibrium conditions with $\mu_t = 0, \forall t$.

B.6.2 Proof of Proposition 8

With the balance sheet of the government, the equilibrium conditions are

$$\frac{B_{g,t+1}}{R_t} = B_{gt} + T_t \tag{B.6.8}$$

$$C_t = Z_tF(K_{bt}) + Z_tH(K - K_{bt}) - b_t + \frac{b_{t+1}}{R_t} - B_{gt} + \frac{B_{g,t+1}}{R_t} \tag{B.6.9}$$

$$\Lambda_t = u'(C_t) \tag{B.6.10}$$

$$q_t = \beta E_t[\frac{\Lambda_{t+1}}{\Lambda_t}(Z_{t+1}H'(K - K_{b,t+1}) + q_{t+1})] \tag{B.6.11}$$

$$(1+\mu_t)\frac{1}{R_t} = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}(1+\mu_{t+1})\right) \tag{B.6.12}$$

$$q_t(1+\mu_t) = \beta E_t\left(\frac{\Lambda_{t+1}}{\Lambda_t}[(Z_{t+1}F'(K_{b,t+1}) + q_{t+1})(1+\mu_{t+1}) - \underline{\mathrm{d}}\mu_{t+1}Z_{t+1}F'(K_{b,t+1})]\right) \tag{B.6.13}$$

$$\mu_t\left((1-\underline{\mathrm{d}})Z_tF(K_{bt})-b_t+\frac{b_{t+1}}{R_t}+q_t(K_{bt}-K_{b,t+1})+T_t\right)=0 \tag{B.6.14}$$

$$(1-\underline{\mathrm{d}})Z_tF(K_{bt})-b_t+\frac{b_{t+1}}{R_t}+q_t(K_{bt}-K_{b,t+1})+T_t\geq 0 \tag{B.6.15}$$

By substituting T_t using the government's budget constraint, the last two equations can be re-written as

$$\mu_t\left((1-\underline{\mathrm{d}})Z_tF(K_{bt})-b_t+\frac{b_{t+1}}{R_t}+q_t(K_{bt}-K_{b,t+1})-B_{gt}+\frac{B_{g,t+1}}{R_t}\right)=0 \tag{B.6.16}$$

$$(1-\underline{\mathrm{d}})Z_tF(K_{bt})-b_t+\frac{b_{t+1}}{R_t}+q_t(K_{bt}-K_{b,t+1})-B_{gt}+\frac{B_{g,t+1}}{R_t}\geq 0 \tag{B.6.17}$$

Set $b_{t+1}+B_{g,t+1}=b_{t+1}^{DE}$, $K_{bt}=K_{bt}^{DE}$, all the equilibrium conditions are satisfied, where the superscript DE represents the decentralized competitive equilibrium in Section 2.3 with initial bank debt equals to b_0+B_{g0}.

B.6.3 Proof of Proposition 9

To simplify notations, without loss of generality, let's proceed with $\tau=\frac{1}{2}$ so that the private and the public sector have the same utility function, the same revenue flows and the same initial debt. Write $y^*=\frac{1}{2}\left(H(K-K_b^*)+F(K_b^*)\right)$ and $y_1=\frac{1}{2}(H(K-K_{b1})+F(K_{b1}))$. With $\mu_0>0$, we must have $y_1<y^*$. I will keep using log utility but the conclusion should be applied to other CRRA utility functions as well.

For the public sector, the lifetime budget constraint is:

$$G_0+\frac{1}{\hat{R}}\left(\sum_{j=1}^{+\infty}\frac{G_j}{R^{j-1}}\right)=y^*+\frac{1}{\hat{R}}\left(y_1+\sum_{j=2}^{+\infty}\frac{y^*}{R^{j-1}}-b_0\right)$$

By Euler equation, we also know that $G_j=G_{j-1}$, $\forall j\geq 2$, therefore, the above equation can be rewritten as

$$G_0+\frac{G_1}{R-1}\frac{R}{\hat{R}}=y^*+\frac{1}{\hat{R}}y_1+\frac{1}{\hat{R}}\frac{y^*}{R-1}-b_0 \tag{B.6.18}$$

In addition, the Euler equation in period 0 tells

$$\beta\hat{R} = \frac{\Lambda_{g0}}{\Lambda_{g1}} = \frac{G_1}{G_0}. \tag{B.6.19}$$

Similarly, for the private sector, the lifetime budget constraint is:

$$C_0 + \frac{C_1}{R-1}\frac{R}{\hat{R}} = y^* + \frac{1}{\hat{R}}y_1 + \frac{1}{\hat{R}}\frac{y^*}{R-1} - b_0 \tag{B.6.20}$$

but the Euler equation in period 0 is a bit different:

$$\frac{\beta\hat{R}}{1+\mu_0} = \frac{\Lambda_0}{\Lambda_1} = \frac{C_1}{C_0}. \tag{B.6.21}$$

By comparing equations (B.6.18),(B.6.19) with (B.6.20),(B.6.21), we immediately get $C_1 < G_1$ and $C_0 > G_0$ given that $\mu_0 > 0$, so that $\Lambda_1 > \Lambda_{g1}$. It remains to show that a sufficiently small $\epsilon > 0$ transfer from the public sector to the private sector will increase aggregate welfare of households.

By assuming that $\mu_0(\epsilon) < \mu_0(0)$, we obtain that revenue in period 1 satisfies $y_1(\epsilon) > y_1(0)$. It means relaxing dividend constraint alleviates capital misallocation and pushes up aggregate output.

After we deduct ϵ from the public sector to the private sector, if y_1 doesn't change, then G_1 goes down by $\frac{\hat{R}(R-1)}{R^2}\epsilon$ and G_0 drops by $\frac{R-1}{R}\epsilon$. However, since $y_1(\epsilon) > y_1(0)$, we get $|\Delta G_1| < \frac{\hat{R}(R-1)}{R^2}\epsilon$ and $|\Delta G_0| < \frac{R-1}{R}\epsilon$. The public welfare decreases by

$$|\Delta G_0|\,\Lambda_{g0} + \frac{\beta}{1-\beta}|\Delta G_1|\Lambda_{g1} < \frac{R-1}{R}\epsilon\Lambda_{g0} + \frac{\beta}{1-\beta}\frac{\hat{R}(R-1)}{R^2}\epsilon\Lambda_{g1} = \frac{R}{\hat{R}}\epsilon\Lambda_{g1}$$

Then we are left to prove that the private sector's welfare increase would dominate the above. First, if after the bailout transfer, in the Euler equation (B.6.21), μ_0 doesn't change, then $\Delta C_1 > \frac{\hat{R}(R-1)}{R[(1+\mu_0)(R-1)+1]}\epsilon$ and $\Delta C_0 > \frac{(R-1)(1+\mu_0)}{(1+\mu_0)(R-1)+1}\epsilon$ as aggregate output $y_1(\epsilon) >$

$y_1(0)$. The private welfare increases by

$$\Delta C_0\Lambda_0 + \frac{\beta}{1-\beta}\Delta C_1\Lambda_1 > \frac{(R-1)(1+\mu_0)}{(1+\mu_0)(R-1)+1}\epsilon\Lambda_0 + \frac{\beta}{1-\beta}\frac{\hat{R}(R-1)}{R[(1+\mu_0)(R-1)+1]}\epsilon\Lambda_1$$
$$= \frac{R}{\hat{R}}\frac{R}{(1+\mu_0)(R-1)+1}\epsilon\Lambda_1$$

Going back to combine equations (B.6.18),(B.6.19) and also equations (B.6.20),(B.6.21), we obtain

$$\frac{R}{\hat{R}}\frac{(1+\mu_0)(R-1)+1}{R-1}C_1 = \frac{R}{\hat{R}}\frac{R}{R-1}G_1,$$

which means that $\frac{\Lambda_{g1}}{R} = \frac{\Lambda_1}{(1+\mu_0)(R-1)+1}$. So we draw the conclusion that transferring $\epsilon > 0$ from the public sector to banks leads to aggregate welfare improving, conditional on in the Euler equation (B.6.21), μ_0 doesn't change. Then we apply the following Lemma to complete the proof.

Lemma 4. *In equations (B.6.20) and (B.6.21), welfare in the private sector increases when μ_0 goes down.*

Proof. Solving (B.6.20) and (B.6.21) to arrive at

$$C_1 = \frac{(R-1)\hat{R}}{R[(1+\mu_0)(R-1)+1]}\left(y^* + \frac{1}{\hat{R}}y_1 + \frac{1}{\hat{R}}\frac{y^*}{R-1} - b_0\right)$$

and

$$C_0 = \frac{(R-1)(1+\mu_0)}{(1+\mu_0)(R-1)+1}\left(y^* + \frac{1}{\hat{R}}y_1 + \frac{1}{\hat{R}}\frac{y^*}{R-1} - b_0\right).$$

As a result, total private welfare is

$$\log C_0 + \frac{\beta}{1-\beta}\log C_1 = constant + \log\left(\frac{1+\mu_0}{(1+\mu_0)(R-1)+1}\right) + \frac{1}{R-1}\log\frac{1}{(1+\mu_0)(R-1)+1}$$

Take derivative with respect to μ_0 to obtain

$$\frac{1}{1+\mu_0} - \frac{R}{(1+\mu_0)(R-1)+1} = -\frac{\mu_0}{(1+\mu_0)[(1+\mu_0)(R-1)+1]} < 0, \text{ whenever } \mu_0 > 0.$$

It confirms that total private welfare increases when $\mu_0 \geq 0$ decreases. □

Using the above Lemma, we are certain that with $\mu(\epsilon) < \mu_0(0)$, private welfare will increase more than the case with fixed μ_0 in equation (B.6.21).

Appendix C

Appendix of Chapter 3

C.1 Data Sources

Total import, export, GDP, GDP per capita, population, land area, fuel export as a fraction of merchandise export, and income Gini: World Bank, World Development Indicator, available on World Bank DataBank website. In the cross sectional analysis, we fill missing Papua New Guinea import/GDP and export/GDP 2005 data with available 2004 data. Also missing data on total import and export of Ethiopia and Lesotho in year 2005 are substituted by **IMF DOTS** import and export data.

Longitude and latitude: CIA World Factbook, available at
https://www.cia.gov/library/publications/the-world-factbook/fields/2011.html

Coastline length: World Resource Institute, available at
https://web.archive.org/web/20120419075053/http://earthtrends.wri.org/text/coastal-marine/variable-61.html

Bilateral total (merchandised) trade: UNCTAD Statistics.

Political risk index: Political Risk Service Group, December data of each year.

Corruption perception index: Transparency International.

Control of corruption and **government effectiveness**: World Governance Indicators.

Expropriation risk: Political Risk Service Group, December data of each year. It is the Investment Profile component of political risk index.

Legal origin: LaPorta, Lopez-de-Silanes, Shleifer (2008, JEL), available at
http://scholar.harvard.edu/shleifer/publications/economic-consequences-legal-origins.

Mortality rate: Acemoglu, Johnson, and Robinson (2001, AER) Appendix Table A2.

MFN import tariff at country level of G7 and China: UNCTAD Statistics. The data represents MFN (Most Favoured Nation) and effectively applied import tariff rates (weighted average) by individual country (as market economy) on manufactured goods, ores and metals. Average tariff of a market country is calculated by taking those products (at HS 6-digit level) that are imported by the market country from each country so tariff rates for those products that are not traded are not included in the calculation.

MFN import tariffs at HS6 level of G7 and China: WITS (World Integrated Trade Solution). For products with multiple production lines, we take Simple Average directly reported in the dataset.

Export at HS 6 level to G7 and China for each country: UN Comtrade

General Government Expense and Employee Compensation: IMF Government Finance Statistics (GFS)

Industry relationship-specificity measure: Nunn(2007). Data available at http://scholar.harvard.edu/files/nunn/files/contract_intensity_io_1997.xls

Gross output/GDP in non-service sector: Constructed from GTAP. We take year 2004 data.

C.2 Gravity Equations with Institutional Quality

In this Appendix, we aim to verify a key assumption in our model: better institutional quality promotes international trade more than it does domestic trade.

We augment the standard empirical gravity equation in two ways. First, we expand the sample of bilateral trade to include internal trade (a country's trade with itself) for all countries in the sample. Second, we add by institutional quality, and an interaction term between institutional quality and a dummy for international trade as additional regressors.

A country's internal trade is the difference between the value of its gross output and the value of its international trade (Wei, 1996). Since it is easy to obtain data on the value of bilateral merchandize trade but nearly impossible to obtain data on bilateral service trade, we will focus on merchandize trade. Using the national input-output tables in the GTAP (Global Trade Analysis Project) database, we compute gross output in the non-service sectors for all countries in 2005 by multiplying the value added in the non-service sectors in 2005 with the ratio of gross output/GDP in the non-service sectors in 2004[1]. A country's gross non-service trade with itself is then computed as its gross non-service output minus the sum of all its non-service exports to all other countries. Following Wei (1996), domestic distance for country i, d_{ii}, is proxied by 1/4 of the country's distance to the nearest neighbor.

We perform two sets of empirical regressions. The first empirical setup (no country fixed effect) is

$$\begin{aligned} \log(export_{ij}) &= \beta_0 + \beta_1 \log(d_{ij}) + \gamma_1 q_i + \gamma_2 q_j + \rho * dummy(i \neq j) * q_i \\ +\lambda * \; dummy(i &= j) + \upsilon_1 X_i + \nu_2 X_j + \mu q_i q_j + \epsilon_{ij} \end{aligned} \tag{C.2.1}$$

where the left hand side is exports from country i to country j, while on the right hand side, d_{ij} is the greater circle distance between countries i and j, q_i denotes institutional quality in country i, X_i includes $log(GDP)$[2], landlock dummy and coastline length/area.

In this specification, the key parameter of interest is ρ. A positive and significant coefficient on the interaction term would validate the idea that the same improvement in a country's institutions would promote more international trade more than it does internal trade.

The regression results are reported in Panel A of Table C.1. The standard gravity variables such exporter's log GDP and importer's log GDP are always positive and statistically significant (not reported to save space). A positive and significant coefficient on the dummy(i=j) shows home bias in trade. Most important to us, we find that the coefficient on importer's institutional quality (q_j) is positive and significant, and the coefficient on the interaction term ($dummy(i \neq j) * q_i$) is also positive and significant. This means that

[1] Because IO tables are not available for every year, we can obtain the ratio for 2004 and 2007 (in the neighborhood of 2005). The ratios in these two years are quite similar.

[2] We notice that when we perform gravity equations with institutional quality and GDP, one problem is that institutional quality could affect trade via its effect on GDP as well. To capture the total effect of institutional quality on trade, we use the predicted value of log(GDP) by log(population) to substitute log(GDP).

with an improvement in an importer's institution, there would be more bilateral trade with anyone (including with itself), and the increase in international trade is more than that in internal trade.

In Panel B of Table C.1, we instrument a country's institutional quality by settler mortality based on the idea of Acemoglu, Johnson and Robinson (2001). We obtain the same results. In particular, better institutions generate a bigger positive response in international trade than in domestic trade.

In the second specification, we add separate importer fixed effects and exporter fixed effects:

$$\begin{aligned} \log(\exp ort_{ij}) &= \beta_0+\beta_1 \log(d_{ij}) + \theta_i+\theta_j \\ + \rho * dummy(i &\neq j) * q_i+\lambda * dummy(i=j) + \mu q_i q_j+\epsilon_{ij} \end{aligned} \tag{C.2.2}$$

where θ_i and θ_j are exporter or importer fixed effects. This specification is more general than the first one, and therefore is preferred.

The results are reported in C.2. The coefficient, ρ, on the interaction term between a dummy for international trade and the importer's quality of institution is positive and statistically significant. This supports the notion that international trade is more sensitive to domestic institutional quality than internal trade.

Table C.1: Gravity Equation with Institutional Quality - No Fixed Effects

Dependent Variable: log($export_{ij}$)					
Panel A: No IV for Institutional Quality					
	(1)	(2)	(3)	(4)	(5)
$log(d_{ij})$	-1.574***	-1.696***	-1.636***	-1.578***	-1.618***
	(0.028)	(0.028)	(0.027)	(0.027)	(0.030)
q_i	0.015	-0.016	0.015	-0.085	-0.041
	(0.021)	(0.092)	(0.204)	(0.186)	(0.128)
q_j	0.107***	0.554***	1.295***	1.445***	0.582***
	(0.014)	(0.022)	(0.024)	(0.026)	(0.066)
$dummy(i \neq j) * q_i$	0.123***	0.722***	1.630***	1.913***	0.709***
	(0.017)	(0.090)	(0.205)	(0.188)	(0.119)
dummy(i=j)	18.414***	12.627***	9.899***	10.378***	16.227***
	(1.245)	(0.468)	(0.219)	(0.215)	(1.153)
Exporter Fixed Effect	No	No	No	No	No
Importer Fixed Effect	No	No	No	No	No
Institutional quality q measure	PR index	CPI	ctr corrupt	gvnment	exprop risk
N	9045	9702	10197	10197	9045
R^2	0.696	0.697	0.700	0.722	0.640

Panel B: Mortality Rate as IV for Institutional Quality					
	(1)	(2)	(3)	(4)	(5)
$log(d_{ij})$	-2.266***	-2.322***	-2.334***	-2.362***	-2.389***
	(0.079)	(0.075)	(0.079)	(0.074)	(0.108)
q_i	0.100	0.360	0.810	0.744	0.891
	(0.111)	(0.374)	(0.620)	(0.608)	(0.939)
q_j	0.209**	0.864***	1.899***	1.874***	1.563**
	(0.093)	(0.146)	(0.117)	(0.102)	(0.681)
$dummy(i \neq j) * q_i$	0.167***	0.805***	1.752***	1.820***	1.111**
	(0.062)	(0.300)	(0.640)	(0.620)	(0.470)
dummy(i=j)	18.642***	10.581***	7.234***	7.233***	16.925***
	(3.923)	(1.146)	(0.512)	(0.456)	(3.903)
Exporter Fixed Effect	No	No	No	No	No
Importer Fixed Effect	No	No	No	No	No
Institutional Quality q Measure	PR index	CPI	ctr corrupt	gvnment	exprop risk
N	2085	1946	2085	2085	2085
R^2	0.624	0.668	0.621	0.699	0.326

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports trade gravity equation with institutional quality and no country fixed effect. Panel A directly uses institutional quality while Panel B uses mortality rate as instrument variable.

Table C.2: Gravity Equation - Adding Importer and Exporter Fixed Effects

Dependent Variable: $\log(export_{ij})$

Panel A: No IV for Institutional Quality

	(1)	(2)	(3)	(4)	(5)
$log(d_{ij})$	-1.800***	-1.783***	-1.801***	-1.813***	-1.802***
	(0.028)	(0.027)	(0.027)	(0.027)	(0.028)
$dummy(i \neq j) * q_i$	0.127***	0.763***	1.702***	1.983***	0.734***
	(0.019)	(0.103)	(0.216)	(0.214)	(0.102)
dummy(i=j)	17.882***	12.619***	9.374***	9.571***	15.843***
	(1.347)	(0.504)	(0.243)	(0.231)	(0.995)
Exporter Fixed Effect	Yes	Yes	Yes	Yes	Yes
Importer Fixed Effect	Yes	Yes	Yes	Yes	Yes
Institutional quality q_i measure	PR index	CPI	ctr corrupt	gvnment	exprop risk
N	9045	9702	10197	10197	9045
R^2	0.828	0.825	0.821	0.821	0.829

Panel B: Mortality Rate as IV for Institutional Quality

	(1)	(2)	(3)	(4)	(5)
$log(d_{ij})$	-2.252***	-2.209***	-2.244***	-2.252***	-2.255***
	(0.059)	(0.058)	(0.058)	(0.059)	(0.058)
$dummy(i \neq j) * q_i$	0.161**	0.845**	1.796**	1.789**	1.100**
	(0.073)	(0.366)	(0.823)	(0.722)	(0.495)
dummy(i=j)	18.310***	11.159***	7.536***	7.636***	17.382***
	(4.654)	(1.347)	(0.487)	(0.412)	(4.166)
Exporter Fixed Effect	Yes	Yes	Yes	Yes	Yes
Importer Fixed Effect	Yes	Yes	Yes	Yes	Yes
Institutional Quality q Measure	PR index	CPI	ctr corrupt	gvnment	exprop risk
N	2085	1946	2085	2085	2085
R^2	0.829	0.836	0.830	0.832	0.829

Standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports trade gravity equation with institutional quality and both exporter and importer fixed effects. Panel A directly uses institutional quality while Panel B uses mortality rate as instrument variable.

C.3 Residual Openness and Institutional Quality

A country's actual openness (e.g., import as a share of GDP) is affected by both intrinsic (exogenous) openness and policies. In this appendix, we undertake a two-step exercise. First, we decompose a country's actual openness into (a) intrinsic openness - the fitted value from regressing the actual openness on the country's geographic features and the population size, and (b) "residual openness" - the residuals from the above regression. Second, we check how much a country's institutional quality could be "explained" by "residual openness" relative to intrinsic openness.

We start with the following regression:

$$\begin{aligned}\log(trade/GDP_i) \quad &= \quad \gamma_0+\gamma_1\log(population_i)+\gamma_2 remoteness_i+ \\ &\quad\quad \gamma_3 landlock\_dummy_i+\gamma_4 coast/area_i+\epsilon_i\end{aligned}$$

Table C.3 shows that the set of intrinsic openness variables collectively explains about 37% of the actual openness.

In the second step, we regress institutional quality on both the "residual openness" and the set of intrinsic openness variables. The institutional quality is measured by one of the five indices, respectively: the political risk index, control of corruption (as measured by Transparency International), control of corruption (as measured by the World Bank Institute), government effectiveness (WBI), and expropriation risk (WBI).

$$\begin{aligned}q_i \quad &= \quad \beta_0+\beta_1\log(population_i)+\beta_2 remoteness_i+\beta_3 landlock\_dummy_i \\ &\quad\quad +\beta_4 coast/area_i+\delta * residual\_open+\xi_i \qquad \text{(C.3.1)}\end{aligned}$$

Table C.4 reports the results. We find that residual openness is not statistically significant in any of the regressions, whereas the intrinsic openness variables do seem to matter as in the main text. In particular, a country that is relatively large or far from the world market or have a shorter coastline tends to have worse quality of institutions.

It is striking that "residual openness" is uncorrelated with quality of institutions. It suggests that variations in openness induced by own trade policies that are not explained by intrinsic openness are unlikely to influence institutional quality. (In comparison, our paper has shown that trade liberalization by other countries might very well affect a country's incentive to investing in institutional quality.)

Table C.3: Intrinsic Openness and log(trade/GDP)

	(1)	(2)	(3)	(4)	(5)	(6)
	log(trade/GDP)	log(trade/GDP)	log(trade/GDP)	log(trade/GDP)	log(trade/GDP)	log(trade/GDP)
log(population)	-0.159***		-0.171***	-0.175***	-0.153***	-0.157***
	(0.025)		(0.024)	(0.024)	(0.021)	(0.022)
remoteness		-0.460***	-0.549***	-0.548***	-0.484***	-0.488***
		(0.131)	(0.113)	(0.113)	(0.104)	(0.105)
landlock dummy				-0.130*		-0.075
				(0.078)		(0.072)
coast/area					1.098**	1.013**
					(0.425)	(0.458)
Observations	148	148	148	148	148	148
R^2	0.214	0.078	0.323	0.336	0.368	0.372

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regressions results of actual openness on intrinsic openness measures. Variable coast/area means coastline length divided by land area.

Table C.4: Intrinsic Openness, Residual Openness and Institutional Quality

	(1) PR index	(2) PR index	(3) CPI	(4) CPI	(5) ctr corrupt	(6) ctr corrupt	(7) gvnment	(8) gvnment	(9) exprop risk	(10) exprop ris
log(population)		-2.906***		-0.327***		-0.121***		-0.061		-0.435***
		(0.620)		(0.093)		(0.045)		(0.043)		(0.123)
remoteness		-16.244***		-1.539**		-0.845***		-1.166***		-2.389***
		(3.599)		(0.631)		(0.294)		(0.281)		(0.679)
landlock		-2.745		-0.442		-0.205		-0.243		-0.521
		(2.268)		(0.345)		(0.168)		(0.162)		(0.559)
coast/area		12.021		6.421***		2.618***		2.393***		2.806**
		(7.394)		(2.089)		(0.817)		(0.903)		(1.318)
residual open	0.710	0.510	-0.141	-0.247	-0.009	-0.009	0.168	0.168	0.389	0.356
	(3.263)	(2.878)	(0.557)	(0.435)	(0.243)	(0.204)	(0.251)	(0.213)	(0.696)	(0.665)
Observations	120	120	139	139	148	148	148	148	120	120
R^2	0.000	0.305	0.001	0.243	0.000	0.206	0.004	0.240	0.004	0.215

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Notes: this table reports the regressions results of institutional quality on intrinsic openness measures and residual openness. Variable coast/area means coastline length divided by land area.

C.4 A Scale Effect in the Public Sector?

In this appendix, we check if a larger population implies a lower cost in delivering public services as a share of GDP (the scale effect).

The dependent variable is general government expenditure (relative to GDP) from IMF's Government Finance Statistics (GFS). We regress

$$(gov\exp enditure_i/GDP_i) = \alpha_0 + \alpha_1 \log(population_i) + \epsilon_i \tag{C.4.1}$$

Government expenditure exhibits fluctuations from one year to the next. To reduce noise, the left hand side variable is averaged across all years during 2000-2015. The right hand side variable is log(population) in year 2005. The sample consists of all countries for which the data are available for at least five years during 2000-2015. If there is a scale effect, we would expect to see a negative coefficient on log population.

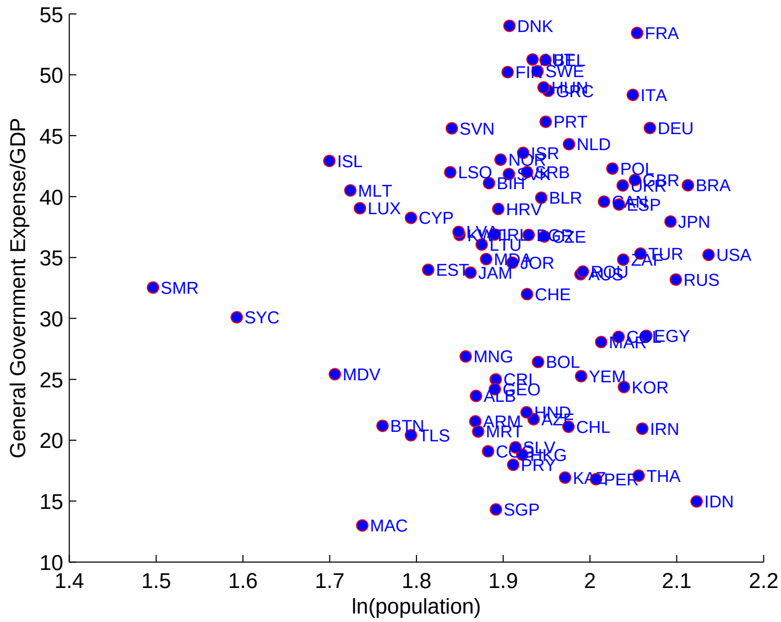
Figure C.1 presents a scatter plot. Contrary to the scale effect hypothesis, there is no discernible negative relationship between the two. The regression confirms this: the slope coefficient is even positive though not statistically significant. As another check, we replace the dependent variable by public sector payroll as a share of GDP, and present a scatter plot in Figure C.2. Again, we do not see a statistically significant relationship between the two variables.

As the population becomes larger, we suspect that the number of layers of government tends to increase also. That may be one reason why the data do not support the notion of a scale effect in public service provision.

C.5 Export Opportunities and Institutional Quality

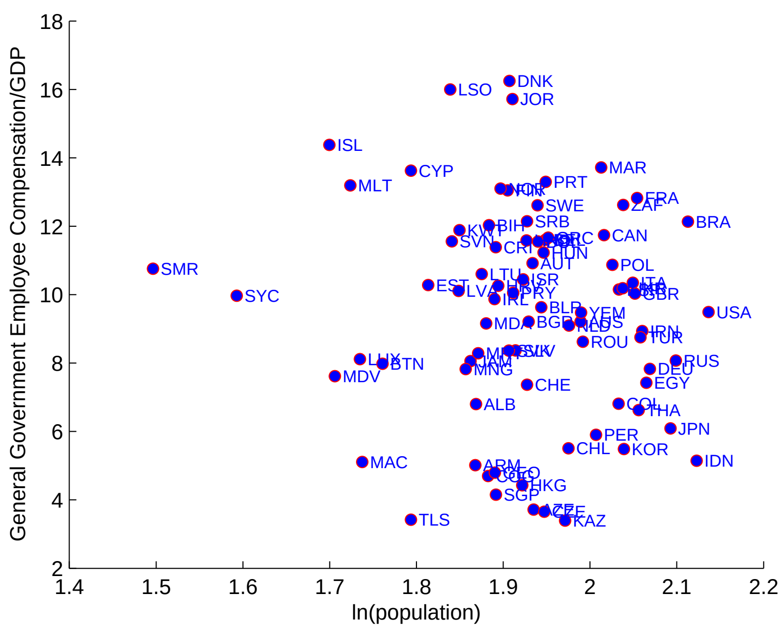
The benchmark model in the main text leaves out general equilibrium income effect, thus only import trade cost matters. In this appendix, we provide a model featuring export

Figure C.1: General Government Expenditure (% of GDP) and log Population Size



Notes: the OLS regression shows a slope of 1.052 with robust standard error 1.365, not statistically significant.

Figure C.2: General Government Employee Compensation and Population Size



Notes: the OLS regression shows a slope of -0.413 with standard error 0.384, not statistically significant.

costs and explore how exogenous changes in export opportunities will endogenously affect the institutional quality.

We begin by presenting an economy with a fixed institutional quality and then endogenize institutional quality. The home country productivity is normalized to 1. It imports N^* number of varieties from foreign countries. There are in total N varieties produced domestically with population L. Foreign aggregate demand for each domestic variety is

$$D^*(p\tau_e^*)^{-\sigma}$$

where D^* is taken as exogenous (the numeraire is foreign variety's f.o.b. price $p^* = 1$), τ_e^* is a function of the physical distance, institutional quality and foreign import policy, and p is the f.o.b price of domestic good.

Domestic households utility is

$$u = logH$$

where H is the consumption of final good which is a CES aggregation of both foreign and domestic varieties with elasticity of substitution $\sigma > 1$. The demand function from domestic residents faced by a domestic variety is

$$\frac{\sigma}{\sigma - 1} WL(p\tau)^{-\sigma}$$

where W is wage. A labor market clearing condition requires

$$N[\frac{\sigma}{\sigma - 1} WL(p\tau)^{-\sigma} + D^*(p\tau_e^*)^{-\sigma}] = L.$$

Assuming that the firms are monopolistically competitive, we obtain

$$p = \frac{\sigma}{\sigma - 1} W.$$

This simplifies the labor market clearing condition to yield:

$$N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}=W^\sigma L. \tag{C.5.1}$$

This equation implies that a lower τ_e^* means a larger part of domestic income (right hand side) is from foreign markets (second term of the left hand side). Since a change in the wage will affect the domestic market size, this equation gives an implicit function $W(q)$.

We assume $\tau=\tau(q)$, $\tau_m=h_m d\tau^*(q)$, $\tau_e^*=h_e d\tau^*(q)$ where d is physical distance between home and foreign[3], h_m and h_e are foreign trade policy (exogenous to home country), and q is institutional quality. Take log on both sides and take derivative with respect to q:

$$\begin{aligned}\frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}[\frac{d\log W}{dq}-\sigma\frac{d\log\tau(q)}{dq}]&\\ +\frac{ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}(-\sigma)\frac{d\log\tau_e^*(q)}{dq} &= \sigma\frac{d\log W}{dq}\end{aligned}$$

Therefore,

$$\begin{aligned}\frac{d\log W(q)}{dq} &= -\sigma\frac{1}{\sigma-\frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}}[\frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}\frac{d\tau(q)}{dq}\\ &\quad+\frac{ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}\frac{d\log\tau_e^*(q)}{dq}]\\ &= \sigma\frac{1}{\sigma-\frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}}\{-\frac{d\log\tau(q)}{dq}\\ &\quad+\frac{ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}[-\frac{d\log\tau_e^*(q)}{dq}-(-\frac{d\tau(q)}{dq})]\}.\end{aligned}$$

A representative domestic agent's welfare before institutional cost is

$$\log u=\log[\frac{\sigma}{\sigma-1}W/P]$$

[3]The physical distance within home country d_{ii} is normalized to 1.

where domestic price index is

$$P = [N(p\tau)^{1-\sigma} + N^*(p^*\tau_m)^{1-\sigma}]^{\frac{1}{1-\sigma}}.$$

Now we start to endogenize institutional quality by assuming that there is a per capita cost $\phi(q)$ to maintain level q institutional quality. A representative agent's welfare after deducting the institutional cost is

$$\log u = \log W(q) + \log[1-\phi(q)] + \frac{1}{\sigma-1}\log[N(p\tau(q))^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}].$$

The first order condition with respect to q is

$$\begin{aligned}
\frac{\phi'(q)}{1-\phi(q)} &= \frac{d\log W(q)}{dq} - \frac{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}[\frac{d\log\tau(q)}{dq} + \frac{d\log W}{dq}] \\
&\quad - \frac{N^*(h_m d\tau^*(q))^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}\frac{d\log\tau^*(q)}{dq} \\
&= [1 - \frac{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}]\frac{d\log W(q)}{dq} \\
&\quad - \frac{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}\frac{d\log\tau(q)}{dq} \\
&\quad - \frac{N^*(h_m d\tau^*(q))^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}\frac{d\log\tau^*(q)}{dq} \\
&= [1 - \frac{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}]\frac{d\log W(q)}{dq} \\
&\quad - \frac{d\log\tau(q)}{dq} + \frac{N^*(h_m d\tau^*(q))^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma} + N^*(h_m d\tau^*(q))^{1-\sigma}}[-\frac{d\log\tau^*(q)}{dq} - (\frac{d\log\tau(q)}{dq})]
\end{aligned}$$

We take note of a few implications. First, it is easy to see from equation (C.5.1) that fix q, a decline in foreign tariff h_e will decrease τ_e^* and thus W goes up. Therefore, $[1 - \frac{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}+N^*(h_m d\tau^*(q))^{1-\sigma}}]$ goes up, and $\frac{N^*(h_m d\tau^*(q))^{1-\sigma}}{N[\frac{\sigma}{\sigma-1}W\tau(q)]^{1-\sigma}+N^*(h_m d\tau^*(q))^{1-\sigma}}$ goes up. It is sufficient to say the right hand side rises when h_e goes down if $\frac{d\log W(q)}{dq}$ also rises.

Notice that foreign sales share

$$\frac{ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}} = 1 - \frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{W^\sigma L}$$

will then be raised. Therefore, when $-\frac{d\log\tau_e^*(q)}{dq} - (-\frac{d\tau(q)}{dq})$ is large enough or

$$\sigma >> \frac{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}},$$

we conclude that the right hand side of the first order condition to q will shift up, generating a higher institutional quality in equilibrium.

To be more rigorous, denote $x = \frac{ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}{N\frac{\sigma}{\sigma-1}(WL)(\frac{\sigma}{\sigma-1}\tau)^{-\sigma}+ND^*(\frac{\sigma}{\sigma-1}\tau_e^*)^{-\sigma}}$ and re-write

$$\begin{aligned}\frac{d\log W(q)}{dq} &= \sigma\frac{1}{\sigma-x}\{-\frac{d\log\tau(q)}{dq} \\ &\quad +x[-\frac{d\log\tau_e^*(q)}{dq} - (-\frac{d\tau(q)}{dq})]\}\end{aligned}$$

A sufficient condition for institutional quality to increase with exogenous trade cost reduction is the cross derivative $\frac{d^2W(q)}{dqdx} > 0$, that is

$$[-\frac{d\log\tau_e^*(q)}{dq} - (-\frac{d\tau(q)}{dq})] > \frac{\sigma}{\sigma-1+x}[-\frac{d\log\tau(q)}{dq}].$$

From the estimates in the gravity equation regressions with institutional quality, the $[-\frac{d\log\tau_e^*(q)}{dq} - (-\frac{d\tau(q)}{dq})]/[-\frac{d\log\tau(q)}{dq}]$ estimate under the comprehensive institutional quality measure, political risk index, is larger than 10. A conservative value for σ is 2, so it is easy to satisfy the above condition empirically.

In sum, with an increase in the exogenous export opportunities, a country will find the marginal benefit of increasing institutional quality to be higher. The intuition is similar to the benchmark version in the main text that focuses on the import side: at a given quality of institutions, the domestic income now has a larger part coming from the export market. If exports are more sensitive to institutions than domestic trade, this generates incentives for the country to upgrade its institutional quality.