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Essays on Banking Crises and Fiscal Crises: A Tale of Two Crises

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Economics

by

Yizhi Xu

2018

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ABSTRACT OF THE DISSERTATION

Essays on Banking Crises and Fiscal Crises: A Tale of Two Crises

by

Yizhi Xu

Doctor of Philosophy in Economics

University of California, Los Angeles, 2018

Professor Aaron Tornell, Co-Chair

Professor Roger E. Farmer, Co-Chair

This dissertation studies how market expectations of systemic bailouts affect credit recoveries, how countries' macro-fiscal conditions change around fiscal distress, and how banking crises and fiscal crises interact with each other and restrict economic recoveries. Chapter 1 is written based on my job market paper. Using daily put options data of U.S. bank holding companies, I measure each bank holding company's exposure to the systemic bailout factor, which is the sensitivity of each bank's out-of-the-money put option price to the variations of sector-wide put option basket-index spreads. I show that low market expectations of the

banking sector systemic bailouts played a significant role in the weak bank credit recovery after the subprime crisis. Bank holding companies with higher pre-crisis exposure to the systemic bailout factor experienced larger post-crisis deviations from the pre-crisis bank credit growth trend. Perhaps surprisingly, such pattern is persistent even for banks that are less affected by the post-crisis financial regulations and less exposed to borrowers from the deteriorating sectors. Furthermore, I drill down to the commercial bank subsidiary level data while controlling for parent bank holding company fixed effects. This analysis reveals that commercial bank subsidiaries within the same bank holding company present same credit growth patterns even though they have different exposure to financial regulations and deteriorating sectors. Chapter 2 is coauthored with my colleague at the International Monetary Fund. We present a new database of fiscal crises covering different country groups, including low-income developing countries (LIDCs) that have been mostly ignored in the past. We find countries faced on average two crises since 1970. We also shed some light on policies and economic dynamics around crises. Surprisingly, advanced economies face greater turbulence, with half of them experiencing economic contractions. Fiscal policy is usually procyclical around fiscal crises and we also find that the decline in economic growth is magnified if accompanied by a financial crisis. Chapter 3, which is coauthored with my advisor, Aaron Tornell, studies the interplay between banking crises and fiscal crises when the government exhausts fiscal space to clear up banking sector non-performing loans. Exploiting a newly constructed data set on various fiscal costs of resolving non-performing loans, we find banking crises accompanied with fiscal distress could dampen the positive growth effects related with active non-performing loans resolutions conducted by government. We empirically show that, depending on the timing of banking crises and fiscal crises, such disruptive effects are the result of either lacking fiscal policy space or the bank-sovereign nexus. However, immediate government response to restore fiscal space or regain access to international capital markets could help enhancing medium-term output and credit recoveries even after banking-fiscal twin crises.

The dissertation of Yizhi Xu is approved.

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Aaron Tornell, Committee Co-Chair

University of California, Los Angeles

2018

DEDICATIONS

*To millions of families,
which are affected by banking crises and fiscal crises.*

*To my parents, Lixiang Zhan and Ziwei Xu,
for their endless and selfless support and care in the past 28 years.*

*To Sarah,
for her sacrifice, encouragement, and love.*

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Chapter 1

Shadow Banking and Systemic Bailout Exposure

1.1 Introduction

The modern banking system in the United States is an aggregate of commercial banks and shadow banks. Unlike the regulated and explicitly guaranteed commercial banking sector, the shadow banking sector is subject to less regulations and exposed to the risk of lacking enough government guarantees¹. In this complex system, commercial banks are closely linked to shadow banks via the securitization market, where some of the mortgages on commercial banks' balance sheets are sold to shadow banks². Since the bailout guarantees to shadow banks are implicit and systemic, creditors' expectations of sector-wide systemic bailouts have an impact on shadow banks' borrowing constraint. Such impact may indirectly affect the lending capacity of commercial banks through the securitization market.

In this chapter, I investigate if the decline in market expectations of the banking sector

¹I define commercial banks as depository institutions that have access to the federal deposit insurance or can borrow from the Federal Reserve at the Discount Window. The commercial banks are unregulated nonbank financial institutions that also provide financial intermediations but are exposed to implicit government guarantees. Examples of shadow banks are security broker-dealers, insurance companies, money market funds, etc.

²Poszar et al. (2010) outlines a very detailed framework of the shadow banking system in the United States where securitization activities link all the components.

systemic bailouts played a significant role in the slow bank credit recovery after the subprime crisis. More specifically, I use micro-level data to empirically examine the relation between market expectations of systemic bailouts and bank credit growth patterns. Our main hypothesis argues that bank holding companies with higher exposure to the systemic bailout factor experienced greater credit loss from the pre-crisis trend during recovery periods. In addition, I test if the main hypothesis is driven by post-crisis financial regulations or weak credit demand from borrowers. The empirical findings that I have obtained are rationalized by a structural model that features many characteristics of the modern banking system.

Our empirical analysis is based on a new measurement of each bank holding company's exposure to the systemic bailout factor. I define such factor as market expectations of systemic bailouts to the shadow banking sector³. To measure how likely the market believes bailout guarantees will be granted in case of a systemic default, I follow Kelly, Lustig, and Van Nieuwerburgh (2016) and compute the difference in costs of Out-of-The-Money (OTM) put options for the banking sector index KBE⁴ and its corresponding basket. Since put options act as "crash insurance" for the underlying assets, the price difference between put options that insure the banking sector index and the counterparts that insure a basket of individual banks calibrates the systemic bailout effect that is priced in the former but not in the latter. Thus, such basket-index spread is larger when the market believes systemic bailouts to the whole sector is more likely than individual bailouts. Each bank's exposure to the systemic bailout factor is hereby computed as the sensitivity of their own put option prices to the variations of the aggregate level put option basket-index spreads around announcement dates

³One should note that a greater amount of systemic bailout guarantees amid the U.S. subprime crisis are towards the shadow banking sector or the shadow banking subsidiaries of bank holding companies. For instance, the Trouble Asset Relief Program (TARP) provided by the Treasury targets bank holding companies that suffered from losses due to asset-backed securities. The Term Asset-Backed Securities Loan Facility (TALF) launched by the Fed purchased asset-backed securities directly from the market for providing liquidity to the distressed shadow banking sector.

⁴Kelly, Lustig, and Van Nieuwerburgh (2016) use financial sector index XLF. Instead, I apply their approach to KBE, the banking sector index, to only concentrate on systemic bailout expectations within the banking sector.

related with systemic bailouts.

To empirically test if the decline in market expectations of systemic bailouts is an important reason for the weak post-crisis credit recovery, I outline one main hypothesis as well as two alternative hypotheses. First, shadow bank creditors' expectations of systemic bailouts are closely related to borrowing constraints of shadow banks and the liquidity in the securitization market. In turn, such effect would transmit to the lending capacity of commercial banks via the securitization market. In this sense, the market itself disciplines the risk-taking of shadow banks. Bank holding companies that were more exposed to the systemic bailout factor during the crisis onset would be more adversely affected during recovery periods, especially when the market expects no more systemic bailouts. I name this explanation as the *systemic bailout expectations* hypothesis.

Second, bank holding companies that were more exposed to the systemic bailout factor could be the ones that are more likely to be regulated by the post-crisis financial regulations. Higher likelihood of being guaranteed by the federal government incentivizes more risk-taking in the securitization market and more holdings of toxic asset-backed securities. However, the post-crisis financial regulations such as the Dodd-Frank Wall Street Reform and Consumer Protection Act requires higher risk retention when securitizing balance sheet assets and higher capital buffer when holding risky structured financial assets. These new regulations would substantially prevent banks from extending new credit during recovery periods. Therefore, the effect in the main hypothesis might have been endogenously driven by financial regulations other than the market itself. In other words, there could be an alternative hypothesis for slow credit growth after the crisis, which is the *financial regulations* hypothesis.

Third, weak demand for bank credit from the real sector may have been responsible for the slow post-crisis credit recovery. During the crisis run-up, banks might have lowered lending standards when issuing credit. However, the credit demand by distressed borrowers or borrowers from a distressed sector could be persistently weak during recovery periods. To

make it worse, it could be costly for banks to extend credit to new borrowers with higher credit demand. Hence, the channel associated with factors from the credit demand side is classified as the *credit demand* hypothesis.

The empirical tests with bank holding company level data and the local projections approach *a la* Jordà (2005) favor the main hypothesis (*systemic bailout expectations* hypothesis). First, the group of bank holding companies with higher exposure to the systemic bailout factor experienced significantly larger post-crisis credit loss from the pre-crisis growth trend. In fact, our tests further reveal that the credit growth path of low exposure banks reverts to the pre-crisis trend 5 years after the crisis onset. However, such reversion to the pre-crisis trend does not appear for the high exposure banks. Second, the significant credit loss from the pre-crisis trend still exists for banks that are supposed to be less adversely affected by the post-crisis financial regulations (i.e. lower exposure to the securitization market and lower holdings of structured financial products) but more exposed to the systemic bailout factor. This finding is inconsistent with the *financial regulations* hypothesis, which claims that financial regulations are the main reason for the slow credit recovery. Third, linking each bank to its borrowers composition through loan level data *DealScan*, I find the main hypothesis is still valid for banks with less pre-crisis lending to non-tradable sectors such as constructions and financial services ⁵. In this regard, the *credit demand* hypothesis could not be a leading explanation for slow post-crisis credit recovery as well.

Furthermore, I drill down to the commercial bank subsidiary level data via the U.S. Call Report and merge it with the parent bank holding company balance sheets. The commercial bank level data allows us to compare credit growth patterns across different commercial bank subsidiaries within the same bank holding company (i.e. same exposure to the systemic bailout factor). The analysis reveals that there is no significant difference in credit growth patterns within the same bank holding company, even though commercial bank subsidiaries

⁵The non-tradable sectors experienced more significant boom and bust cycles around financial crises (Ranciere and Tornell, 2016). Borrowers from non-tradable sectors are considered in this chapter as the ones that have weaker credit demand during the aftermath of crises.

may be affected differently by financial regulations and deteriorating credit demand. This result provide another evidence for the *systemic bailout expectations* hypothesis. In addition, I explore whether the impact on parent bank holding company credit growth is through less credit originations by each commercial bank subsidiary (intensive margin) or less commercial bank subsidiaries survival during the crisis aftermath (extensive margin). Our merged data favors the former, which shows that lenders have become more cautious after the subprime crisis when facing very low market expectations of systemic bailouts.

I rationalize the empirical findings with a structural model of the modern banking system. In the model, traditional commercial banks are subject to the capital requirement so that they securitize and move on-balance-sheet mortgages to off-balance-sheet (or shadow bankers). Shadow banks purchase mortgages from the securitization market by issuing a menu of safe (non-defaultable) and risky (defaultable or put-option-like) bonds⁶. In contrast to commercial banks, shadow banks can trade mortgages among themselves such that they can diversify idiosyncratic risks and expose themselves to systemic risk. For shadow banks that issue safe bonds, mortgage diversification guarantees a safe return to repay creditors even in the worse realization of their portfolio. However, for shadow banks that issue risky bonds, mortgage diversification allows all of them to be exposed to enough systemic risk such that systemic bailouts could be granted in a bad state. With this model set-up, creditors' expectations of systemic bailouts are important because they determine shadow banks' borrowing constraint when issuing risky bonds.

The equilibrium growth path follows the boom-bust cycle model *a la* Schneider and Tornell (2004) and Ranciere and Tornell (2016), where creditors simultaneously fund the same type of shadow bank bonds and their expectations of systemic bailouts to shadow banks may endogenously determine the total bank credit growth rate. Intuitively, higher expectations

⁶Safe shadow bank bonds may be debt securities such as commercial paper (CP) or asset-backed commercial paper (ABCP) in money market funds that rarely break the buck. Risky bonds refer to private-label (subprime) mortgage-backed securities (MBS) that inherit certain default risk, and put-option-like securities such as credit default swaps (CDS) and synthetic collateralized debt obligations (CDO) that insures against default risks. Pozsar et al. (2010) elaborate on the detail of securities issued by shadow banks.

of systemic bailouts relax shadow banks' borrowing constraint when issuing risky bonds. With more liquidity in the securitization market, mortgages are securitized and transferred with higher market value and it could in turn relax commercial banks' borrowing constraints. Eventually, the lending capacity of the banking sector is increased. The second implication of the model is on the comparison between different types of risky bonds. Since the put-option-like securities feature higher leverage, the growth enhancing effect due to higher market expectations of systemic bailouts is larger if the shadow banking sector issues put-option-like securities. Finally, the last implication is focused on the case where shadow bank creditors expect low likelihood of systemic bailouts. With a decline in systemic bailout expectations, the banking system that is funded by risky shadow bank bonds would be more disciplined by the market and experience larger credit loss.

Related Literature. This chapter is closely related to three strands of literature. First, since the onset of the recent subprime crisis, both empirical and theoretical studies have been focused on the role of the unregulated nonbank financial institutions (i.e. shadow banks) as an alternative of traditional commercial banks. For instance, empirical papers such as Gorton and Metrick (2012), Covitz, Liang, and Suarez (2009), Shin (2009), and Kacperczyk and Schnabl (2010, 2013) investigate patterns and effects of the run on the whole shadow banking system. In this chapter, I rationalize the bust of the shadow banking system as the result of systemic risk exposure. When shadow banks diversify enough portion of their mortgage portfolio, a banking crisis is no longer triggered by idiosyncratic risks but by the systemic risk (i.e. systemic banking crisis). In this regard, I am in line with the model of shadow banking in Gennaioli et al. (2013), in which banks diversify their mortgage portfolio in order to improve financial stability from an ex-ante perspective. However, I extend their model in two aspects. First, our model also study the link between commercial banks and shadow banks. Second, more importantly, portfolio diversification might not improve financial stability if shadow banks issue risky bonds but could increase the likelihood of systemic bailouts in

the bad states. This chapter is also related to theoretical papers such as Plantin (2015), Huang (2016), and Begenau and Landvoigt (2017). All these three papers model shadow banking as an outside option for traditional commercial banks to pursue regulatory arbitrage. They suggest that financial stability and welfare are inverse U-shape functions of financial regulations on commercial banks. Although I also consider regulatory arbitrage as the main purpose of shadow banking and securitization activities, the commercial banking sector and the shadow banking sector are related through the input-output link (i.e. securitization market) instead of working as substitutes.

Second, a vast literature has studied the moral hazard problem arose in the securitization market. For instance, Purnanandam (2011) provides empirical evidence that the mortgage originators during the subprime crisis run-up periods provided poor quality control when screening securitized mortgages. Gorton and Pennacchi (1995), Pennacchi (1988), and ParLOUR and Plantin (2008) provide theoretical framework for both the moral hazard problem and the risk retention solution in securitization. Ashcraft and Schuermann (2008) list seven key information frictions emerge in the securitization process. In this chapter, I take into account two main moral hazard problems facing commercial bankers and shadow bankers: 1) Commercial banks (i.e. mortgage originators) may not monitor the quality of securitized mortgages and thus risk retention in the securitization process guarantees the monitoring incentive; 2) shadow banks (i.e. mortgage servicers) may divert the borrowed funds after liquidation and therefore creditors may fund shadow bank bonds up to the amount such that diversion would not be chosen by shadow bankers. Importantly, these two moral hazard problems are somewhat related in the model since the shadow bank borrowing constraint (formed by non-diversion constraint) affect the market value of securitized mortgages, which in turn determines the risk retention constraint.

Finally, this chapter also contributes to the literature of systemic bailout guarantees. Theoretical papers such as Acharya and Yorulmazer (2008), Acharya et al. (2011), and Bianchi (2016) design the optimal or the socially efficient bailout schemes. However, this

chapter is close to Schneider and Tornell (2005), Rancière et al. (2008), Farhi and Tirole (2012), and Rancière and Tornell (2016). They consider systemic bailouts as a credit market imperfection which encourages risk-taking activities. Similarly, systemic bailouts in our paper encourage risk-taking by incentivizing systemic risk exposure such that the shadow banking sector collapses systemically. In addition, empirical papers use various methods to measure market expectations of systemic bailouts. For instance, Acharya et al. (2015) analyze the risk-sensitivity of credit spreads of financial institutions and argue that firms with larger size and more contribution to systemic risk are associated with higher market expectations of implicit bailouts. Schweikhard and Tsesmelidakis (2012) compare equity-implied credit spreads to actual credit default swap (CDS) quotes and ascribe the difference between the two to bailout expectations. However, these approaches would substantially reduce our sample size to decades of bank holding companies. Thus, I follow Kelly et al. (2016) which use the OTM put option basket-index spread to gauge market expectations of systemic bailouts. Since each bank holding company might be affected differently by systemic bailouts, as an extension of Kelly et al. (2016), I measure bank level exposure to systemic bailouts by computing responsiveness of their put option prices to the variations of put option basket-index spread. Such novel bank level data could be used for future empirical research on banking sector systemic bailouts.

1.2 Motivating Evidence

1.2.1 Fact 1: Heterogeneous Liability Compositions

Banks' liability compositions are highly heterogeneous across sectors: traditional commercial banks are mostly funded by deposits with explicit FDIC guarantees, while shadow banks are mostly funded by risky short-term debt securities with implicit federal guarantees. Although banks' liability compositions are highly homogeneous within sectors and highly constant over time (Hanson et al. 2015), commercial banks and shadow banks rely on very different funding

Table 1.1: US commercial banks and shadow banks liability compositions

	2000 Q1	2005 Q1	2010 Q1	2015 Q1
Depository institutions				
Net interbank liabilities	1.74%	2.70%	3.76%	2.12%
Checkable deposits	10.52%	7.62%	7.03%	11.73%
Time and savings deposits	53.59%	55.63%	57.11%	60.29%
Federal funds and repos	8.86%	6.90%	4.75%	1.58%
Debt securities	1.48%	1.40%	4.71%	1.68%
Loans	6.69%	6.26%	4.14%	3.01%
Taxes payables	0.24%	0.37%	-0.61%	-0.19%
Other liabilities	16.89%	19.27%	19.11%	19.78%
<i>Total Liabilities</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
Security brokers and dealers				
Security repos	61.08%	66.57%	61.05%	50.73%
Corporate bonds	2.05%	2.02%	2.78%	3.55%
Loans	25.04%	20.31%	22.05%	31.87%
Trade and tax payables	2.04%	1.17%	2.00%	0.79%
Other liabilities	9.79%	9.93%	12.12%	13.06%
<i>Total Liabilities</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>

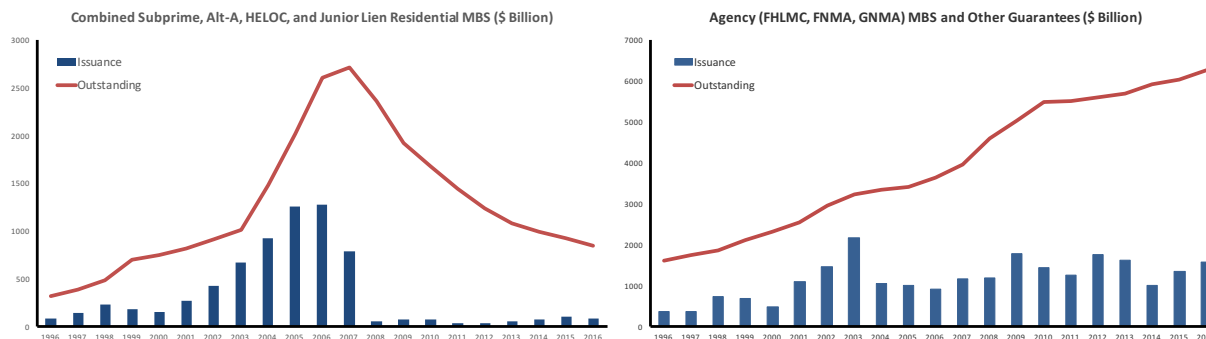
Note: This table illustrates the liability compositions of U.S. depository institutions (commercial banks) and security brokers and dealers (shadow banks) as of 2000Q1, 2005Q1, 2010Q1, and 2015Q1 using the “Financial Accounts of the United States” (Flow of Funds).

structures.

As an illustration, Table 1.1 shows the liability compositions of U.S. depository institutions (commercial banks) and security brokers and dealers (shadow banks) from the “Financial Accounts of the United States.” Checkable deposits and time and savings deposits historically take up 60% of depository institutions’ liabilities. In a sharp contrast, security repos⁷, which are not guaranteed by the federal government but are collateralized by risky securities, take up 60% of security brokers and dealers’ liabilities.

⁷A repo (repurchase agreement) is a short-term contract that swaps liquidity and collateral between two parties in the market. It is the most common source of funds for the shadow banking sector (Pozsar, 2010)

Figure 1.1: Issuance and Outstanding of US subprime residential mortgage-backed securities and agency mortgage-backed securities



Note: This figure displays the market access of the riskiest shadow bank bonds (subprime RMBS) and the safest shadow bank bonds (agency MBS) since 1996 based on the aggregate data published by the Securities Industry and Financial Markets Association (SIFMA).

1.2.2 Fact 2: Loss of Market Access for Risky Shadow Bank Securities

The riskiest shadow bank securities that were used as the underlying collateral in the repo market before the crisis has lost market access since the crisis onset. One example of the risky shadow bank bonds is the subprime residential mortgage-backed securities (RMBS). The left panel of Fig. 1 displays issuance and outstanding of the subprime RMBS in the last two decades. As a comparison, the right panel of Fig. 1.1 shows the same figures for agency (FHLMC, FNMA, and GNMA) mortgage-backed securities and other guarantees, which are considered as safer shadow bank securities. The market appetite for riskier shadow bank securities has been weak since the crisis. Issuance of the subprime RMBS declined from more than 1 trillion dollars in 2006 to less than 100 billion dollars after 2008. By contrast, the safer shadow bank securities still managed to maintain market access.

1.2.3 Fact 3: Low Post-Crisis Market Expectations of Systemic Bailouts

The market expectations of systemic bailouts to the banking sector is high during the crisis run-up, but winds down after a series of government rescue programs. There are various approaches in empirical literature measuring market expectations of systemic bailouts. I employ the approach in Kelly et al. (2016) which uses the difference in costs between out-of-the-money put options for individual banks and puts on the financial sector index (i.e. basket-index option price spreads) to gauge market expectations of systemic bailouts to the financial sector. More specifically, this approach is based on the “too-systemic-to-fail” argument that systemic bailouts are expected to be more likely when puts on the financial sector index (e.g. XLF) are relatively cheaper than the corresponding share-weighted basket of put options. I use this approach, among other things ⁸, because of the following reasons. First, instead of measuring each individual bank’s likelihood of receiving bailouts, this approach draws attention to market expectations on systemic bailouts to the whole sector. Second, since investors purchase out-of-the-money put options to insure their positions in the event of a price crash, the basket-index option price spreads can accurately reflect investors’ expectations⁹. Finally, although banks’ credit default swap spreads can be used to measure expectations on systemic bailouts, there are only around 20 bank holding companies that have issued credit default swaps before the recent financial crises according to Markit database. However, the sample of put options covers 384 bank holding companies with a complete daily price dataset.

Since Kelly et al. (2016) compute the basket-index spreads with the financial sector

⁸Acharya et al. (2015) analyze the risk-sensitivity of credit spreads of financial institutions and argue that firms with larger size and more contribution to systemic risk are associated with higher market expectations on implicit bailouts. Schweikhard and Tsesmelidakis (2012) compare equity-implied credit spreads to actual credit default swap (CDS) quotes and ascribe the difference between the two to bailout expectations. However, such approach restricts the sample of the financial sector to decades of companies.

⁹Expectations of bailouts can be jointly determined by various factors such as size, systemic risk contributions, asset-backed security holdings, etc.

index XLF, I repeat their approach with a focus on the banking sector index, KBE. Thus, the banking sector’s basket-index spread is defined as the per dollar costs of basket and index insurance (implied price over strike price):

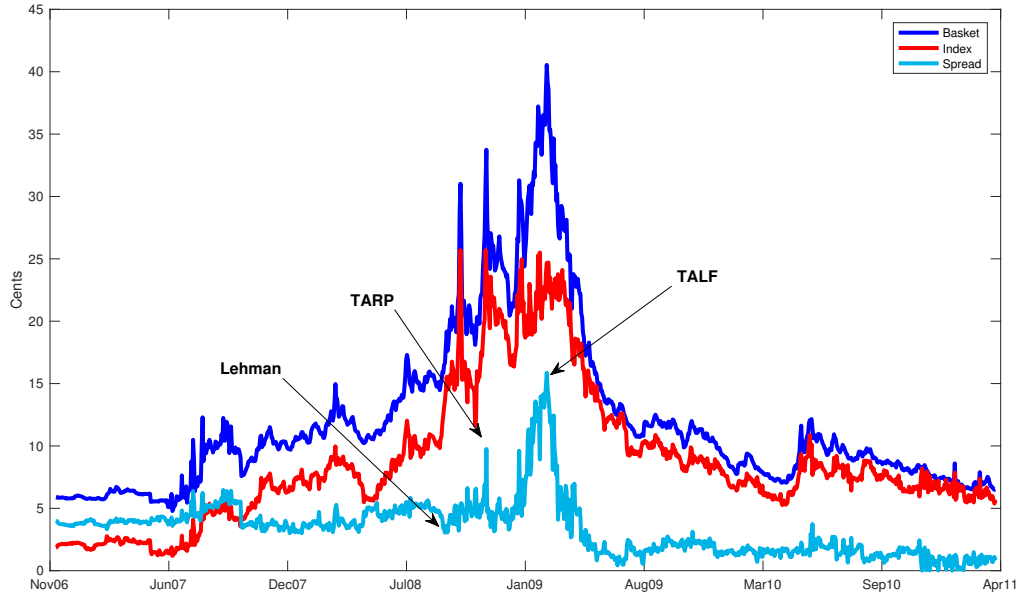
$$Put\ Spread = \frac{P^{basket} - P^{index}}{K^{index}}$$

where P^{index} is the put option price of KBE, P^{basket} is the corresponding basket price weighted by the share in KBE, and K^{index} is the share-weighted strike price of the index. Since the stock and share in KBE varies a lot over time, I document the holdings at the end of each quarter based on the Center for Research in Security Prices (CRSP) database. Table 1.9.4 in the appendix reports the top 20 holdings in KBE at 12/31/2007 and 12/31/2009. I follow Kelly et al. (2016) and focus primarily on options with 365 days to maturity and delta of 25¹⁰. Fig. 1.2 shows that the OTM put option basket-index spread was consistently higher during the run-up to the subprime crisis and reached the peak on March 3, 2009, when Treasury and Federal Reserve eventually launched the Term Asset-Backed Securities Loan Facility (TALF)¹¹. However, the basket-index spread drops significantly and remains at a low level afterwards, which reveals that the market expects no more systemic bailouts after TALF.

¹⁰Please refer Kelly et al. (2016) Section I “Measuring the Basket-Index Spread” for the detail of computing put spread. Accordingly, the basket is constructed by matching strike prices such that $K^{basket} = K^{index}$. Given underlying stock price S_j for bank holding company j and the inequality $\sum_{j=1}^N w_j \max(K_j - S_j, 0) \geq \max(K^{index} - \sum_{j=1}^N S_j, 0)$, we can conclude that the put spread is also a positive number.

¹¹The purpose of TALF, according to the Fed, is to “increase credit availability and support economic activity by facilitating renewed issuance of consumer and small business asset-backed securities at more normal interest rate spreads.” In other words, such program was launched to support the market value of risky shadow bank bonds.

Figure 1.2: Market expectations of systemic bailouts based on put options basket-index spread



Note: This figure plots the series of OTM put option costs on KBE index, basket, and basket-index spread over the period between November 2006 and April 2011. Following Kelly et al. (2016), delta is 25 and time to maturity is 365 days.

1.2.4 Taking Stock

Based on these facts manifested from both aggregate and micro-level data, our synthesis is that the shadow banking sector has experienced the loss of market access for newly issued risky securities accompanied by weak market expectations of systemic bailouts by the government. Shadow banks' business model heavily relies on short-term debts (e.g. repos) that are collateralized by risky securities such as subprime mortgage-backed securities. However, when market expectations of systemic bailouts are low, the underlying collateral might not be as attractive as it was before the crisis. Moreover, government regulations on the issuance of asset-backed securities would amplify the disruptive effect on securitization activities and credit intermediations through the shadow banking sector. In the rest of this chapter, I take these facts into account and address the question of how market expectations of systemic

bailouts affect risky shadow bank bonds issuance and determine the commercial bank credit origination capacity via the securitization market.

1.3 Data and Empirical Strategy

1.3.1 Data Construction

Our main data is merged from four sources: (1) *Options Volatility Surface*, which is provided by Option Metrics, (2) *FR Y-9C Consolidated Report of Condition and Income* of bank holding companies from the Federal Reserve Bank of Chicago, (3) Call Report (*FFIEC 031 and FFIEC 041 Consolidated Reports*) of commercial banks, which is also available from the Federal Reserve Board of Chicago, and (4) the commercial and industrial (C&I) loan level data that comes from the Thomson Reuters DealScan database. The four data sources are merged at a commercial bank level according to the structure presented in Fig. 1.3.

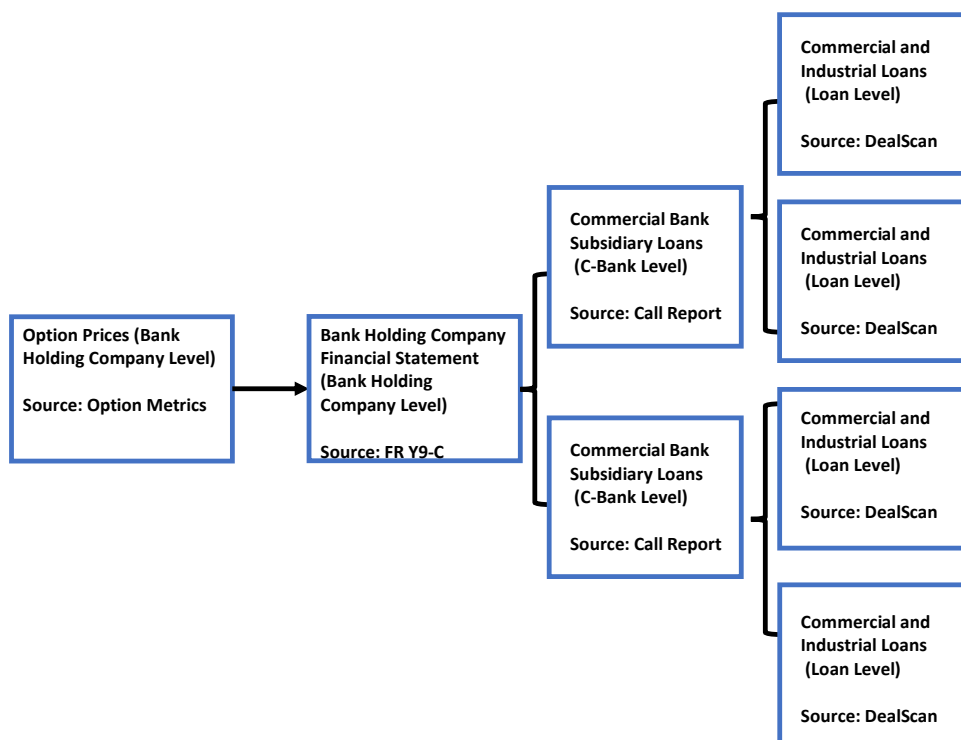
Options Volatility Surface file provides daily standardized implied volatilities for put and call options that have been interpolated over a grid of time to maturity and option delta. Both FR Y-9C and FFIEC 031/041 are bank level consolidated reports with the distinction that the former could be a sum of different commercial bank subsidiaries and shadow bank (non-bank) subsidiaries. Since I focus on the impact of systemic bailout expectations on commercial bank credit originations, I aggregate commercial bank loans (obtained from Call Report) at a bank holding company level for testing our main hypothesis. Finally, I exploit the syndicated commercial and industrial loan level data for computing each bank holding company's exposure to the deteriorating sectors. The loan-level data include the identities of the borrowers and lenders of each syndicated loan as well as the share of each participating bank holding company, so we can match each bank holding company with their syndicated loan borrowers¹². I explore the database and obtained 384 bank holding companies that

¹²Unfortunately, such loan level data only allows us to match borrowers to bank holding companies instead of commercial bank subsidiaries. As will be described later, since the Wharton Research Data Services

have out-of-the-money (OTM) put options traded in the market during the second half of 2008 and have full financial statements data from consolidated reports around the subprime crisis. Our sample covers periods over 2005Q1-2015Q4 and 384 bank holding companies. Table 1.9.4 in appendix reports the summary statistics.

In the subsections that follow, I describe the measurement of the main bank holding company level indices: exposure to the systemic bailout factor (put option beta), exposure to the securitization market, and exposure to weak borrowers.

Figure 1.3: Structure of data



Note: This figure presents the structure of data that are obtained from the following four sources: (1) Option Volatility Surface (bank holding company level standardized option prices), (2) FR Y-9C Consolidated Reports of U.S. bank holding companies, (3) FFIEC 031 and FFIEC 041 Consolidated Reports of commercial banks, and (4) DealScan syndicated commercial and industrial loans.

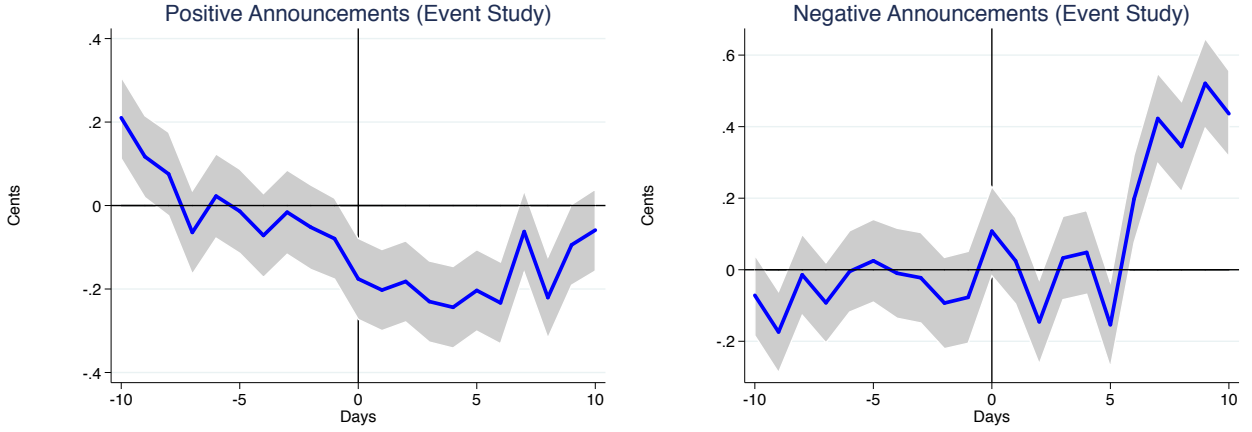
(WRDS) provides the *DealScan-Compustat Linking Table*, I also use Compustat to find the NAICS sector code of each borrower.

Exposure to Systemic Bailouts (Put Option Beta) For the purpose of empirical tests, I measure investors' reaction to holding each individual bank holding company's put options when their expectations of systemic bailouts to shadow bank change. Thus, I exploit daily put option price data in the sample of 384 bank holding companies that exist in the second half of 2008 when a series of systemic bailout programs were announced. I define each bank holding company's exposure to the systemic bailout factor as the responsiveness of the put option cost to variations in the basket-index spreads in 8 event windows. The event windows are constructed based on public announcements that are closely related with shadow bank bailouts during 2008 Q3-Q4.

First, I identify 4 public announcements/events during the last two quarters of 2008 that have increased the likelihood of systemic bailouts to the shadow banking sector: (1) July 13, 2008: Paulson requests government funds to take over Fannie Mae and Freddie Mac, (2) October 3, 2008: The Trouble Asset Relief Program (TARP) passes the U.S. House of Representatives, (3) October 6, 2008: The Term Auction Facility is increased to \$900 billion, and (4) November 25, 2008: The Term Asset-Backed Securities Loan Facility (TALF) is announced. I also identify 4 public announcements/events during the same episode that have reduced the probability of systemic bailouts to the shadow banking sector: (1) September 15, 2008: Lehman Brothers files for bankruptcy, (2) September 29, 2008: The TARP does not pass the house, (3) November 7, 2008: President Bush warns against too much government intervention in the financial sector, and (4) November 13, 2008: Paulson's plan to use TARP funds to buy troubled assets from banks is not passed. Fig. 1.4 presents the event studies of put option costs (implied price over strike price) over 21-day time windows around positive announcements and negative announcements. The cost of put options significantly decreases after positive announcements but significantly increases after negative announcements.

Second, each bank holding company's exposure to systemic bailouts is defined as the sum of put option price responsivenesses to the variations in the banking sector put option basket-

Figure 1.4: Option prices around event dates



Note: Put option costs (cents) over 21-day time windows around positive announcements (left) and negative announcements (right).

index spread (market expectations of systemic bailouts) around 8 announcement dates. The following is the formula to compute our main bank level index:

$$Exposure\ to\ Bailouts_i = \sum_{j=1}^8 \beta_{i,j,Bailout} \quad (1.1)$$

where $\beta_{i,j,Bailout}$ is a bank holding company's "put option beta" that captures the exposure to the systemic bailout factor around announcement date j . Given the announcement date T_j , such put option beta is extracted from the following regression over the event window $t \in \{T_j - 10, T_j + 10\}$

$$\Delta \left(\frac{P}{K} \right)_{i,j,t} = \beta_{i,j,Bailout} \Delta Spread_{j,t} + \beta_{i,j,Risk} Leverage_{i,j,t} + \epsilon_{i,j,t} \quad (1.2)$$

where the left hand side variable $\Delta (P/K)_{i,j,t}$ indicates the daily change in the out of the money of bank i 's put option, and $\Delta Spread_{j,t}$ is the daily change in the banking sector basket-index spread that has been calibrated above. Since the changes in bank market leverage ratio would alter the riskiness of underlying equity of put options, I also control for the

market leverage ratio $Leverage_{i,j,t}$, which is the log ratio of book value of assets to market value of equity.

Exposure to the Securitization Market: Following Loutskina (2011) and Huang (2017), I define a bank holding company’s exposure to the securitization market as the likelihood that it can securitize the loans on its balance sheet. The construction of such measure involves three steps. The first step is to calculate the whole banking sector’s potential to securitize loans of a category for the quarter according to the aggregate data from “Financial Accounts of the United States” published by the Federal Reserve Board. The five categories of loans that I take into account are i) home mortgages, ii) multi-family residential mortgages, iii) commercial mortgages, iv) consumer credit, and v) farm mortgages. Appendix 1.9.3 explains the detail on how we can locate the aggregate data in “Financial Accounts of the United States”. The second step is to aggregate commercial bank subsidiary level stock of loans according to parent bank holding companies. Since a bank holding company may control multiple commercial bank subsidiaries¹³, I extract the loan amount data from the commercial bank level Call Report published by the Federal Financial Institutions Examination Council (FFIEC) and aggregate the total amount of each category for the parent bank holding companies. I explain the detail of Call Reports data in Appendix 1.9.3. Finally, I derive the exposure to the securitization market by computing the weighted average of each bank holding company’s loan amount based on the economy-wide securitization ratio for each loan category. I use the following formula to compute bank holding company i ’s exposure to the

¹³For instance, JPMorgan Chase & Co., the largest bank holding company as of October 2017, manages 44 commercial bank subsidiaries. The organization hierarchy is documented here, which is based on the regulatory reporting form FR Y-10.

securitization market at time t :

$$Exposure\ to\ Securitization_{i,t} = \sum_{m=1}^5 \left[\left(\frac{Economy\ Wide\ Securitized\ Loans_{m,t}}{Economy\ Wide\ Total\ Loans_{m,t}} \right) \times \left(\frac{Type\ m\ Loans_{i,t}}{Total\ Loans_{i,t}} \right) \right] \quad (1.3)$$

where the first ratio in (1.3) is obtained from “Financial Accounts of the United States”, and the second ratio is obtained through aggregating commercial bank level data based on parent bank holding companies.

Exposure to Weak Borrowers: In order to investigate the importance of credit demand when explaining the post-crisis credit growth patterns, I measure each bank holding company’s exposure to borrowers from the deteriorating sectors. Since DealScan provides the information on syndicated commercial and industrial loans, most of the loans are financed by a group of bank holding companies. The data includes each bank holding company’s share of participations in the syndicated loans. Thus, we can obtain the amount of commercial and industrial loans accessed by private and public firms from each bank holding company. In addition, the *DealScan-Compustat Linking Table* helps us to access *Compustat* and explore the information on each borrower’s characteristics. Since the real estate sector (NAICS: 53) and the constructions sector (NAICS: 23) experienced the largest negatively shock after the subprime crisis, the borrowers from these two sectors are treated as the ones from the deteriorating sectors with weak credit demand. Thus, each bank holding company’s exposure to weak borrowers is its participated lending to companies from the real estate sector and the constructions sector as a share of its total participated lending in the syndicated commercial and industrial loans market. The following formula is used to compute bank holding

company i 's exposure to weak borrowers at time t :

$$Exposure\ to\ Weak\ Borrowers_{i,t} = \frac{\sum_{n \in \Omega_{weak}} [Participate\ Rate_{i,n,t} \times Loan\ Amount_{i,n,t}]}{\sum_{n \in \Omega} [Participate\ Rate_{i,n,t} \times Loan\ Amount_{i,n,t}]}$$

where Ω is a set of all the borrowers that have historically accessed the syndicated commercial and industrial loans market, and Ω_{weak} is a subset of Ω that includes companies from the real estate sector and the constructions sector.

1.3.2 Empirical Strategy

The post-crisis periods of the U.S. banking sector is characterized by weak recoveries in bank credit. The premise of our empirical tests is that low market expectations of systemic bailouts to the shadow banking sector is the main contributor to the weak recovery of bank credit. Thus, we expect that bank holding companies with higher exposure to the the systemic bailout factor during the onset of the crisis (late 2008) would experience larger credit loss from its pre-crisis credit growth trend. Thus, the main hypothesis, the *systemic bailout expectations* hypothesis, is phrased as the following.

Systemic Bailout Expectations Hypothesis (H1). *Bank holding companies with higher pre-crisis exposure to shadow bank bailouts experience larger post-crisis credit deviation from the pre-crisis trend.*

For identification of *Hypothesis 1*, the main question that I want to address is whether banks with higher exposure to systemic shadow bank bailouts (i.e. put option beta) experience larger deviation in total credit from the pre-crisis trend. The empirical tests focus on the episodes around the recent subprime crisis. Using the bank holding company level data on total credit from 2004Q1 to 2008Q4, I compute the pre-crisis average credit growth rate and the deviation of post-crisis total credit from the trajectory based on pre-crisis trend. I split the sample bank holding companies into two bins based on the exposure to systemic shadow

bank bailouts during the last two quarters of 2008.

In order to study the variation in time series trajectories of bank holding companies in different bins, I turn to the local projection technique introduced by Jordà (2005). More formally, the dependent variable, $\Delta_h y_{i,T}$, is the cumulative deviation from the pre-crisis trend, which is computed as the difference between 100 times the log of total credit and 100 times the log of projected pre-crisis trend value at h quarters after crisis-quarter T (i.e. 2008Q4). The indicator variable denoted by $d_{i,T}$ distinguishes the groups of bank holding companies based on the exposure to systemic bailouts, and is equal to 1 if the exposure is higher than the median and zero otherwise. I also include control variables $X_{i,T}$ ¹⁴ with 8 lags before T to address the issue of omitted variables bias. The impact of the exposure to systemic bailouts on post-crisis credit recovery can be measured using the following baseline local projection specification:

$$\Delta_h y_{i,T} = \mu_h + \gamma_h d_{i,T} + \Theta X_{i,T} + \epsilon_{i,T} \quad (1.4)$$

where μ_h measures the cumulative deviation from pre-crisis trend for bank holding companies in the group of lower exposure to systemic bailouts, while $\mu_h + \gamma_h$ measures the cumulative deviation for the group of high exposure.

However, some identification concerns may arise in terms of the main factors of weak credit recovery. First, the bank holding companies with higher exposure to the systemic bailout factor might have taken excessive risk during the run-up to the crisis, which eventually led to more adverse effect by the post-crisis financial regulations such as the Dodd-Frank Act. Indeed, securitization of balance sheet items have been one of the most common means of

¹⁴The control variables are the ones that show up most in the banking literature. They are size, leverage, total credit, return on asset (ROA), return on equity (ROE), systemic risk contributions (CoVar), non-performing loans ratio, liquidity etc. In order to address the endogeneity issue, I reduce the control variables to those that are extremely rigid in the ranking among all the sample banks. Table 1.9.4 displays the transition matrix of these variables. I set 90% as the threshold of transition probability and ROA, ROE, and Liquidity are removed from our control variable list. Such change does not alter our empirical results.

risk-taking by the U.S. banking sector before the subprime crisis. As such, the Dodd-Frank Act was designed to regulate the financial institutions that have significant participations in the securitization market through risk retentions¹⁵. Thus, I propose the second hypothesis, the *financial regulations* hypothesis, as the following.

Financial Regulations Hypothesis (H2). *The effect in H1 is stronger if a bank holding company's exposure to the securitization market during the crisis onset is higher.*

Second, in line with the literature on investigating the impact of weak credit demand¹⁶, I take into account the effect of credit demand shock on total bank credit growth patterns. In fact, banks might have lowered lending standards when issuing credit during the crisis run-up. However, the credit demand by distressed borrowers or borrowers from a distressed sector could be persistently weak during recovery periods. Thus, I form the next alternative hypothesis, the *credit demand* hypothesis as the following.

Credit Demand Hypothesis (H3). *The effect H1 is stronger if a bank holding company's exposure to borrowers from deteriorating sectors is higher.*

The *financial regulations* hypothesis (H2) and the *credit demand* hypothesis (H3) are both built on the effect explained in the *systemic bailout expectations* hypothesis (H1). I argue in these two hypotheses that the effect is stronger for the bank holding companies with higher exposure to the securitization market, or with higher exposure to borrowers from the deteriorating sectors. Therefore, I modify the baseline local projection specification (1.4) by

¹⁵Both Title VII and Title IX of Dodd-Frank concerns the securitization activities of bank holding companies. Title VII “Wall Street Transparency and Accountability” regulates the structured financial products traded in the over the counter swaps markets. Title IX “Investor Protections and Improvements to the Regulation of Securities” provides a regulatory guideline in Subtitle D that 5% of the risk must be retained during the asset-backed securitization process.

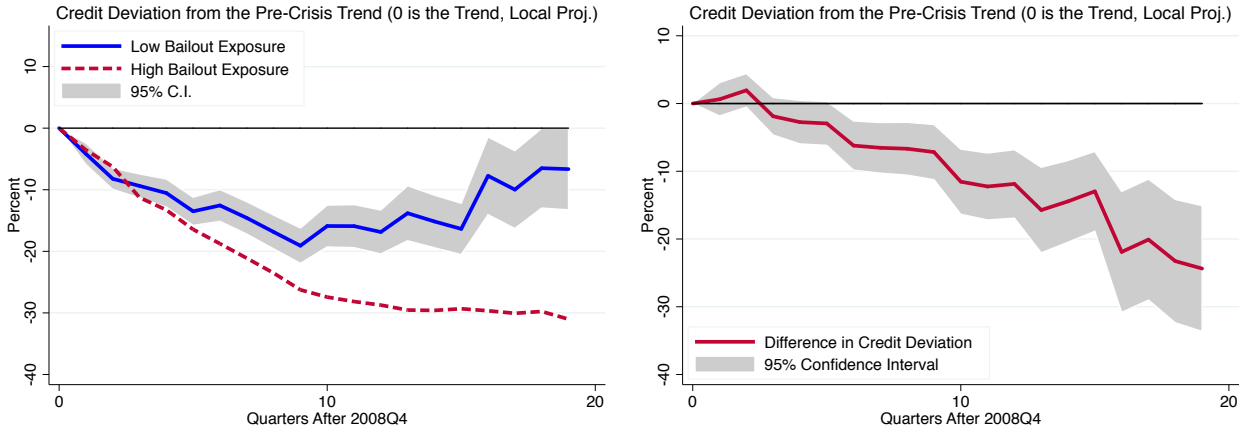
¹⁶Khawaja and Mian (2008) study the loan level data in Pakistan, Jimenez et al. (2012, 2014) study the loan level data in Spain, and Duchin and Sosyura (2014) focus on the U.S. mortgage and Syndicated loan level data.

interacting the exposure to systemic bailouts dummy $d_{i,T}$ with i) a measure of the exposure to the securitization market, or ii) a measure of the exposure to the borrowers from deteriorating sectors. The modified local projection specification is

$$\Delta_h y_{i,T} = \mu_h + \gamma_h^{HI} d_{i,T} \times \delta_{i,T} + \gamma_h^{LO} d_{i,T} \times (1 - \delta_{i,T}) + \Theta X_{i,T} + \epsilon_{i,T} \quad (1.5)$$

where the dummy variable $\delta_{i,T}$ equates to 1 if bank i 's average exposure to the securitization market in 2008 is above the median across sample bank holding companies for H2, or if bank i 's average exposure to borrowers from deteriorating sectors in 2008 is above the median for H3. I report the estimates of $\mu_h + \gamma_h^{HI}$ and $\mu_h + \gamma_h^{LO}$, which are respectively the cumulative trend deviations for the two groups of bank holding companies: high exposure to systemic shadow bank bailouts but differ in the exposure to the securitization market or the exposure to weak borrowers. The two estimates help us to find the evidence of whether financial regulations or the weak credit demand is the dominant (or only) reason for the weak recovery of bank credit recovery after the subprime crisis. For instance, if the group of bank holding companies with high exposure to systemic bailouts but less exposure to the securitization market (less adverse effect by the Dodd-Frank Act) also presents significant credit growth deviations from the pre-crisis trend (especially after 2010Q3, the enactment quarter of Dodd-Frank), I argue that financial regulations do not completely explain what I have observed in the main hypothesis (H1) and the substantial decline in market expectations of systemic bailouts might also be of great importance. The same argument applies to the treatment of the exposure to weak borrowers.

Figure 1.5: Baseline local projections



Note: This set of figures display the estimation results based on the baseline local projection specification $\Delta_h y_{i,T} = \mu_h + \gamma_h d_{i,T} + \Theta X_{i,T} + \epsilon_{i,T}$, where the dependent variable, $\Delta_h y_{i,T}$, is the cumulative deviation from the pre-crisis trend, $d_{i,T}$ is a dummy variable that is equal to 1 if bank holding company i 's exposure to systemic bailouts is higher than the median, and $X_{i,T}$ is a vector of control variables. The left panel shows the cumulative percentage deviations of bank credit from its pre-crisis trend (the horizontal zero line) for the two groups of bank holding companies (i.e. μ_h and $\mu_h + \gamma_h$), where a negative percentage indicates a growth path below the pre-crisis trend. The right panel shows the difference in growth path, γ_h , between the two groups.

1.4 Main Empirical Results

1.4.1 Results for the Main Hypothesis

I start with the results obtained from the baseline specification. Using the local projection technique, I estimate the response of post-crisis credit deviation from pre-crisis trend to the outbreak of the subprime crisis. The main results are presented in Fig. 1.5 for the estimates of two groups with different degree of exposure to systemic bailout factor (left panel), as well as the difference in post-crisis deviation, γ_h , for the two groups (right panel). In order to show the long-run impact, I present the estimation results up to 20 quarters after T (2009Q1-2012Q4).

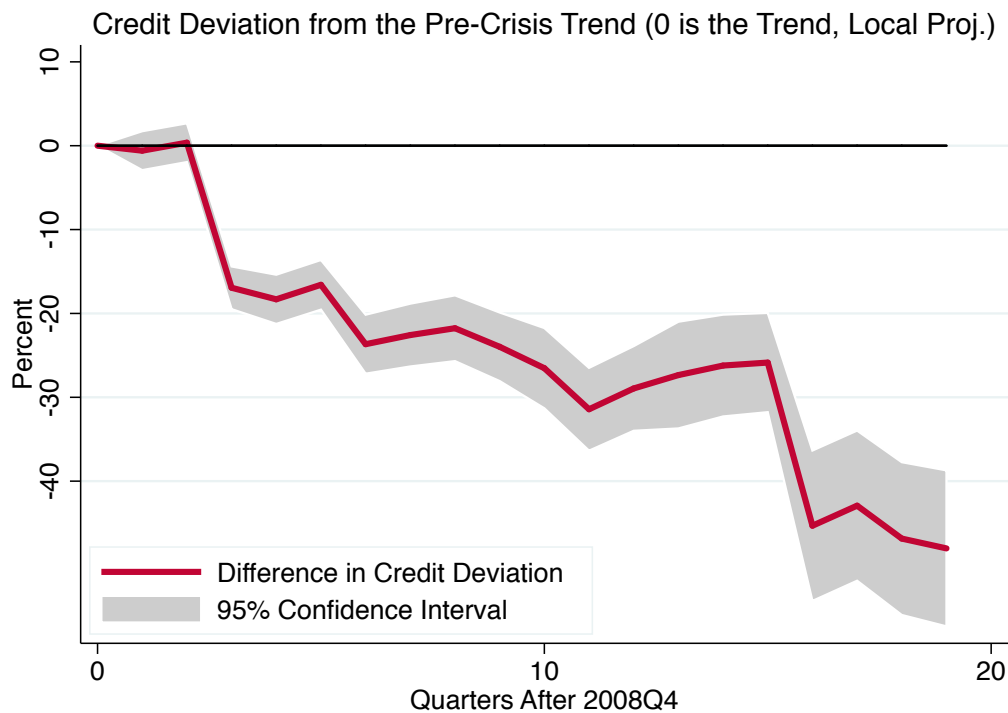
The main estimation result reveals two characteristics of the post-crisis credit growth patterns among U.S. bank holding companies. First, as the left panel of Fig. 1.5 shows, although the group of bank holding companies with higher exposure to the systemic bailout

factor had an additional 4.89% loss in the bank credit 8 quarters after 2008Q4, both groups have experienced a significant decline from the pre-crisis trend since the onset of the crisis (18.57% and 23.46%). The initial deviation from the trend for both groups is consistent with what has been described in the empirical literature that banks go through a process of painful deleveraging during the crisis episodes (e.g. Ivashina and Scharfstein 2010, Gorton and Metrick 2012). Second, there is a quite significant divergence in total credit growth path for the two groups of bank holding companies starting from the 8th quarter after 2008Q4. On the left panel of Fig. 1.5, bank holding companies with lower exposure to systemic shadow bank bailouts had almost caught up with the pre-crisis trend at the end of the sample periods (20 quarters after the onset of crisis), but the deviation from the pre-crisis trend for the high exposure to systemic bailouts group remains significant. In total, the high exposure group experience an additional 24.96% credit deviations from the trend and there is no evidence of convergence up to 5 years after the crisis onset. The right panel displays the estimates of the post-crisis trend deviations difference between the two groups (i.e. γ_h) as well as their 95% confidence intervals, which are generated by the same local projection specification. Comparing with their respective pre-crisis trend, there is a significant long-run difference in trend deviation between the two bank holding company groups. These findings based on the baseline local projection specification are in line with the *Systemic Bailout Expectations Hypothesis* which states that high expectation on systemic bailouts to shadow banks may be growth enhancing during pre-crisis episodes but could be followed by a larger deviation from pre-crisis trend when a large decline in market expectations of systemic bailouts arises.

The previous results based on dummies that indicate groups of banks with different exposure to the systemic bailout factor are illustrating but somewhat restrictive. The setup assumes that the effect on the banks in the same group is alike. However, as the degree of exposure to the systemic bailout factor varies, the credit growth pattern might also vary. A natural way to relax this assumption is to use the continuous exposure to systemic bailouts variable in the empirical tests, instead of making it discrete. Thus, in the baseline local

projection specification, I replace the dummy variable $d_{i,T}$ by the continuous variable of each bank holding company's exposure to the systemic bailout factor (measured in Equation 1.1). Fig. 1.6 shows the estimation the credit growth path divergence for bank holding companies with 10 units difference in the put option beta (i.e. exposure to the systemic bailout factor) based on the new specification. Perhaps surprisingly, bank holding companies with different exposure to the systemic bailout factor exhibit a persistent and notable divergence in long-term credit growth. The estimation implies that a 1 unit difference in the put option beta led to about an additional 5% total credit deviations from the pre-crisis trend.

Figure 1.6: Baseline local projections (continuous measure of exposure to the systemic bailout factor)



Note: This figure displays the estimation results based on the baseline local projection specification $\Delta_h y_{i,T} = \mu_h + \gamma_h Exposure_{i,T} + \Theta X_{i,T} + \epsilon_{i,T}$, where the dependent variable, $\Delta_h y_{i,T}$, is the cumulative deviation from the pre-crisis trend, $Exposure_{i,T}$ is a continuous variable that indicates bank holding company i 's exposure to the systemic bailout factor, and $X_{i,T}$ is a vector of control variables. The estimates show the divergence in growth path for bank holding companies with 10 units difference in the exposure to the systemic bailout factor (i.e. $10 \times \gamma_h$).

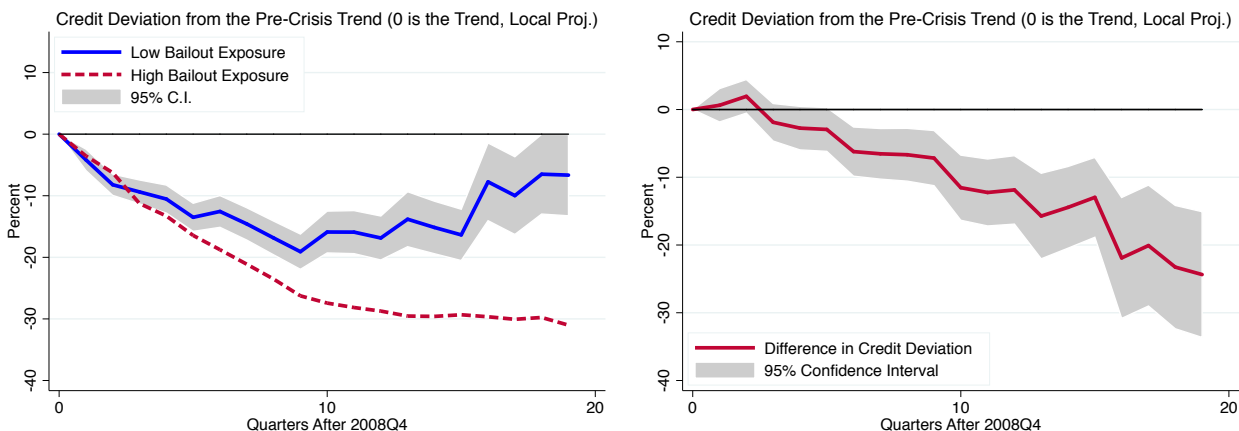
1.4.2 Results for the Alternative Hypotheses

Next, I turn to local projection specification (1.5) and investigate the importance of other factors such as the post-crisis financial regulations on shadow banking and weak credit demand recovery in driving the effect in the *systemic bailout expectations* hypothesis. Thus, given high exposure to systemic bailouts, I test the two alternative hypotheses: *financial regulations* hypothesis and *credit demand* hypothesis. Our purpose is to observe if bank holding companies that are more negatively affected by post-crisis financial regulations or weak credit demand would experience larger deviations from the pre-crisis credit trend.

In the *financial regulations* hypothesis, should financial regulations on shadow banking be the main contributor, I expect that the trend deviations for banks that are less affected by regulations (lower exposure to the securitization market) would be notably smaller, especially after 2010Q3 (the enactment of Dodd-Frank). Otherwise, financial regulations such as the Dodd-Frank Act may not be the dominant factor explaining the empirical findings in Fig. 1.5 and Fig. 1.6.

Fig. 1.7 presents the estimation results based on the specification (1.5), in which the left panel shows the cumulative deviation from the trend for i) the group with low exposure to the systemic bailout factor (blue solid), ii) the group with high exposure to the systemic bailout factor and high exposure to the securitization market (red dash), and iii) the group with high exposure to systemic bailouts low exposure to the securitization market (green dash). As is shown in the left panel of Fig. 1.7, both groups with high exposure to the systemic bailout factor experienced permanent deviations from the pre-crisis long-run credit trend. I find the difference in trend deviations for the two groups of bank holding companies that have high exposure to the systemic bailout factor is small even in the long-term. In particular, the estimated credit deviation for the group of low exposure to the securitization market is 34.26% 7 years after the crisis onset while the same figure for the group of high exposure to the securitization market is 42.81%. Moreover, the right panel of Fig. 8 reveals that the deviation from the pre-crisis trend for the group with high exposure to the systemic

Figure 1.7: Local projections for the financial regulations hypothesis

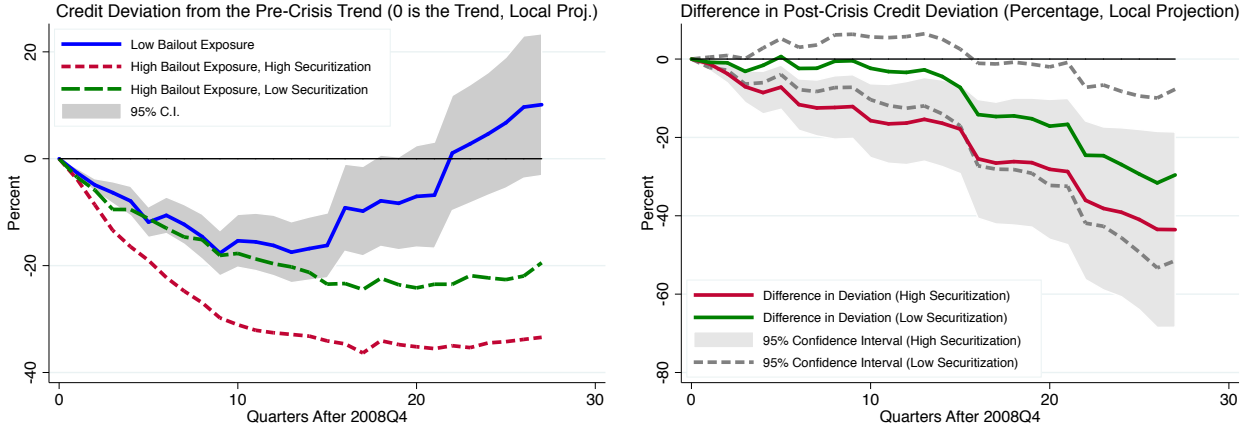


Note: This set of figures display the estimation results based on the baseline local projection specification $\Delta_h y_{i,T} = \mu_h + \gamma_h^{HI} d_{i,T} \times \delta_{i,T} + \gamma_h^{LO} d_{i,T} \times (1 - \delta_{i,T}) + \Theta X_{i,T} + \epsilon_{i,T}$, where the dependent variable, $\Delta_h y_{i,T}$, is the cumulative deviation from the pre-crisis trend, $d_{i,T}$ is a dummy variable that is equal to 1 if bank holding company i 's exposure to the systemic bailout factor during 2008Q3-Q4 is higher than the median, $\delta_{i,T}$ is a dummy variable that equates to 1 if bank holding company i 's average exposure to the securitization market during 2008Q3-Q4 is above the median across the 384 sample bank holding companies, and $X_{i,T}$ is a vector of control variables. The left panel shows the cumulative percentage deviations of bank credit from its pre-crisis trend (the horizontal zero line) for three groups of bank holding companies (i.e. μ_h , $\mu_h + \gamma_h^{HI}$, and $\mu_h + \gamma_h^{LO}$), where a negative percentage indicates a growth path below the pre-crisis. The right panel shows the differences in growth path for the two treatment groups, γ_h^{HI} and γ_h^{LO} . The measurement of each bank holding company's exposure to the securitization market is described in Section 1.3.1.

bailout factor but low exposure to the securitization market is insignificantly different from our benchmark group (the group with low exposure to the systemic bailout factor). These empirical regularities are inconsistent with the *financial regulations hypothesis*, in which higher likelihood of being regulated by the post-crisis financial sector regulations would amplify the effect characterized in the *systemic bailout expectations hypothesis*. This supports our presumption that financial regulation alone is not the only explanation for the post-crisis persistent credit growth deviation from the trend.

In order to test the *credit demand hypothesis*, I stick to the specification (1.5) but redefine the dummy variable $\delta_{i,T}$ as an indicator of whether the bank holding company's exposure to the borrowers from the deteriorating sectors is higher than the median in the sample in 2008. As Fig. 8 illustrates, both groups with high exposure to the systemic bailout factor but

Figure 1.8: Local projections for the credit demand hypothesis



Note: This set of figures display the estimation results based on the baseline local projection specification $\Delta_h y_{i,T} = \mu_h + \gamma_h^{HI} d_{i,T} \times \delta_{i,T} + \gamma_h^{LO} d_{i,T} \times (1 - \delta_{i,T}) + \Theta X_{i,T} + \epsilon_{i,T}$, where the dependent variable, $\Delta_h y_{i,T}$, is the cumulative deviation from the pre-crisis trend, $d_{i,T}$ is a dummy variable that is equal to 1 if bank holding company i 's exposure to systemic bailouts during 2008Q3-Q4 is higher than the median, $\delta_{i,T}$ in the interaction terms is a dummy variable that equates to 1 if bank holding company i 's average exposure to borrowers from deteriorating sectors during 2008Q3-Q4 is above the median across sample bank holding companies, and $X_{i,T}$ is a vector of control variables. The left panel shows the cumulative percentage deviations of bank credit from its pre-crisis trend (the horizontal zero line) for three groups of bank holding companies (i.e. μ_h , $\mu_h + \gamma_h^{HI}$, and $\mu_h + \gamma_h^{LO}$), where a negative percentage indicates a growth path below the pre-crisis. The right panel shows the differences in growth path for the two treatment groups, γ_h^{HI} and γ_h^{LO} . The measurement of each bank holding company's exposure to borrowers from deteriorating sectors is described in Section 1.3.1.

different levels of exposure to weak borrowers exhibit substantial downward deviations from the pre-crisis credit trend in the recovery periods. Although the group with higher exposure to weak borrowers and higher exposure to the systemic bailout factor shows stronger credit loss especially during the periods immediately after the crisis onset, the group with lower exposure to weak borrowers but higher exposure to the systemic bailout factor have also experience very strong credit loss from the pre-crisis trend. Thus, the results shown in Fig. 8 cannot support the *credit demand hypothesis*. In other words, this finding suggests that the very weak recovery of bank credit after the subprime crisis is not dominantly explained by the deteriorating credit demand.

1.5 Evidence from Commercial Bank Level Data

Bank holding companies with higher put option beta (i.e. exposure to the systemic bailout factor) during the crisis onset would experience a larger credit loss from the pre-crisis trend. Section 1.4 has provided evidence based on bank holding company level data. Could I find more supporting evidence if we drill down to the commercial bank level data and compare credit growth patterns of different commercial bank subsidiaries within the same bank holding company? Do the changes in the market expectations of systemic bailouts affect credit growth of commercial banks differently even though they are under the umbrella of the same bank holding company? Commercial bank subsidiaries of the same bank holding company have same put option beta but have different exposure to the securitization market and deteriorating borrowers. In this section, I use the merged commercial bank level data from the Call Report and empirically examine if commercial banks within the same bank holding company could experience different credit loss after the financial crisis. Moreover, I take into account the merger and acquisition information of commercial bank subsidiaries and restrict the empirical tests with the sample of commercial banks that have survived after the subprime crisis. In this way, I address the concern that acquired failed commercial banks might be irrelevant to the parent bank holding company's put option beta that is measured during the crisis onset.

1.5.1 Fixed Effects Regressions

According to the *systemic bailout expectations hypothesis*, weak recovery of bank credit is due to the notable reduction in market expectations of systemic bailout guarantees. In addition, the commercial bank subsidiaries (on balance sheet) and the shadow bank subsidiaries (off balance sheet) of a bank holding company are by their nature in different safety nets, where guarantees to the former is explicit and to the latter is implicit. Thus, changes in the market expectations of systemic bailouts would first affect shadow bank subsidiaries' borrowing

constraint, which is sensitive to market perceptions of systemic bailouts, before such shock is transmitted to commercial bank subsidiaries. In other words, credit growth patterns of commercial bank with different characteristics (e.g. exposure to the securitization market and exposure to weak borrowers) should be similar as long as they are within the same parent bank holding company. In contrast, if the effect driven by post-crisis financial regulations and weak credit demand is significant, I would expect to see commercial bank within the same bank holding company but have distinct exposure to the securitization market and weak borrowers would experience different levels of post-crisis credit loss.

The key for the empirical tests is a commercial bank level dataset so that I can control for the bank holding company fixed effects. Table 1.9.4 displays the fixed effects regression results with the following specification.

$$\ln(g_{i,c}^{post}) = \beta_1 d_i + \beta_2 d_i \times \delta_{i,c} + \Theta X_{i,c} + \alpha_i + \epsilon_{i,c} \quad (1.6)$$

where d_i has the same definition with previous sections (dummy variable that indicates the level of bank holding company i 's exposure to the systemic bailout factor or put option beta), $g_{i,c}^{post}$ is the average quarterly credit growth rate of the commercial bank subsidiary c under the parent bank holding company i during post-crisis periods (2009Q1-2012Q4), $\delta_{i,c}$ is a dummy variable that indicates the level of exposure to the securitization market and exposure to weak borrowers at the commercial bank level ¹⁷, and $X_{i,c}$ is a vector of commercial bank level control variables. In Table 1.9.4, I present the estimation results of specification (1.6). As Column (1) shows, the effect of higher parent bank holding company's put option beta (exposure to the systemic bailout factor) is disruptive to the credit growth of the commercial bank subsidiaries. For bank holding companies with high put option beta, the affiliated commercial banks experience an additional 4.223% quarterly loss in post-crisis credit growth.

¹⁷Since DealScan only provides lenders' information at the bank holding company level, I re-define the exposure to weak borrowers as the fraction of commercial bank loans that are real estate loans (RIAD 4246 in Commercial Bank Call Report).

Column (2) and (4) reports the estimations with the interaction, which reveals the additional effects due to higher exposure to the securitization market (financial regulation hypothesis) or higher exposure to weak borrowers (credit demand hypothesis). The estimation implies that commercial banks with higher exposure to the securitization market experience an additional 2.252% reduction in the quarterly credit growth rate. Similarly, commercial banks with higher exposure to weak borrowers incur an additional 2.643% loss in the quarterly credit growth rate. However, such seemingly strong adverse effects caused by financial regulations and weak credit demand are significantly reduced by more than half when I control for parent bank holding company fixed effects. As Column (3) and (5) display, the additional losses in credit growth due to higher exposure to the securitization market or higher exposure to weak borrowers are respectively reduced to 1.019% and 1.450%. In other words, the difference in credit growth across commercial banks is absorbed by the bank holding company fixed effects which are identical for commercial bank subsidiaries under the same umbrella.

In addition, I consider a fixed effect specification with corresponding continuous variables instead of dummy variables. Table 1.9.4 reports the estimations in the same fashion as Table 1.9.4. As Column (1) shows, the disruptive effect following higher exposure to the systemic bailout factor is robust to the change in regression variables. Moreover, the comparison between Column (2) and (3) reveals that different impact by higher exposure to the securitization market is notably reduced after controlling for the bank holding company fixed effects. Perhaps surprisingly, the additional effects due to higher exposure to the weak borrowers still exist even after the inclusion of bank holding company fixed effects. Such pattern is even stronger when I only consider the sub-sample of commercial banks with above median exposure to the real estate sector. In the subsection that follows, I show that such pattern is mostly caused by some bank holding companies' acquisitions of failed commercial banks which have extremely high pre-crisis exposure to the real estate sector.

1.5.2 Subsample of Surviving Commercial Banks

The commercial banks with extremely high exposure to the real estate sector experience substantially higher credit loss from the pre-crisis trend even after the inclusion of parent bank holding company fixed effects. This finding is seemingly against our conclusions in the previous empirical tests, in which weak credit demand caused by borrowers from the deteriorating sectors is not the dominant reason for slow credit recovery. In fact, the empirical evidence from the sample covering all commercial banks regardless of merger and acquisition history does not inform us about whether the bank holding company fixed effects fully absorb the difference across commercial banks. Indeed, some commercial banks might have been required by their charters to specialize in real estate lending. This may lead to bank failure and the subsequent acquisitions by outside bank holding companies. Meanwhile, some bank holding companies have grown through acquiring failed commercial banks with heavy exposure to the real estate sector. In either cases, bank holding company fixed effects may not explain the variations across commercial banks. In another word, the effect of systemic bailout expectations on shadow bank subsidiaries is irrelevant to the credit growth of commercial bank subsidiaries before acquisitions. Before proposing the strategy to resolve this issue, I provide two examples of bank acquisitions during the aftermath of subprime crisis to illustrate our argument.

Acquisition of Guaranty Bank by BBVA Compass: Guaranty Bank (Texas) was the second largest commercial bank in Texas, with 162 branches across Texas and California and \$13 billion in assets at the end of the first quarter of 2009. BBVA Compass is an US-based bank holding company and is the subsidiary of BBVA (the second largest bank in Spain). According to its charter, Guaranty Bank is required to keep 70% of its assets in housing related investments. This requirement has led to extremely high exposure to the housing market collapse risk. To make it worse, in April 2009, the Office of Thrift Supervision ordered Guaranty Bank to write off its loss in mortgage-backed securities related business.

This order has cost the bank a total amount of \$1.5 billion capital, which left the bank with inadequate Tier 1 capital ratio. As a result, the bank's share price plummeted from \$18.50 to 15 cents by the end of the second quarter. Eventually, the majority of bank assets were taken by the Federal Deposit Insurance Corporation (FDIC) and sold to BBVA Compass, a bank holding company which had no presence in California and low presence in Texas before the acquisition.

Acquisitions of IndyMac and other commercial banks by OneWest Bank: OneWest Bank is a bank holding company that was founded at March 19, 2009. Since its establishment, OneWest Bank has grown through acquiring failed commercial bank assets that are closely related with mortgages or mortgage-backed securities. For instance, it began operations immediately after acquiring distressed assets of the Independent National Mortgage Corporation (also called IndyMac Bank, the seventh largest mortgage originator in the US until its failure) from the FDIC. On December 18, 2009, it completed the acquisition of First Federal Bank of California (\$6 billion in assets and \$5 billion in deposits). On February 19, 2010, it acquired La Jolla Bank (\$4 billion in assets and \$3 billion in deposits). Obviously, the development of OneWest Bank is through acquiring outside commercial banks.

As illustrated by the examples above, the parent bank holding company could be unrelated with its commercial bank subsidiaries especially before acquisitions. If the acquisition of failed commercial banks is a result of commercial banks' excessive pre-crisis exposure to distressed borrowers, higher exposure to the real estate sector could be followed by significant bank credit deviations from the trend even after controlling for bank holding fixed effects. Thus, I consider a subsample that only includes commercial banks with a full history (2005Q1-2012Q4) of affiliations to their parent bank holding companies. Table 1.9.4 reports the fixed effect regression results. Importantly, with the filtered sub-sample, the additional effects on post-crisis credit growth following higher exposure to the weak borrower decreases

substantially after the inclusion of parent bank holding company fixed effects.

1.6 A Model of the Banking System

I present a model of the modern banking system that features both commercial banks and shadow banks. What connects commercial banks and shadow banks is the “originate-to-distribute” (OTD) securitization market, where commercial banks originate mortgages and sell part of them to shadow banks that have an exclusive technology of portfolio diversification. I discuss key assumptions of the model in Section 1.6.3.

In the model, each commercial banker issues mortgages that are funded by risk-less deposits. To circumvent regulatory equity requirement, commercial bankers sell a portion of their mortgages to shadow bankers. However, the OTD business model goes hand in hand with a moral hazard problem—commercial banks may not screen and monitor the mortgages that are supposed to be transferred from their balance sheets to shadow banks. Thus, risk retention during securitization is necessary, where a certain fraction of the mortgages that has been securitized is required to be insured by commercial banks. Moreover, the degree of risk retention is higher as the market value of securitized mortgages is lower, since monitoring provides less extra value to commercial banks. Because the market value of securitized mortgages is determined by the liquidity position in shadow banks, the second half of the model draws attention to various bonds issuance strategies that are available to shadow banks.

Shadow banks have access to three types of security issuance strategies: non-defaultable bonds, defaultable bonds, and option-like catastrophe bonds. All three bonds require portfolio diversification. In line with Gennaioli, Shleifer, and Vishny (2013), the non-defaultable bonds guarantees creditors a risk-less return and improves financial stability. The defaultable bonds (DB), however, allow occasional default but is associated with higher leverage. Finally, the option-like catastrophe bonds (CB) that only repays a full amount in the bad

state. Catastrophe bonds emerge as government provides at least partial bailout guarantees to shadow banks and feature a higher leverage when the bailout guarantee is generous enough. The latter two strategies is different from the first one in two perspectives. First, the defaultable bonds and the catastrophe bonds require government bailout guarantee with a certain probability. Second, since bailouts are systemic in a manner that creditors will be guaranteed only when all the shadow banks default on the same type of bonds, shadow banks are incentivized to hold a substantial amount of market portfolio so that they are exposed to systemic risk and the banking system is fragile.

1.6.1 Model Set-up

Agents and Environment Time is discrete and infinite. There are competitive and risk-neutral investors who can lend any amounts as long as they are promised an expected payoff of $1+r$. Meanwhile, there are also overlapping generations of bankers who live for two periods and have linear preferences over consumption goods: $c_t + \frac{1}{1+r}c_{t+1}$, where $1+r$ is the risk free rate. Commercial bankers and shadow bankers are both endowed with one unit of banking labor ($l_t^j = 1, j \in \{c, s\}$). In the first period of her life, a banker supplies inelastically her unit labor. At the end of the first period, she receives wage income v_t^j and uses it as net worth w_t^j for banking activities. In the second period of her life, a banker receives profit and consumes.

Investment Projects Commercial bankers are located on “islands” indexed by $i \in \Omega_I$. Each island bears idiosyncratic shocks that follow $\theta_{i,t} \sim F_{\theta,\omega}$ and $\theta_{i,t} \in \Omega_\theta \equiv [\underline{\theta}, \bar{\theta}]$, where $\omega \in \{g, b\}$ indicates aggregate state (i.e. good or bad). A bad state b arrives with a probability λ and a lower expected value of $\theta_{i,t}$ (i.e. $E_b[\theta_{i,t}] < E_g[\theta_{i,t}]$). The island specific productivity $Z_{i,t}^j$ is dependent on idiosyncratic risk $\theta_{i,t}$ and capital $k_{i,t}^j$ funded by commercial banks and shadow banks. More specifically, $Z_{i,t}^c = \theta_{i,t} (k_{i,t}^c)^{1-\alpha}$ and $Z_{i,t}^s = \theta_{i,t} (k_{i,t}^s)^{1-\beta}$.

Besides consumption goods, there are also mortgages (i.e. investment goods) in the economy with relative price $p_t = p_t^{Mortgage} / p_t^{Consumption}$. Capital in an investment project can is

funded by mortgages issued by bankers in the previous period and fully depreciates after one period (i.e. $k_t^c = I_{t-1}^c$ and $k_t^s = I_{t-1}^s$)¹⁸. For securitized mortgages, the realized value of $\theta_{i,t+1}$ at $t + 1$ is dependent on whether commercial bankers on the same island have screened and monitored mortgage quality during securitization. Without screening and monitoring, I assume $\theta_{i,t+1} = \underline{\theta}$ for $\omega \in \{g, b\}$. Otherwise, $\theta_{i,t+1}$ is drawn from its distribution $F_{\theta,\omega}$. All young bankers maximize their expected profit immediately after knowing aggregate state ω . Since idiosyncratic shocks are uncorrelated across islands, and they are realized at the end of each period, it is convenient to write the optimization problem by dropping the i -subscript¹⁹.

C-Banks Commercial bank (thereafter C-bank) i produces mortgages y_t^c using bank funded capital k_t^c and young banker's labor l_t^c , and operates a Cobb-Douglas production technology

$$y_t^c = Z_t^c (k_t^c)^\alpha (l_t^c)^{1-\alpha} \quad (1.7)$$

In the beginning of each period t , aggregate state ω is known, and young C-bankers decides (i) a fraction $1 - \phi_t$ of mortgages that they intend to obtain from old C-bankers²⁰, and (ii) whether they will screen and monitor the quality of the mortgage pool transferred to shadow banks (χ_t ²¹). Since young C-bankers choose ϕ_t at the beginning of t , whereas θ_t is unknown until the end of t , the amount of mortgages inherited by young C-bankers is based on the

¹⁸This set-up is in line with Kalantzis, Ranciere, and Tornell (2015) and Begenau and Landvoigt (2017) where bankers invest in borrowers' capital.

¹⁹In the rest of this chapter, I will drop i -subscript for convenience. However, one should keep in mind the model describes bankers' decisions on each island, and later I will aggregate the credit growth and return on equity for all the islands.

²⁰ $1 - \phi_t$ can be understood as the investment share within the commercial banking sector, while ϕ_t is the securitization scale.

²¹ χ_t indicates the monitoring decision, which is equal to 1 if C-banks monitors the quality of the transferred mortgage pool at t .

expected output given only aggregate state ω ²²

$$I_t^c = (1 - \phi_t) E_\omega [y_t^c] \quad (1.8)$$

Meanwhile, the rest of mortgages are purchased by young shadow bankers (thereafter S-bankers). Since young C-banks may not screen and monitor the quality of transferred mortgages, the input for young S-bankers at the beginning of t is

$$I_t^s = \phi_t (\chi_t E_\omega [y_t^c] + (1 - \chi_t) \underline{\theta} I_{t-1}^c) \quad (1.9)$$

To fund their investment projects, young C-bankers use their wage income v_t^c as net worth and issue deposit that guarantee safe return at the end of her first period. Thus, the budget constraint of a C-bank is $p_t I_t^c \leq w_t^c + b_t^c$ where $w_t^c = v_t^c$. Both wage and deposit are denominated by consumption goods for young C-bankers to purchase mortgages from old C-bankers. The deposit b_t^c promises a repayment $L_{t+1}^c = (1 + r)b_t^c$ and is fully guaranteed by the government. With that being said, the old C-banker i 's cash flow at $t + 1$ is $p_{t+1} y_{t+1}^c - v_{t+1}^c l_{t+1}^c - L_{t+1}^c$ if she is solvent, but is zero if she is insolvent²³.

Since monitoring securitized mortgages is costly to C-banks, a moral hazard problem arises during securitization. Thus, buyers (S-bankers) have to ask C-bankers to insure against a certain fraction φ_t of transferred mortgages. For each dollar of insured mortgages, C-banks pays mortgage buyers $E_t [\theta_{t+1}] - \underline{\theta}$ after θ_{t+1} is realized. Given that $\theta_{t+1} = \underline{\theta}$ without monitoring, the incentive-compatibility (risk retention) constraint imposed by S-bankers is

$$\varphi_t p_t I_t^s \left(E_t [\theta_{t+1}] - \int \theta_{t+1} dF(\theta) \right) + C_t \leq \varphi_t p_t I_t^s (E_t [\theta_{t+1}] - \underline{\theta}) \quad (1.10)$$

²²Such notion of decision making before idiosyncratic risk realization captures the delay from mortgage origination to final sales in the originate-to-distribute business model (Purnanandam, 2010) and, more importantly, guarantees single price in the securitization market such that arbitrage across islands is impossible.

²³C-banker i is insolvent if $p_{t+1} y_{t+1}^c - v_{t+1}^c l_{t+1}^c - L_{t+1}^c < 0$.

where $C_t = C(w_t^s)$ is an upfront cost of screening mortgage quality at t which is linear in buyer's equity size: $C(w_t^s) = c \cdot w_t^s$ ²⁴. Under this constraint, C-banks are granted partial ownership of securitized mortgage, with which they are responsible for all the return uncertainty. Thus, the required risk retention fraction set by S-bankers satisfies $\varphi_t \geq \frac{C_t \cdot E_t[\theta_{t+1}]}{p_t I_t^s (E_t[\theta_{t+1}] - \underline{\theta})}$.

The profit maximization problem of young C-bankers at t is

$$\max_{\phi_t, \chi_t} E_t [\delta \zeta_{t+1}^c (p_{t+1} y_{t+1}^c - v_{t+1}^c l_{t+1}^c - L_{t+1}^c) - \chi_t C_t]$$

where $\delta = 1/(1+r)$ is the discount rate, ζ_{t+1}^c is equal to 1 if the C-bank is solvent, and the risk retention constraint (1.10) holds. Moreover, C-banks are subject to the equity requirement

$$\kappa p_t (I_t^c + \varphi_t I_t^s) \leq w_t^c \quad (1.11)$$

where C-banks' minimum equity holding is a fixed multiple κ of total assets plus the insured mortgage portfolio. The timing is illustrated in Fig. 9 at the end of this subsection.

S-Banks The S-banks are also located on different islands, where young S-bankers manage capital funded by mortgages with Cobb-Douglas production technology

$$y_t^s = Z_t^s (k_t^s)^\beta (l_t^s)^{1-\beta} \quad (1.12)$$

and use net worth w_t^s and S-bank bonds b_t^s to purchase the mortgages from C-banks. However, since the securitization transaction is accomplished before $\theta_{i,t}$ is known, the market clearing condition is conditional on the aggregate state: $p_t \phi_t E_\omega [I_t^s] = E_\omega [w_t^s + b_t^s]$. Taking as given the amount of mortgages transferred from C-banks, the market value of the mortgage, p_t , is contingent upon the liquidity in the S-banks.

In contrast to C-banks, S-banks are subjected to less regulations. First, there is no

²⁴Alternatively, one could model monitoring cost as a fixed cost or a function of securitized mortgage pool size. However, I will show in the next section that the current formulation is the simplest one that ensures I have binary risk retention scale $\varphi_t \in \{\varphi_H, \varphi_L\}$ over time.

minimum equity requirement imposed on S-banks. Second, S-bankers are allowed to issue bonds with default risk. Section 1.6.2 elaborates on three types of S-bank bonds. Third, S-bankers may divert all the funds they have raised without committing to promised repayment.

An S-bank's borrowing constraint arises when creditors impose a non-diversion constraint, but the tightness of borrowing constraint is dependent on creditors' choice of S-bank bonds. To implement a diversion scheme in the second period of her life, an S-banker has to incur a liquidation cost that is proportional to total investable funds $h[w_t^s + b_t^s]$, in which h measures law enforceability and loss in the process of assets liquidation. S-bankers will not divert as long as the diversion cost surpasses the current value of expected repayment $E_t [L_{t+1}^s]$

$$\delta E_t [L_{t+1}^s] \leq h [w_t^s + b_t^s] \quad (1.13)$$

The profit maximization problem of a young S-banker at t is

$$\max_{\Omega_{B,t}, \xi_t} E_t [\delta \zeta_{t+1}^s (p_t y_{t+1}^s - v_{t+1}^s l_{t+1}^s - (1 - \xi_t) L_{t+1}^s) - \xi_t h (w_t^s + b_t^s)]$$

where ζ_{t+1}^s is equal to 1 if the S-banker does not default, ξ_t is equal to 1 if she sets up a diversion scheme at t , and $\Omega_{B,t}$ is a menu of bonds issuance strategies.

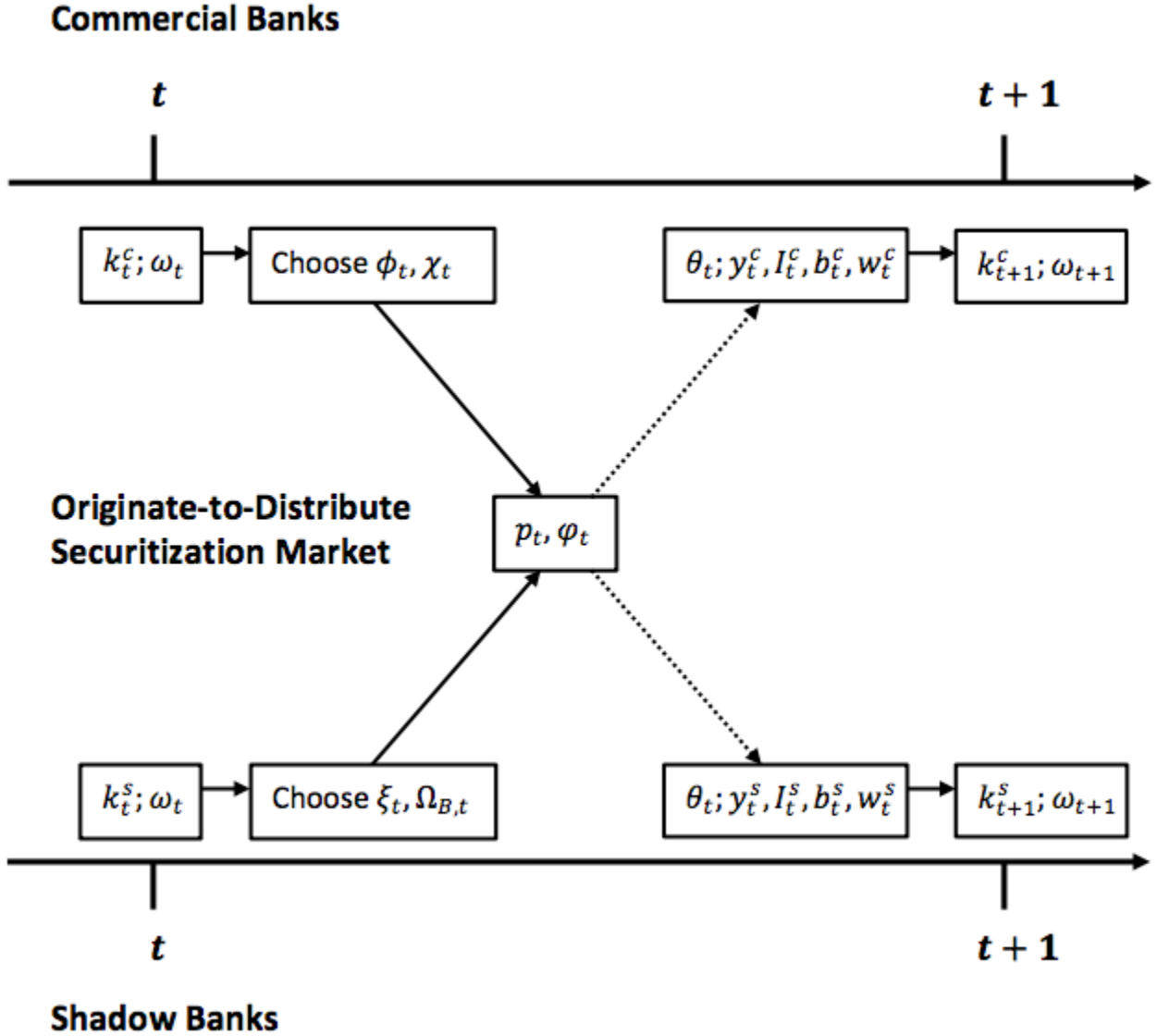
Without the occurrence of default at t , a young S-banker's net worth is her competitive wage $w_t^s = v_t^s = (1 - \beta)p_{t-1}y_t^s$. Otherwise, default leads to old S-bankers' revenue being wiped out and young S-bankers' net worth becoming $w_t^s = \mu p_{t-1}y_t^s$ ²⁵.

1.6.2 Shadow Bank Bonds

S-banks offer a menu with three types of bonds. The first type, non-defaultable standard bonds, is risk-less. However, the other two types, defaultable standard bonds and catastrophe bonds, feature occasional defaults. This subsection presents the detail of these bonds.

²⁵Default procedure causes substantial loss to banks and I assume what can be recovered by young S-bankers is tiny ($\mu < 1 - \beta$).

Figure 1.9: Timeline from t to $t + 1$



Note: This figure illustrates the timeline of the full model. Aggregate state is known in the beginning of each period. C-bankers and S-bankers maximize expected profit in the second period of their life by choosing $\{\phi_t, \chi_t\}$ and $\{\xi_t, \Omega_{B,t}\}$, which pins down the price p_t and risk retention degree φ_t in the originate-to-distribute securitization market. With the realization of θ_t at the end of period t , all the investment and capital structure are settled. Afterwards, young C-bankers and S-bankers enter period $t + 1$ and consume their realized profit at the end of $t + 1$.

Non-Defaultable Standard Bonds (NB) S-banks are different from C-banks not only because of loose regulations, but also due to their access to other islands for swapping mortgage portfolio (i.e. risk diversification). Therefore, the pool of S-bank i 's original mortgages that is diversified has a sure productivity in each aggregate state of next period $Z_{t+1}^{s,\omega} = E_\omega [\theta_{t+1}] (k_{t+1}^s)^{1-\beta}$. Ex ante, the diversified pool and undiversified pool have the same unconditional expectations on θ_{t+1} (i.e. $E_t [\theta_{t+1}] = (1-\lambda)E_g [\theta_{t+1}] + \lambda E_b [\theta_{t+1}]$). Denote the fraction of original mortgage that is diversified as η_t . The expected amount of mortgages generated by S-banks in the next period is

$$E_t [y_{t+1}^s] = \eta_t \underbrace{((1-\lambda)E_g [\theta_{t+1}] + \lambda E_b [\theta_{t+1}]) I_t^s}_{\text{diversified pool}} + (1-\eta_t) \underbrace{E_t [\theta_{t+1}] I_t^s}_{\text{undiversified pool}} \quad (1.14)$$

Furthermore, after paying wage to young S-bankers at $t+1$, old S-bankers are still able to fully repay NB creditors in the most unlucky realization of productivity (i.e. $\theta_{t+1} = \underline{\theta}$):

$$(1+r)b_t^s \leq \beta (\eta_t \cdot E_b [\theta_{t+1}] + (1-\eta_t)\underline{\theta}) p_t I_t^s \quad (1.15)$$

Note that Condition (1.15) guarantees the stability of S-banks. Accordingly, government bailout guarantee is unnecessary under the issuance of NB.

Finally, since $E_t [L_{t+1}^s] = (1+r)b_t^s$, the non-diversion constraint is

$$\delta(1+r)b_t^s \leq h(w_t^s + b_t^s) \quad (1.16)$$

which limits the leverage ratio of S-banks who issue NB. With the leverage ratio that meets Condition (1.16), one determines the minimum diversification scale η_t through Condition (1.15).

Defaultable Standard Bonds (DB) NB characterizes the shadow banking system that

is repressed by infinitely risk-averse creditors. However, with risk-neutral investors, S-banks may also issue bonds with default risk. The key assumption in this model is that the government bailouts to S-banks is systemic. Therefore, S-bankers intend to be exposed to systemic risk to the extent that all of them become insolvent simultaneously. This can be accomplished when S-banks diversify an enough portion of their mortgage pool such that

$$(1 + \rho_t)b_t^s \leq \beta (\eta_t E_g [\theta_{t+1}] + (1 - \eta_t)\underline{\theta}) p_t I_t^s \quad (1.17)$$

$$(1 + \rho_t)b_t^s \geq \beta (\eta_t E_b [\theta_{t+1}] + (1 - \eta_t)\bar{\theta}) p_t I_t^s \quad (1.18)$$

where Condition (1.17) ensures that all shadow banks are solvent in the good state even when all islands encounter $\theta_{t+1} = \underline{\theta}$, and Condition (1.18) guarantees systemic insolvency in the bad state even when all islands end up with $\theta_{t+1} = \bar{\theta}$.

Given systemic insolvency of S-banks, DB creditors expect government could step in and guarantee them with a probability u . Thus, creditors are willing to hold DB as long as

$$1 + r = (1 - \lambda + \lambda u) (1 + \rho_t) \quad (1.19)$$

where the right hand side of Equation (1.19) validates that creditors are fully repaid when 1) good state arrives or 2) bad state arrives but government guarantees creditors.

The non-diversion constraint is in a similar fashion as that for NB with the exception that S-bankers now have full liabilities to creditors only in the good state

$$\delta (1 - \lambda) (1 + \rho_t) b_t^s \leq h (w_t^s + b_t^s) \quad (1.20)$$

Catastrophe Bonds (CB) Behaving like a credit default swap issuer, issuer of catastrophe bonds repays creditors a small premium $L_{t+1}^s = \Delta$ if she is solvent, but promises to repay $L_{t+1}^s = (1 + \rho_t)b_t^s$ she turns out to be insolvent. In order to obtain systemic bailouts in case of default, Conditions (1.17) and (1.18) still hold for S-banks who issue CB. Thus, S-bankers

either pay an infinitesimal amount Δ to creditors in the good state or default on CB and exploit systemic bailouts in the bad state. Note the non-diversion constraint is never binding for issuers of CB. In the model, I assume government purchases S-banks' assets $w_t^s + b_t^s$ with a predetermined price g . Thus, risk-neutral creditors are willing to hold CB as long as

$$(1 + r)b_t^s = (1 - \lambda)\Delta + \lambda u g(w_t^s + b_t^s) \quad (1.21)$$

For simplicity, I set $\Delta \rightarrow 0$ so that S-banks have no liabilities to creditors in the good state. The interest rate, hence, can be derived as $1 + \rho_t = g(w_t^s + b_t^s)/b_t^s$.

1.6.3 Discussion of the Model Set-up

Originate-to-Distribute Securitization: In the model, C-banks and S-banks are connected through the originate-to-distribute (OTD) securitization model. C-banks originate mortgages and sell a portion of originated mortgage portfolio to S-banks who have the capability to diversify idiosyncratic risk of transferred mortgage pool. Such OTD model is a substitution of the traditional originate-to-hold model and became especially popular after the Gramm–Leach–Bliley Act which removed the barrier among commercial banks, investment banks, security companies, insurance companies, etc. Bord and Santos (2012) document the rise and evolution of the OTD model with the U.S. loan level data.

Moral Hazard in Securitization: The moral hazard problem arises with the prevalence of the OTD securitization model in the banking sector. Lack of incentives to monitor securitized mortgage quality²⁶ is documented by Ashcraft and Schuermann (2008) as one of seven agency problems that arise in the securitization market. In this model, the moral hazard problem emerges because monitoring the quality of securitized mortgages is costly to

²⁶Such information friction also appears as adverse selection in which arrangers (C-banks) securitize bad loans to third parties (S-banks) and keep the good ones.

C-bankers. As such, S-banks require C-banks to retain a certain fraction of securitized mortgages so that the latter may have enough monitoring incentive. Such risk retention through mortgage risk insurance is studied in Acharya, Schnabl, and Suarez (2013) who found asset-backed commercial paper conduits that are sponsored by commercial banks retained most mortgage risk within the banking sector. The set-up of risk retention is in line with many theoretical papers in modeling agency problems over the course of loan sales (e.g. Pennacchi, 1988; Gorton and Pennacchi, 1995; Parlour and Plantin, 2008).

Catastrophe Bonds: The catastrophe bonds in our model are theoretical securities that capture out-of-the-money (OTM) put options and credit default swaps (CDS). The similarity between these two types of securities is that they promise to repay only if a bankruptcy state realizes. However, the toxic cocktail that combines catastrophe bonds and government bailouts guarantee could lead to a “financial black-hole” where negative net present value projects are funded (Ranciere and Tornell, 2012). In the model extension, I argue that the issuance of shadow bank catastrophe bonds could also lead to the break-down of financial discipline where risk retention constraint does not hold any more.

1.7 Analysis

The equilibrium of the model is a set of choices made by C-bankers and S-bankers across islands. They follow a credit market game *a la* Schneider and Tornell (2004) and Ranciere and Tornell (2016). When aggregate state ω is known, young C-banks decides the scale of securitization ϕ_t and whether they will monitor securitized mortgages χ_t . Young S-bankers decide a diversion scheme ξ_t , a risk retention requirement for C-banks φ_t , and a menu of bonds issuance plans $\Omega_{B,t} = \{B_t^{NB}, B_t^{DB}, B_t^{CB}\}$. Each plan is characterized by a set of decisions on interest rate, leverage, and diversification scale made by S-bankers: $B_t^k = (\rho_t^{s,k}, \Gamma_t^{s,k}, \eta_t^{s,k})$, where $k \in \{NB, DB, CB\}$. The market value p_t of banking goods (I_t^c and I_t^s) is determined

such that securitization market clears. All the decisions are made before θ_t is realized.

Definition: *An equilibrium of the model consists of a collection of stochastic processes $(\phi_t, \chi_t, \xi_t, \Omega_{B,t}, I_t^c, I_t^s, y_t^c, y_t^s, w_t^c, w_t^s)$ and a set of prices (p_t, v_t^c, v_t^s) such that on each island:*

- (1) *The profit maximization problems of C-banks and S-banks are solved;*
- (2) *The securitization market of mortgages (I_t^s) and the labor market of bankers (l_t^c, l_t^s) clear;*
- (3) *Young bankers at $t = 0$ are endowed with net worth $w_0^c = (1 - \alpha)p_0y_0^c$ and $w_0^s = (1 - \beta)y_0^s$, and net worth of bankers during $t \geq 1$ evolves such that $w_t^c = v_t^c$ and*

$$w_t^s = \begin{cases} v_t^s & \text{if solvent} \\ \mu p_{t-1} y_t^s & \text{if insolvent} \end{cases}$$

In the rest of this section, I characterize the optimal decisions of C-banks and S-banks in the equilibrium. Multiple equilibria emerges for S-banks because of less restrictions on bonds issuance and the existence of systemic bailout guarantee to creditors of S-banks. Then, I take stock and analyze the growth of total credit in each equilibrium, which varies when the probability of bailout guarantee changes.

1.7.1 C-Bank Optimization in Equilibrium

Young C-bankers' optimal decision at t includes a securitization scale ϕ_t and a monitoring choice χ_t . Moreover, young C-bankers' net worth at t is the competitive wage $w_t^c = v_t^c = (1 - \alpha)y_t^c$. Given the risk retention constraint, we can derive the payoff of C-banks at $t + 1$ as

$$\begin{aligned}\pi_{t+1}^c &= \max \{ \alpha p_{t+1} y_{t+1}^c - b_t^c(1+r), 0 \} = \max \{ \alpha p_{t+1} \theta_{t+1} I_t^c - (1 - 1/\Gamma_t^c) p_t I_t^c (1+r), 0 \} \\ &= \Gamma_t^c w_t^c \left(1 \left[\theta_{t+1} \geq \frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right] (\alpha \theta_{t+1}^+ p_{t+1}/p_t - (1 - 1/\Gamma_t^c)(1+r)) \right) \quad (1.22)\end{aligned}$$

where $\Gamma_t^c = p_t I_t^c / w_t^c$ is the leverage ratio of C-banks at t . Taking the expectation of this expression with respect to θ_{t+1} , one obtains

$$E_t [\pi_{t+1}^c] = \Gamma_t^c w_t^c \left[\left(1 - F_\theta \left(\frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right) \right) (\alpha \theta_{t+1}^+ p_{t+1}/p_t - (1 - 1/\Gamma_t^c)(1+r)) \right] \quad (1.23)$$

where $F_\theta \left(\frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right)$ is C-bank's probability of being insolvent at $t+1$ based on the cumulative distribution function of θ_{t+1} , and $\theta_{t+1}^+ \equiv E_t \left[\theta_{t+1} \mid \theta_{t+1} \geq \frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right]$ is the expectation of idiosyncratic shock conditional on survival. Notice that the price p_t of mortgages at t is a decreasing function of the securitization scale ϕ_t . Thus, I obtain the following relation between securitization scale and C-banks' expected profit at t .

Lemma 1.1. (C-Banks' Expected Profit)

The expected profit of young C-banks at t is higher when the securitization scale ϕ_t is lower.

$$\frac{\partial E_t [\pi_{t+1}^c]}{\partial \phi_t} \leq 0$$

Proof. For the proof, see Appendix 1.9.1.1. □

Thus, maximizing C-banks' expected profit requires minimizing their securitization scale ϕ_t . However, the minimum equity requirement (1.11) kicks in and sets a lower bound for the securitization scale. The proposition that follows characterizes C-bankers' optimal decisions on securitization scale, leverage, and monitoring.

Proposition 1.1. (C-Banks: Securitization Scale, Leverage, and Monitoring)

C-bankers' profit maximizing decisions on securitization scale ϕ_t , leverage Γ_t^c , and monitoring χ_t are all determined by risk retention degree φ_t . That is,

$$\phi_t = \frac{1 - (1 - \alpha) / \kappa}{1 - \varphi_t}, \quad \Gamma^c = \frac{1}{\kappa} \left(1 + \frac{\phi_t}{1 - \phi_t} \varphi_t \right) \quad (1.24)$$

and $\chi_t = 1$ if $\varphi_t \geq c \cdot E_t [\theta_{t+1}] / [(E_t [\theta_{t+1}] - \underline{\theta}) \Gamma_t^s]$.

Proof. Following the minimum equity requirement at t in Condition (1.11), it is straightforward to show that the lower bound for the securitization scale is $\phi_t \geq \underline{\phi}_t \equiv \frac{1 - (1 - \alpha) / \kappa}{1 - \varphi_t}$. Since Lemma 1.1 shows that $E_t [\pi_{t+1}^c]$ is negatively related with ϕ_t , we conclude that $\phi_t = \underline{\phi}_t$ for C-bank profit maximization. Finally, since $C(w_t^s) = c \cdot w_t^s$, the risk retention degree φ_t set by mortgage buyers (S-bankers) is a function that is decreasing in the leverage ratio Γ_t^s . \square

Proposition 1.1 presents the optimal decision of C-bankers. Minimizing securitization scale leads to higher expected profit. However, C-banks may still securitize and transfer a fraction of their mortgage pool to S-banks for maintaining a minimum equity requirement. This is in line with the theoretical literature on motivations of mortgage securitization (e.g. Pennacchi 1988, and Parlour and Plantin 2008) and the empirical literature on regulatory arbitrage in the process of securitization (e.g. Acharya and Schnabl 2009; Acharya, Schnabl, and Suarez 2013; Adrian and Shin 2009; Nadauld and Sherlund 2009; Pozsar et. al. 2012). Moreover, notice that risk retention degree φ_t connects C-banks and S-banks through transactions in the securitization market. On one hand, φ_t determines the optimal decisions made by C-bankers. On the other hand, S-bank's leverage ratio Γ_t^s governs the magnitude of φ_t . The latter is legitimate because shadow banks with higher leverage ratio can generate higher market value of securitized mortgages, which increases the value of monitoring mortgages to C-banks.

1.7.2 S-Bank Optimization in Equilibria

As described in the set-up of the model, S-banks issue three types of bonds. Here, I characterize symmetric equilibria under the issuance of non-defaultable standard bonds (NB), defaultable standard bonds (DB), and catastrophe bonds (CB).

Proposition 1.2. (*S-Banks: Symmetric Equilibria*)

There exists three S-bank symmetric equilibria paths featuring one of three bonds among $\{NB, DB, CB\}$. Moreover, given aggregate state ω at t , the following conditions hold for each equilibrium:

(1) Only one type of S-bank bonds is funded during tranquil periods where the interest rates on bonds $1 + \rho_t^s$ are respectively

$$1 + \rho_t^{s,NB} = 1 + r, \quad 1 + \rho_t^{s,DB} = \begin{cases} \frac{1+r}{1-\lambda+\lambda u} & \text{when } t \neq \tau \\ 1+r & \text{when } t = \tau \end{cases}, \quad 1 + \rho_t^{s,CB} = \begin{cases} \frac{1+r}{\lambda u} & \text{when } t \neq \tau \\ 1+r & \text{when } t = \tau \end{cases}$$

where τ denotes crisis periods.

(2) S-banks' leverage ratio, which is defined as $\Gamma_t^s \equiv (w_t^s + b_t^s)/w_t^s$, for each symmetric equilibrium is

$$\Gamma_t^{s,NB} = \frac{1}{1-h}, \quad \Gamma_t^{s,DB} = \begin{cases} \frac{1}{1-h(1+\lambda u/(1-\lambda))} & \text{when } t \neq \tau \\ \frac{1}{1-h} & \text{when } t = \tau \end{cases}, \quad \Gamma_t^{s,CB} = \begin{cases} \frac{1}{1-\lambda \delta u g} & \text{when } t \neq \tau \\ \frac{1}{1-h} & \text{when } t = \tau \end{cases}$$

(3) S-banks hold a portion $\eta_t \geq \bar{\eta}^k$ of market portfolio such that Condition (1.15) holds for $\bar{\eta}^{NB}$ and Condition (1.17) and (1.18) hold for both $\bar{\eta}^{DB}$ and $\bar{\eta}^{CB}$. The realized output at the end of $t+1$ is $y_{t+1}^s = [\eta_t E_\omega[\theta_{t+1}] + (1-\eta_t)\theta_{t+1}] I_t^s$.

(4) S-banks takes on systemic risk when issuing DB and CB such that all S-banks are insolvent when the bad state arrives, during which creditors are expected to be bailed out with a probability u . However, systemic bailouts cannot be granted in consecutive periods. Thus, DB and CB would not be funded during a crisis period, but the issuance may resume immediately

afterwards.

(5) Given realized w_t^s at the end of t , the net worth w_{t+1}^s evolves such that

$$w_{t+1}^s = \begin{cases} (1 - \beta)p_t y_{t+1}^s & \text{when } t + 1 \neq \tau \\ \mu p_t y_{t+1}^s & \text{when } t + 1 = \tau \end{cases}$$

for DB and CB, or $w_{t+1}^s = (1 - \beta)p_t y_{t+1}^s$ for NB.

Proof. For the proof, see Appendix 1.9.1.2. □

According to this proposition, only one type of bonds is funded in a symmetric equilibrium. This is because the bailouts to S-bankers are granted systemically, on condition that all S-bankers simultaneously default on the same type of bonds. Thus, any collections of heterogeneous decisions are unstable. Without all the S-banks defaulting on the same type of bonds, systemic bailouts would not be granted.

Moreover, the equilibrium with NB distinguishes itself from the other two equilibria in two perspectives. First, issuing NB is safe to creditors. Thus, the shadow banking sector is stable and does not present boom and bust cycles. However, in the other two risky symmetric equilibrium paths, a substantial amount of young S-banker's net worth is wasted in the event of default (see Proposition 1.2(5)). Second, although all the three equilibria require certain degree of mortgage pool diversification, the reasons are distinct. For issuers of NB, mortgage pool diversification is associated with the purpose of ensuring solvency even with the worst realization of idiosyncratic risk $\theta_{t+1} = \underline{\theta}$. However, issuers of DB and CB intend to take enough systemic risk so that systemic bailout guarantee is granted in the bad state. Thus, the systemic risk taking allows issuers of DB and CB to operate with a higher leverage within a certain range of u . The following corollary compares the leverage ratio of S-banks in different symmetric equilibria.

Corollary 1.1. (*S-Bank Leverage Ratio*)

The leverage ratio of S-banks who issue non-defaultable bonds $\Gamma^{s,NB}$ is independent of the systemic bailout probability u . Yet, both $\Gamma_t^{s,DB}$ and $\Gamma_t^{s,CB}$ are increasing in u when $t \neq \tau$. Given restriction that $g \geq h/[\lambda(1-\lambda)]$, the relations of these three leverage ratio at $t \neq \tau$ are as follows: (1) $\Gamma_t^{s,DB} \geq \Gamma_t^{s,NB}$, (2) $\Gamma_t^{s,CB} \geq \Gamma_t^{s,NB}$ if $u \geq \bar{u} \equiv h/(\lambda g)$, and (3) $\Gamma_t^{s,CB} \geq \Gamma_t^{s,DB}$ if $u \geq \bar{\bar{u}} \equiv h/[g - h/(1-\lambda)]$.

Proof. For the proof, see Appendix 1.9.1.3. □

1.7.3 Total Credit Growth

Corollary 1.1 shows that, within a certain range of bailout probability u , the equilibria with DB and CB relax S-banks' borrowing constraint in the tranquil periods. However, with systemic risk taking and high leverage, the shadow banking sector that issues DB and CB is unstable and prone to the banking crisis caused by systemic insolvency. Thus, the net worth of young S-bankers are mostly wiped out and the leverage is substantially restricted in the crisis periods²⁷. With these two contradictory forces generated by systemic risk exposure, I take stock and assess the impact of S-bank bonds issuance on total credit growth. In addition, I treat the safe equilibrium with NB as a benchmark and investigate if issuing risky bonds (DB and CD) is growth enhancing when increasing the likelihood of systemic bailouts guarantee.

In this section, total credit provided by the banking sector includes mortgages held by C-banks and the mortgage pool held by S-banks after securitization. Indeed, besides the traditional commercial banking sector, shadow banks perform as financial intermediaries that channel funds from creditors in the wholesale funding markets to borrowers. Thus, the total credit provided by the banking sector at t is

²⁷Note I assume in the model that the systemic bailout guarantee cannot be consecutive. Thus, S-banks may only issue the non-defaultable standard bonds (NB) in the crisis periods.

$$\begin{aligned}
Credit_t &\equiv p_t (I_t^c + I_t^s) = \left(\frac{1 - \phi_t}{\phi_t} + 1 \right) (w_t^s + b_t^s) \\
&= \begin{cases} \frac{1 - \beta}{\phi_t} E_g [\theta_t] \Gamma_t^s \cdot Credit_{t-1} & \text{when } t \neq \tau \\ \frac{\mu}{\phi_t} E_b [\theta_t] \Gamma_t^s \cdot Credit_{t-1} & \text{when } t = \tau \end{cases}
\end{aligned}$$

where the second equality is derived from conditions (1.8), (1.9), and (1.12). As shown by Proposition 1.1, the value of ϕ_t is fixed in the equilibrium with NB ($\phi_t = \phi_H$) due to the constant leverage ratio $\Gamma^{s,NB}$. However, ϕ_t is binary overtime in an equilibrium with DB or CB, where $\phi_t \in \{\phi_H, \phi_L\}$ and the lower securitization scale ϕ_L occurs during tranquil or recovery periods.

In the safe equilibrium, S-banks never default on creditors and the leverage ratio $\Gamma^{s,NB}$ is always a constant. Thus, the long-run growth rate of total credit is

$$\gamma^{NB} \equiv \frac{Credit_t}{Credit_{t-1}} = \frac{1 - \beta}{\phi_H} E_\omega [\theta_t] \Gamma^{s,NB} \quad (1.25)$$

which does not depend on the systemic bailout probability u .

However, the risky equilibrium with DB or CB presents systemic banking crises in which all S-banks simultaneously default on creditors. During tranquil periods ($t \neq \tau$), the growth rate of total credit is

$$\gamma^{k,tr} \equiv \frac{Credit_t}{Credit_{t-1}} = \frac{1 - \beta}{\phi_L} E_g [\theta_t] \Gamma^{s,k} \quad (1.26)$$

where $k \in \{DB, CB\}$. Meanwhile, the average growth rate during a crisis period and the following recovery period ($t = \tau$ and $t = \tau + 1$) is

$$\gamma^{k,cr} = \left(\frac{\mu}{\phi_H} E_b [\theta_t] \Gamma^{s,NB} \right)^{1/2} \left(\frac{1 - \beta}{\phi_L} E_g [\theta_t] \Gamma^{s,k} \right)^{1/2} \quad (1.27)$$

The term in the first brackets captures the growth rate during a crisis period, while the term

in the second brackets shows the growth rate during a recovery period immediately after the crisis periods. S-banks only issue NB during a crisis period. Starting from a recovery period, S-banks revert to the previous risky equilibrium path and issue DB or CB.

To derive long-run credit growth path in a risky equilibrium k , I compute the limiting distribution of a three-state Markov chain over three period types: tranquil, crisis, and recovery. I denote the limiting distribution as Π and the transition matrix as T . Each element $T_{i,j}$ of the transition matrix is the probability of transiting from period type i to period type j . Thus, the limiting distribution follows the pattern that $\Pi = T\Pi$, with which we can obtain that

$$T = \begin{pmatrix} 1 - \lambda & \lambda & 0 \\ 0 & 0 & 1 \\ 1 - \lambda & \lambda & 0 \end{pmatrix}, \quad \Pi = \begin{pmatrix} (1 - \lambda) / (1 + \lambda) \\ \lambda / (1 + \lambda) \\ \lambda / (1 + \lambda) \end{pmatrix}$$

Accordingly, the long-run average credit growth rate of a risky equilibrium $k \in \{DB, CB\}$ is

$$\gamma^k = \left(\frac{1 - \beta}{\phi_L} E_g [\theta_t] \Gamma^{s,k} \right)^{(1-\lambda)/(1+\lambda)} \left(\frac{\mu}{\phi_H} E_b [\theta_t] \Gamma^{s,NB} \right)^{\lambda/(1+\lambda)} \left(\frac{1 - \beta}{\phi_L} E_g [\theta_t] \Gamma^{s,k} \right)^{\lambda/(1+\lambda)} \quad (1.28)$$

I now use the growth rate in the safe equilibrium as a benchmark and study if financial deregulations (i.e. the issuance of DB and CB) is growth enhancing for total credit. With (1.25) and (1.28), the percentage difference in credit growth between a risky equilibrium $k \in \{DB, CB\}$ and the safe equilibrium NB is

$$\Delta \log \gamma^k \equiv \log \gamma^k - \log \gamma^{NB} = \frac{\lambda}{1 + \lambda} \log \left(\frac{\mu}{1 - \beta} \right) + \frac{1}{1 + \lambda} \log \left(\frac{\phi_H}{\phi_L} \right) + \frac{1}{1 + \lambda} \log \left(\frac{\Gamma^{s,k}}{\Gamma^{s,NB}} \right) \quad (1.29)$$

By definition, a risky equilibrium k is growth enhancing if and only if $\log \gamma^k - \log \gamma^{NB} > 0$,

which is equivalent as the following condition,

$$\Phi(k, u) \equiv \frac{\Gamma^{s,k}}{\Gamma^{s,NB}} \cdot \frac{\phi_H}{\phi_L} > \left(\frac{1-\beta}{\mu} \right)^\lambda \quad (1.30)$$

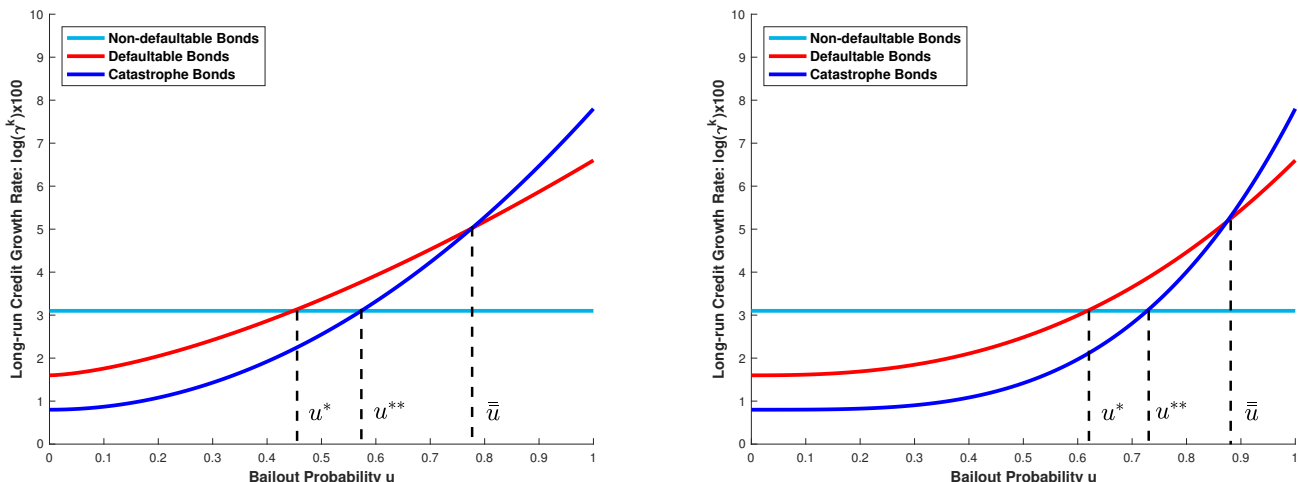
where $\Phi(k, u)$ measures the benefit to long-run growth due to a risky equilibrium k , whereas $\left(\frac{1-\beta}{\mu} \right)^\lambda$ measures the distress cost in crisis periods of a risky equilibrium path. The intuition of Condition (1.30) is formed on two contradictory effects. First, the risky equilibrium path relaxes S-banks' borrowing constraint. The relaxed borrowing constraint not only leads to higher leverage ratio, but also increases C-bankers' incentive to monitor securitized mortgage quality, which reduces risk retention during securitization. With less risk retention during tranquil periods (lower φ_L and ϕ_L), more credit is originated. Second, tranquil periods with higher credit growth are interrupted by systemic defaults, which gives rise to temporary distress in young S-bankers' net worth and borrowing capacity. The disruption in shadow banking system results in higher risk retention imposed on mortgage originators (C-banks) and crowds out C-banks' balance sheet capacity for new mortgage originations. With these two effects, a risky equilibrium path k is growth enhancing if and only if the benefit from higher leverage $\Phi(u)$ dominates the cost due to financial distress $\left(\frac{1-\beta}{\mu} \right)^\lambda$. Since $\Phi(u)$ is increasing in the probability of systemic bailouts u , the value of u is crucial in determining whether a risky equilibrium k is growth enhancing. The following proposition shows the conditions on u such that DB and CB lead to higher long-run credit growth. In other words, without satisfying these conditions on systemic bailouts to creditors of S-banks, deregulations on the shadow banking sector would otherwise restrict long-run credit growth.

Proposition 1.3. (*Systemic Bailouts and Credit Growth Enhancing*)

In an economy without deregulations on shadow bank bonds issuance among NB, DB, and CB, and given the following restriction on \bar{u} (defined in Corollary 1.1) for a risky equilibrium $k \in \{DB, CB\}$:

$$\Phi(k, \bar{u}) > \left(\frac{1-\beta}{\mu} \right)^\lambda$$

Figure 1.10: Growth enhancing thresholds



Note: This figure illustrates the growth enhancing thresholds of systemic bailout probability, u^* and u^{**} . The left panel characterizes the risky equilibrium paths with binary securitization scale ϕ_H and ϕ_L that are determined by the risk retention constraint. The right panel features constant securitization scale $\phi_t = \phi_H$.

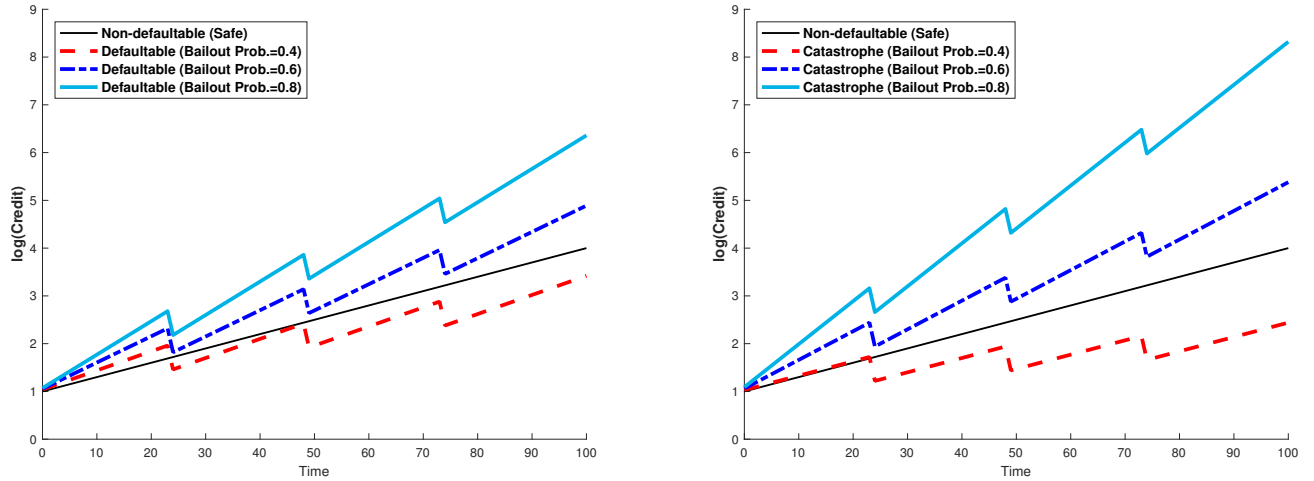
There exists two thresholds of systemic bailouts probability, u^ and u^{**} ($u^{**} > u^*$), such that*

- (1) *If $u < u^*$, both risky equilibria restricted long-run total credit growth,*
- (2) *If $u \in [u^*, u^{**})$, only the risky equilibrium with DB is growth enhancing,*
- (3) *If $u \geq u^{**}$, both risky equilibria are growth enhancing.*

Proof. For the proof, see Appendix 1.9.1.4. □

As numerical exercises to illustrate Proposition 1.3 imply comparative statics, Fig. 1.10 shows the growth enhancing thresholds of different S-bank bonds given the parameters discussed in Appendix 1.9.2. I observe characteristics that are consistent with Proposition 1.3. However, the left panel shows the case where the risk retention constraint (1.10) leads to a binary securitization scale ϕ_H and ϕ_L . In this case, the growth enhancing thresholds of systemic bailout probability u is moderate ($u^* = 0.46$ and $u^{**} = 0.58$). The right panel, on the other hand, presents the case where the variations of ϕ_t through the risk retention constraint is shut down and $\phi_t = \phi_H \forall t$. Following Condition (1.30), it requires higher u for the risky equilibrium paths to be credit growth enhancing ($u^* = 0.61$ and $u^{**} = 0.72$).

Figure 1.11: Growth enhancing effect comparison (DB vs. CB)



Note: This figure shows a comparison between the two risky equilibrium paths. The growth paths follow simulations of 100 periods with the systemic banking crisis happening every 25 periods. I vary the probability of systemic bailouts to shadow bank creditors in the bad state ($u = 0.4, 0.6, 0.8$).

Fig. 1.11 provide a comparison of the two risky equilibrium paths (defaultable standard bonds vs. catastrophe bonds). I simulate the equilibrium credit growth paths for 100 periods with the assumption that the systemic crisis happens every 25 periods²⁸. By varying the probability u of systemic bailouts to shadow bank creditors in the bad state, I observe that the long-term credit growth path could benefit more substantially from the increase in creditors' belief of systemic bailout likelihood.

1.7.4 Comparative Statics

Our model of the modern banking system with multiple equilibria exhibits the difference in long-run total credit growth paths due to different shadow bank bonds and different likelihood of systemic bailouts to shadow banks. Proposition 1.3 characterizes the conditions of systemic bailouts probability u such that the equilibrium with defaultable or catastrophe shadow bank

²⁸Note that this assumption is not strictly equivalent as $\lambda = 0.4$. However, the long-term growth trend with this setting would be the same as the alternative simulation with $\lambda = 0.4$.

bonds is growth enhancing. Now, I provide comparative statics for analyzing the impact of shadow bank systemic bailout expectations on long-run bank credit growth. Specifically, I propose three predictions from the model that validate the credit channel through the “originate-to-distribute” securitization market. Our three predictions are mainly obtained through differentiating $\Delta \log \gamma^k$ with respect to systemic shadow bank bailout probability u :

1. $\partial \Delta \log \gamma^k / \partial u > 0$: **An increase in systemic bailout probability increases the long-run credit growth enhancing effect for a risky equilibrium $k \in \{DB, CB\}$.** As Equation (1.29) shows, higher systemic bailout probability u affects long-run the credit growth gap through increasing shadow bank leverage. Higher shadow bank leverage not only increases market value of bank credit, but also reduces the crowding-out effect on new credit caused by risk retention.
2. $\partial \Delta \log \gamma^{CB} / \partial u > \partial \Delta \log \gamma^{DB} / \partial u$: **The growth enhancing effect in Prediction #1 is stronger for the risky equilibrium path with catastrophe bonds (CB).** This relation holds given the restriction of g in Corollary 1.1. The leverage is more sensitive to the systemic bailout probability u for CB issuers, which contributes to a larger growth enhancing effect characterized in Proposition 1.3.
3. $\partial \Delta \log \gamma^k / \partial u \partial [\phi(1 - \varphi)] > 0$: **The growth enhancing effect in Prediction #1 is stronger for commercial banks with higher exposure to the securitization market²⁹.** An increase in the securitization market exposure amplifies the impact of systemic bailout expectation to long-run total credit growth.

1.7.5 Model Extension: Securitization without Risk Retention

I have established so far the model of a modern banking system with the securitization market. Without the risk retention constraint, a moral hazard problem of mortgage monitoring

²⁹I omit the time subscript because $\phi_t(1 - \varphi_t) = 1 - (1 - \alpha)/\kappa \forall t$.

emerges. The unscreened mortgage or mortgage pool receives inferior return $\underline{\theta}$. They are considered as assets with negative net present value (NPV). In Appendix 1.9.1.5, I show that S-banks that issue catastrophe bonds could still have a return on equity that is greater than the risk-less return $1 + r$ (negative NPV), even without imposing the risk retention constraint. Although such equilibrium path with negative NPV projects could still be credit growth enhancing within a certain range, the financial discipline breaks down. To see the reason, note that S-banks have an infinitesimal amount of debt repayment when issuing catastrophe bonds ($\Delta \rightarrow 0$). As such, S-banks in an equilibrium with catastrophe bonds would fund any projects even with an inferior return $\underline{\theta}$. Without enforcing risk retention, C-banks have more capacity to originate new credit. However, the inferior return repressed long-run credit growth. Modifying (1.28), the long-run credit growth becomes

$$\gamma^k = \left(\frac{1 - \beta}{\phi'_L} \underline{\theta} \Gamma^{s,CB} \right)^{(1-\lambda)/(1+\lambda)} \left(\frac{\mu}{\phi_H} \underline{\theta} \Gamma^{s,NB} \right)^{\lambda/(1+\lambda)} \left(\frac{1 - \beta}{\phi'_L} E_g[\underline{\theta}] \Gamma^{s,CB} \right)^{\lambda/(1+\lambda)} \quad (1.31)$$

where $\phi'_L = 1 - (1 - \alpha)/\kappa$ is the securitization scale without risk retention in tranquil periods. The following corollary characterizes the growth enhancing condition for a risky equilibrium without monitoring.

Corollary 1.2. (Credit Growth without Risk Retention)

In a risky equilibrium with catastrophe bonds, when government fiscal outlays satisfy $g > g^ \equiv \frac{1 - (1 - \lambda)\delta\underline{\theta}}{1 - \lambda\delta u}$, S-banks may not require mortgage monitoring during securitization, which leads to projects with negative NPV being funded during tranquil periods. Then,*

(1) *Such an equilibrium is credit growth enhancing if and only if*

$$\Phi^{Inferior}(CB, u) = \frac{\Gamma^{s,CB}}{\Gamma^{s,NB}} \cdot \frac{\phi_H}{\phi'_L} > \left(\frac{1 - \beta}{\mu} \right)^\lambda \left(\frac{\underline{\theta}}{E_g[\underline{\theta}]} \right)^{1-\lambda} \left(\frac{\underline{\theta}}{E_b[\underline{\theta}]} \right)^\lambda$$

(2) *The growth enhancing threshold u^{***} is higher than its counterpart u^{**} in Proposition 1.3*

if and only if the additional cost of no risk retention is greater than the benefit,

$$\left(\frac{\underline{\theta}}{E_g[\theta]}\right)^{1-\lambda} \left(\frac{\underline{\theta}}{E_b[\theta]}\right)^\lambda \geq \frac{\phi_L(u^{***})}{\phi'_L}$$

1.8 Conclusion

I study in this chapter the market expectations of sector-wide systemic bailout guarantees, and their impact on shadow bank risky bonds issuance and the banking sector credit growth patterns. In the structural model, I link the traditional commercial banking sector to the shadow banking sector by the originate-to-distribute securitization market. Higher market expectations of systemic bailouts to the shadow banking sector could increase shadow banks' leverage in a risky equilibrium and lower risk retention by commercial banks in the securitization market, which increases the credit origination capacity of the banking sector. However, such growth enhancing effect comes at a cost due to the sector-wide banking crisis caused by shadow bank systemic risk exposure. This model implies that whether a risky equilibrium is growth enhancing or growth repressing depends on market expectations of systemic bailouts, the type of risky shadow bank bonds funded by creditors, and regulations on bonds issuance.

Merging U.S. bank holding companies out-of-the-money put options price data with consolidated regulatory balance sheet report and income statement (FR Y9-C and FFIEC 031/041), I measure each individual bank holding company's exposure to the systemic bailout factor (put option beta). Such novel bank level data allows us to test our main hypothesis: bank holding companies with higher exposure to the systemic bailout factor during the crisis would experience larger credit deviation from the pre-crisis trend. With the local projection approach, I observe that the group of bank holding companies with high exposure to systemic bailouts experienced an additional 4.89% cumulative downward deviations from the pre-crisis total credit trend 2 years after the crisis onset, and such difference is even larger in a longer term. In order to identify whether such effect is driven by government regulations on risky

shadow bank bonds or weak credit demand instead of low post-crisis market expectations of systemic bailouts, I also measure bank holding companies' exposure to the securitization market regulations and exposure to borrowers from deteriorating sectors. Our empirical results support our main hypothesis and show the evidence that banks even with less adverse effect by regulations or weak credit demand could still experience large credit loss as long as they are more affected by the significant drop in market expectations of systemic bailouts.

1.9 Appendix

1.9.1 Proof

1.9.1.1 Proof of Lemma 1.1 (C-Banks' Expected Profit)

Proof. By the securitization market clearing condition, the price of securitized mortgage p_t increases as the securitization scale ϕ_t decreases. Thus, we only need to show $\partial E_t [\pi_{t+1}^c] / \partial p_t \geq 0$. The following derivations follow the commercial bank profit maximization problem in Begeau and Landvoigt (2017). The expected value of commercial bank profit $E_t [\pi_{t+1}^c]$ can be rewritten as

$$\begin{aligned} E_t [\pi_{t+1}^c] &= [\Gamma_t^c w_t^c (p_{t+1}/p_t) \alpha] \left[\left(1 - F_\theta \left(\frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right) \right) \left(\theta_{t+1}^+ - \frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right) \right] \\ &= [p_{t+1} I_t^c \alpha] \left[\left(1 - F_\theta \left(\frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right) \right) \left(\theta_{t+1}^+ - \frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right) \right] \end{aligned}$$

where $\theta_{t+1}^+ \equiv E_t \left[\theta_{t+1} \mid \theta_{t+1} \geq \frac{(1 - 1/\Gamma_t^c)(1+r)}{\alpha \cdot (p_{t+1}/p_t)} \right]$. Note that the term in the first square brackets is irrelevant to p_t . Then, it suffices to show that the term in the second square brackets is higher the higher the securitized mortgage price p_t . \square

1.9.1.2 Proof of Proposition 1.2

Proof. Here, we provide the proof of Part (1)-(3) of the proposition, and Part (4)-(5) are both well explained in the main text.

Part (1) Since the non-defaultable standard S-bank bonds are equivalent as C-bank bonds (deposits), shadow bankers offer a competitive interest rate $1 + \rho_t^{s,NB} = 1 + r \forall t$. For the defaultable standard S-bank bonds (DB), Equation (1.19) leads to the interest rate on DB that $1 + \rho_t^{s,DB} = (1+r)/(1-\lambda+\lambda u)$ in tranquil periods ($t \neq \tau$). However, since systemic bailouts are not granted in two consecutive periods, S-bank creditors will only fund

non-defaultable bonds in crisis periods. Thus, $1 + \rho_t^{s,DB} = 1 + r$ when $t = \tau$. The interest rate on catastrophe bonds (CB) in tranquil periods is obtained from the condition that $(1 + \rho_t^{s,CB})b_t^s = g(w_t^s + b_t^s)$. As will be shown later, the leverage of CB issuers is $\Gamma_t^{s,CB} = 1/(1 - \lambda\delta u g)$. Therefore, $1 + \rho_t^{s,CB} = (1 + r)/(\lambda u)$ for $t \neq \tau$. Again, the interest rate in crisis periods is $1 + \rho_t^{s,CB} = 1 + r$ for $t = \tau$.

Part (2) The leverage ratio of S-banks in the safe equilibrium is obtained from the non-diversion constraint (1.16). Thus, the leverage ratio is $\Gamma_t^{s,NB} = 1/(1 - h) \forall t$. In a similar fashion, the leverage ratio of S-banks in a risky equilibrium with defaultable bonds (DB) is obtained from its non-diversion constraint as well. Following constraint (1.20), the leverage ratio in tranquil periods is $\Gamma_t^{s,DB} = 1/[1 - h(1 + \lambda u/(1 - \lambda))]$ for $t \neq \tau$. Since S-banks are funded by non-defaultable bonds in crisis periods, $\Gamma_t^{s,DB} = 1/(1 - h)$ for $t = \tau$. Since there is no non-diversion constraint in a risky equilibrium with catastrophe bonds (CB), the leverage ratio is derived from Condition (1.21). Thus, $\Gamma_t^{s,CB} = 1/(1 - \lambda\delta u g)$ for $t \neq \tau$, and $\Gamma_t^{s,CB} = 1/(1 - h)$ for $t = \tau$.

Part (3) As mentioned above, portfolio diversification in the safe equilibrium is for the purpose of guaranteeing risk-less repayment to S-bank creditors. Such requirement leads to Constraint (1.15). Hence, the minimum diversification fraction of S-bank portfolio is

$$\bar{\eta}^{NB} \equiv \frac{1 + r}{E_b[\theta] - \underline{\theta}} h\delta - \frac{\underline{\theta}}{E_b[\theta] - \underline{\theta}}$$

By contrast, portfolio diversification in a risky equilibrium is for enough systemic risk exposure such that the systemic bailouts will be granted in the bad state. The constraints (1.17) and (1.18) jointly determine that the minimum diversification fraction of S-bank portfolio in

a risky equilibrium with DB is

$$\bar{\eta}_t^{DB} \equiv \max \left\{ -\frac{1 + \rho_t^{s,DB}}{\bar{\theta} - E_b[\theta]} \cdot \frac{1}{1 - \Gamma_t^{s,DB}} + \frac{\bar{\theta}}{\bar{\theta} - E_b[\theta]}, -\frac{1 + \rho_t^{s,DB}}{E_g[\theta] - \underline{\theta}} \cdot \frac{1}{1 - \Gamma_t^{s,DB}} + \frac{\underline{\theta}}{E_g[\theta] - \underline{\theta}} \right\}$$

for $t \neq \tau$, and $\bar{\eta}_t^{DB} = \bar{\eta}_t^{NB}$ for $t = \tau$. Similarly, I can also derive the minimum diversification fraction of S-bank portfolio in a risky equilibrium with CB

$$\bar{\eta}_t^{CB} \equiv \max \left\{ -\frac{1 + \rho_t^{s,CB}}{\bar{\theta} - E_b[\theta]} \cdot \frac{1}{1 - \Gamma_t^{s,CB}} + \frac{\bar{\theta}}{\bar{\theta} - E_b[\theta]}, -\frac{1 + \rho_t^{s,CB}}{E_g[\theta] - \underline{\theta}} \cdot \frac{1}{1 - \Gamma_t^{s,CB}} + \frac{\underline{\theta}}{E_g[\theta] - \underline{\theta}} \right\}$$

for $t \neq \tau$, and $\bar{\eta}_t^{CB} = \bar{\eta}_t^{NB}$ for $t = \tau$. Note that the minimum diversification fractions in both risky equilibria are proportional to the leverage ratio $\Gamma_t^{s,DB}$ and $\Gamma_t^{s,CB}$ in tranquil periods. Thus, with higher market expectations of systemic bailouts, leverage ratio in a risky equilibrium is higher. This in turn increases portfolio diversification fraction so that S-banks are more exposed to the systemic risk. \square

1.9.1.3 Proof of Corollary 1.1

Proof. Proposition 1.3 has already shown that $\Gamma_t^{s,NB} = 1/(1-h)$, $\Gamma_t^{s,DB} = 1/[1 - h(1 + \lambda u/(1 - \lambda))]$, and $\Gamma_t^{s,CB} = 1/(1 - \lambda \delta u g)$ for $t \neq \tau$. Since $\lambda u/(1 - \lambda) > 0$ as long as $u > 0$, the leverage ratio of *DB* issuers is always greater than the leverage ratio of *NB* issuers in tranquil periods ($\Gamma_t^{s,DB} > \Gamma_t^{s,NB}$) when the likelihood of systemic bailouts is strictly positive. Similarly, $\Gamma_t^{s,CB} \geq \Gamma_t^{s,NB}$ if $u \geq \bar{u} \equiv h/(\lambda g)$ and $\Gamma_t^{s,CB} \geq \Gamma_t^{s,DB}$ if $u \geq \bar{\bar{u}} \equiv h/[g - h/(1 - \lambda)]$. Since the fiscal outlay g determines the leverage ratio of *CB* issuers, I require that $g \geq h/[\lambda(1 - \lambda)]$. \square

1.9.1.4 Proof of Proposition 1.3

Proof. Since $\partial \Gamma^{s,k}(u)/\partial u > 0$ and $\partial \phi_L(u)/\partial u < 0$, it follows that $\partial \Phi(k, u)/\partial u > 0$. Then, I show the existence of both u^* and u^{**} (i.e. $u^*, u^{**} < 1$). Given the assumption that $\Phi(k, \bar{u}) >$

$\left(\frac{1-\beta}{\mu}\right)^\lambda \forall k \in \{DB, CB\}$, it suffices to show that \bar{u} is greater than both growth enhancing thresholds u^* and u^{**} . Moreover, Corollary 1.1 proves that $\bar{u} \leq 1$. Thus, $u^*, u^{**} \in (0, 1)$. Finally, since $\Phi(CB, u)|_{u=0} < \Phi(DB, u)|_{u=0}$, it is obvious to show that $u^* < u^{**}$. \square

1.9.1.5 Extension: Securitization without Risk Retention

In a symmetric equilibrium with systemic risk-taking and non-defaultable bonds issuance, a S-bank's expected return on equity (ROE) before paying out young banker's wage is written as,

$$\begin{aligned} E_t \left[ROE_{t+1}^{s,NB} \right] &= \delta \left(p_t \tilde{\theta}_{t+1} I_t^s - L_{t+1}^s \right) / w_t^s \\ &= \left(\delta \tilde{\theta}_{t+1} - h \right) \Gamma_t^{s,NB} \\ &= \frac{\delta \tilde{\theta}_{t+1} - h}{1 - h} \end{aligned} \quad (1.32)$$

where $\tilde{\theta}_{t+1} = E_t[\theta_{t+1}]$ if C-banks monitor securitized mortgages, and $\tilde{\theta}_{t+1} = \underline{\theta}$ if without monitoring. The second equality is obtained with Condition (1.16). To guarantee positive expected ROE, it must hold that $\tilde{\theta}_{t+1} \geq 1 + r$. Hence, quality monitoring is necessary to sustain the equilibrium with NB . In the same manner, a S-bank's expected ROE in a symmetric equilibrium with defaultable bonds is

$$\begin{aligned} E_t \left[ROE_{t+1}^{s,DB} \right] &= (1 - \lambda) \left(\delta \tilde{\theta}_{t+1} - h \right) \Gamma_t^{s,DB} \\ &= \frac{(1 - \lambda) \left(\delta \tilde{\theta}_{t+1} - h \right)}{1 - h(1 + \lambda u / (1 - \lambda))} \end{aligned} \quad (1.33)$$

A necessary condition for this return on equity to be greater than risk-less rate is that $\tilde{\theta}_{t+1} \geq h(1 + r)^{30}$. Thus, as long as $\underline{\theta} < h(1 + r)$, the securitization market without quality

³⁰Strictly, $E_t \left[ROE_{t+1}^{s,DB} \right] \geq 1$ if and only if $\tilde{\theta}_{t+1} \geq \left[\frac{1 - h(1 + \lambda u / (1 - \lambda))}{1 - \lambda} + h \right] (1 + r)$, which has a lower bound of $h(1 + r)$. However, this lower bound is infeasible, as it requires S-bank's leverage ratio to approach infinity.

monitoring is not sustainable for the equilibrium with DB . Finally, a S-bank's expected ROE in a symmetric equilibrium with catastrophe bonds is

$$\begin{aligned} E_t \left[ROE_{t+1}^{s,CB} \right] &= (1 - \lambda) \delta \tilde{\theta}_{t+1} \Gamma_t^{s,CB} \\ &= \frac{(1 - \lambda) \delta \tilde{\theta}_{t+1}}{1 - \lambda \delta u g} \end{aligned} \tag{1.34}$$

With large enough government fiscal cost g on systemic bailout ($g > g^*$)

$$g^* = \frac{1 - (1 - \lambda) \delta \theta}{1 - \lambda \delta u}$$

S-banks are willing to hold unscreened negative NPV mortgages transferred from C-banks, while still having $E_t \left[ROE_{t+1}^{s,CB} \right] \geq 1$.

1.9.2 Model Calibration

The behavior of the model economy as well as the long-run credit growth rate are governed by eleven parameters: $\lambda, \delta, \kappa, h, g, \alpha, \beta, \mu, c, \bar{\theta}_g$ and $\bar{\theta}_b$. I set the discount rate δ , commercial bank minimum equity required ratio κ , the probability of crisis $1 - \lambda$, labor share in the commercial banking sector and shadow banking sector $(1 - \alpha, 1 - \beta)$, and average TFP shocks in a good state and a bad state $(\bar{\theta}_g, \bar{\theta}_b)$ equal to empirical counterparts in the US. Given the values of these parameters, I set the liquidation cost h and expected fiscal outlays in asset purchase g to match the leverage ratio in the shadow banking sector and the leverage ratio among major credit default swaps issuers. I also set the monitoring cost c so that the risk retention scale in the safe equilibrium path matches the scale set by Dodd Frank risk retention rule. Finally, in line with Ranci ere and Tornell (2016), the distress cost $1 - \mu$ is set to match the asset recovery rate in the financial sector.

As shown in the simulations, the crisis probability is set to 4%, which is between the unconditional crisis probabilities 4.49% in Schularick and Taylor (2012) and 2.8% in Gourinchas and Obstfeld (2012). The riskless discount rate $\delta = 1/(1+r)$ is determined by the average annualized mean of 1 year US Treasury nominal yield. I set $r = 2.10\%$ based on the average nominal yields on 1 year Treasury bonds during 2002-2011³¹. The minimum equity ratio κ is set in accordance with Basel II minimum capital ratio of risk-weighted assets, $\kappa = 8\%$. The labor share in both commercial banking sector and shadow banking sector are matched to US labor share obtained from NIPA such that $\alpha = \beta = 33\%$. I compute the average TFP shocks in a good state and a bad state based on according to US total factor productivity during no-recession periods and recession periods (since 1970). Thus, $\bar{\theta}_g = 0.98$ and $\bar{\theta}_b = 1.02$.

Proposition 1.2 has shown that the shadow bank leverage ratio in a risky equilibrium with defaultable bonds is $\frac{1}{1-h(1+\lambda/(1-\lambda))}$ in tranquil periods (with the assumption that $u \rightarrow 1$ in the years leading to the subprime crisis). Since the liquidation cost h governs shadow banks' borrowing constraint, the parameter value of h is chosen such that the risky equilibrium shadow bank leverage ratio matches the leverage ratio of shadow banks during 2002Q1-2007Q2 from the Federal Reserve "Financial Accounts of the United States". I use the security brokers and dealers sector as a representative of the shadow banking sector, and the leverage ratio during tranquil periods is 27.27. Similarly, the leverage ratio of shadow banks who issue catastrophe bonds in Proposition 1.2 is $\frac{1}{1-\lambda\delta g}$ (I still assume $u \rightarrow 1$). I match such theoretical leverage ratio to the leverage ratio of the top 10 credit default swap issuers during 2002Q1-2007Q2 based on their 10K reports³². The computed leverage of these largest CDS issuers based on their 10K is 29.12 during 2002Q1-2007Q2. Since the

³¹I adapt the time horizon in line with Philippon (2015). Piazzesi and Schneider (2006) take a much longer horizon (1952-2006) and obtain that the average nominal yield on 1 year Treasury bonds is 5.56%.

³²The top 10 CDS issuers in the US banking sector are AIG, Bear Stearns, Lehman Brothers, Goldman Sachs, Merrill Lynch, Citigroup, Wachovia, Morgan Stanley, Bank of America, and JPMorgan Chase.

monitoring cost c controls the risk retention incentive in the securitization market, I match the safe equilibrium risk retention ratio $\varphi_H = c/\Gamma^{s,NB}$ (I assume $\underline{\theta} = 0$) to the Dodd Frank risk retention rule that 5% of securitized assets have to be held by sponsors. Finally, the distress cost in the financial sector $1 - \mu$ governs the asset recovery rate $\mu/(1 - \beta)$ of the US financial sector. Following Begenau and Landvoigt (2017), I set the recovery rate as 37% based on Moody's reports on financial sector bonds recovery rate. Summing up all the parameter calibration results, I have the following table:

Table 1.2: Parameter values

Parameter	Definition	Value	Note
λ	Probability of crisis	0.04	Schularick and Taylor (2012), Gourinchas and Obstfeld (2012)
δ	Discount rate	0.98	Average 1 year US Treasury nominal yields: 2.10%
κ	Minimum equity ratio	0.08	Basel II requirement
h	Contract enforceability (1 - Liquidation cost)	0.92	Security brokers and dealers tranquil leverage: 27.27
g	Fiscal outlays in gov. asset purchase	1.03	Major CDS issuers tranquil leverage: 29.12
α	Labor share in C-banks	0.33	NIPA labor share
β	Labor share in S-banks	0.33	NIPA labor share
μ	1 - distress cost	0.42	Moody's financial sector recovery rate: 37%
c	Monitoring cost	0.63	Securitization risk retention ratio: 5%
$\bar{\theta}_g$	Cond. mean of TFP shock in good states	1.02	US TFP during non-recession periods
$\bar{\theta}_b$	Cond. mean of TFP shock in bad states	0.98	US TFP during resession periods

Note: This table reports calibration results of key model parameters based on US aggregate data.

1.9.3 Data

Aggregate Data

The aggregate data is from different sources. The first source is the “Financial Accounts of the United States” (Flow of Funds). In Table 1 of Section 1.2.1, I present the main items of the liability side of U.S.-Chartered Depository Institutions and Security Brokers and Dealers. Here, I list the item names as well as the identification numbers.

U.S.-Chartered Depository Institutions (L.111)

FL764190005	Total Liabilities
FL764110005	Net interbank liabilities
FL763127005	Checkable deposits
FL763130005	Time and savings deposits
FL762150005	Federal funds and security repos
FL764122005	Debt securities
FL763169305	Loans (other loans and advances)
FL763178003	Taxes payable (net)
FL763190005	Miscellaneous liabilities

Security Brokers and Dealers (L.130)

FL664190005	Total Liabilities
FL662151003	Security repurchase agreements
FL663163003	Debt securities (corporate bonds)
FL763130005	Time and savings deposits
FL664123005	Loans
FL663170003	Trade payables
FL663178003	Taxes payable
FL763178003	Taxes payable (net)
FL663190005	Miscellaneous liabilities

Besides balance sheet items of U.S.-chartered depository institutions and security brokers and dealers, Flow of Funds also documents the aggregate data of securitized mortgages in the US. Such aggregate data is used in Section 1.3.1, when I am measuring bank holding companies' exposure to the securitization market by following Loutskina (2011).

Economy Wide Total Loans

FL893065105	Home mortgages
FL893065405	Multifamily residential Mortgages
FL893065505	Commercial Mortgages
FL893065603	Farm Mortgages
FL894123005	Consumer Credit

Economy Wide Securitized Loans

FL413065105	}	Home mortgages
FL673065105		
FL413065405	}	Multifamily residential Mortgages
FL673065405		
FL413065505	}	Commercial Mortgages
FL673065505		
FL413065605		Farm Mortgages
FL673070003		Consumer Credit

Commercial Bank Subsidiary Level Data (Call Report)

This section documents the commercial bank characteristic variables are constructed based on Call Report items (according to Huang (2017)).

Bank identifier: RSSD9001, the unique identifying number (RSSDID) assigned by the Federal Reserve.

Parent bank holding company id: RSSD9348, the RSSDID of the highest holding company. I aggregate balance sheet items of all commercial banks that have the same highest holding company.

Total loans: RCFD1400, the gross book value of total loans and leases.

Home mortgages: RCON1430, real estate loans backed by 1-4 family residential properties.

Multi-family residential mortgages: RCON1460, real estate loans backed by residential properties with more than 4 families.

Commercial mortgages: RCON1480, real estate loans backed by non-farm and nonresidential properties, such as business and industrial properties, hotels, hospitals and dormitories.

Consumer credit: RCFD1975, loans, not secured by real estate, issued to individuals for

family or personal expenditure such as purchasing automobiles and paying medical expenses.

Farm mortgages: RCON1420, real estate loans backed by farmlands

Bank Holding Company (BHC) Level Data (FR Y9-C)

Gross Total Assets (GTA): BHCK2170+BHCK3123+BHCKC435, total assets plus the allowance for loan and leases and the allocated transfer risk reserve as in Berger et al. (2015).

Capital Ratio: BHCKG105/GTA, equity capital divided by GTA.

Return on Assets (ROA): $4 \times \text{BHCK4340} / \text{GTA}$, the Ratio of the annualized net income to GTA.

Return on Equity (ROE): $4 \times \text{BHCK4340} / \text{BHCKG105}$, the Ratio of the annualized net income to equity.

Liquidity: $(\text{BHCK0081} + \text{BHCK0395} + \text{BHCK0397}) / \text{GTA}$, cash divided by GTA.

Total Credit: BHCK2122, total loans and lease financing receivables.

Asset Quality (NPLs Ratio): $\text{BHCK3123} / \text{BHCK2122}$, Non-performing loans to total credit

Synthetic CDO: $(\text{BHCKG340} + \text{BHCKG343}) / \text{GTA}$, sum of the amortized cost of held-to-maturity synthetic CDO and the fair value of available-for-sale synthetic CDO divided by GTA.

Credit Default Swaps: $(\text{BHCKC219} + \text{BHCKC220} + \text{BHCKC221} + \text{BHCKC222}) / \text{GTA}$, fair value of credit default swaps divided by GTA.

Interest Rate Derivatives: $(\text{BHCK8733} + \text{BHCK8737} + \text{BHCK8741} + \text{BHCK8745}) / \text{GTA}$, fair value of interest rate derivatives divided by GTA.

1.9.4 Tables

Stock Holdings in KBE

Table 1.3: Positions in KBE before and after the bankruptcy of Lehman Brothers

	12/31/2007		12/31/2009	
	Name	Weighting	Name	Weighting
1	JPMorgan Chase	8.40	Bank of American	8.94
2	Wells Fargo	8.33	JPMorgan Chase	7.46
3	Bank of American	8.23	Citigroup	7.39
4	Citigroup	7.43	US Bancorp	7.28
5	State Street	4.80	Wells Fargo	6.92
6	Wachovia	4.79	SunTrust Banks	4.87
7	PNC	4.71	Mcintosh Bancshares	4.51
8	US Bancorp	4.59	Regional Financial	4.51
9	Suntrust Banks	4.38	BB&T	4.24
10	Washington Mutual	3.72	PNC	4.18
11	Northern Trust	3.66	Fifth Third Bancorp	4.16
12	Regional Financial	3.61	Capital One Financial	4.07
13	BB&T	3.60	Comerica	3.49
14	Merrill Lynch	3.56	Huntington Bancshares	3.56
15	Capital One Financial	3.44	Merrill Lynch	3.36
16	Fifth Third Bancorp	3.30	State Street	2.89
17	KeyCorp	2.95	KeyCorp	2.81
18	Mcintosh Bancshares	2.87	Central Bancorp	2.73
19	National City	2.82	Commerce Bancshares	2.39
20	Comerica	2.55	People's United Financial	2.30

Note: This table reports the top 20 banks with the largest weights in the banking sector index ETF, KBE, on 12/31/2007 and 12/31/2009. On 12/31/2007, there were 23 banks in KBE; on 12/31/2009, there were 24 banks. The weights are the relative market capitalizations of the top 20 holdings of the index.

Summary Statistics

Table 1.4: Summary Statistics

	Full Sample (N = 16,896)				High Bailout Exposure BHCs (N = 8,448)				Low Bailout Exposure BHCs (N = 8,448)			
	Mean	Q1	Median	Q3	Mean	Q1	Median	Q3	Mean	Q1	Median	Q3
Gross Total Assets (GTA, \$ m)	107.1	5.4	10.5	27.7	128.3	5.3	9.9	28.4	52.4	5.6	12.5	27.5
Capital Ratio (% of GTA)	11.8	9.7	11.2	12.7	12.1	9.7	11.3	12.9	10.9	9.7	10.8	12.3
ROA (% of GTA)	2.0	0.9	2.0	3.4	2.3	1.0	2.0	3.3	1.7	0.1	2.0	3.4
ROE (% of Equity)	5.9	7.3	16.2	27.4	3.6	6.8	15.7	26.8	12.1	7.3	16.6	27.7
Liquidity (% of GTA)	4.8	2.1	3.1	5.6	5.2	2.2	3.2	6.0	3.8	1.8	2.8	4.8
NPLs (% of Total Credit)	1.1	1.1	1.4	1.9	1.0	1.1	1.4	2.0	1.6	1.1	1.4	1.9
Liability (\$ million)	364.5	5.4	10.8	31.2	133.2	5.2	10.5	31.1	63.3	5.7	13.6	32.8
Equity (\$ million)	12.9	0.7	1.4	4.3	15.0	0.7	1.4	4.3	7.0	0.6	1.4	5.4
Total Credit (\$ million)	46.6	3.4	6.3	16.5	55.9	3.4	6.0	16.8	22.7	3.4	7.5	16.1
Exposure to Sec. Market (%)	16.5	11.0	16.5	20.7	14.2	10.9	13.5	19.5	17.4	11.0	16.7	21.0
Put option beta (%)	6.3	1.2	5.9	12.6	11.4	4.8	9.8	15.1	-9.3	-12.2	-2.8	0.2
Synthetic CDO (bps of GTA)	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.3	0.0	0.0	0.0
CDS Holdings (bps of GTA)	55.7	0.0	0.0	0.0	56.8	0.0	0.0	0.0	52.9	0.0	0.0	0.0
Int. Rate Derivatives (% of GTA)	4.2	0.0	0.1	0.5	4.7	0.0	0.1	0.5	3.0	0.0	0.2	0.6
CoVaR (95% CI, in %)	0.7	0.3	0.6	1.0	1.1	0.5	0.9	1.2	0.5	0.2	0.5	0.6

Note: This table reports summary statistics for all bank-level variables used in empirical tests, as well as the numbers in the two subsamples. The high bailout exposure subsample includes the upper 50 percent in put option beta (exposure to systemic bailouts); the low bailout exposure subsample includes the lower 50 percent. The data are collected from 4 different sources: First, the put option beta is calculated by the author with daily put option prices (OptionMetrics) and underlying stock prices (CRSP). Second, the exposure to the securitization market is calculated with commercial bank level data from the Call Report and aggregate data from the Flow of Funds. Third, CoVaR is a measurement of banks' contribution to the systemic risk calculated by Adrian and Brunnermeier (2016). Fourth, all the other variables are from FR Y9-C (BHCs consolidated reports).

Transition Matrices of Control Variables

Table 1.5: Transition Matrices

(1) Gross Total Assets			(2) Capital Ratio		
	$T_i = 0$	$T_i = 1$		$T_i = 0$	$T_i = 1$
$T_i = 0$	98.38	1.62	$T_i = 0$	93.78	6.22
$T_i = 1$	1.64	98.36	$T_i = 1$	6.58	93.41

(3) Total Credit			(4) Return on Assets		
	$T_i = 0$	$T_i = 1$		$T_i = 0$	$T_i = 1$
$T_i = 0$	98.81	1.19	$T_i = 0$	89.01	10.99
$T_i = 1$	1.24	98.76	$T_i = 1$	11.36	88.64

(5) Return on Equity			(6) CoVaR		
	$T_i = 0$	$T_i = 1$		$T_i = 0$	$T_i = 1$
$T_i = 0$	89.55	10.45	$T_i = 0$	93.21	6.79
$T_i = 1$	10.93	89.07	$T_i = 1$	6.28	93.72

(7) Liquidity			(8) NPLs Ratio		
	$T_i = 0$	$T_i = 1$		$T_i = 0$	$T_i = 1$
$T_i = 0$	84.54	15.46	$T_i = 0$	94.56	5.44
$T_i = 1$	15.36	84.64	$T_i = 1$	5.14	94.86

Note: This set of tables reports the transition matrices of the main control variables in the empirical tests. In the display of the transition matrices, $T_i = 0$ indicates the bank-quarter observation belongs to the lower than median group, while $T_i = 1$ indicates the bank-quarter observation belongs to the higher than median group. The rows are for observations in the current quarter, and the columns are for observations in the next quarter. For instance, the upper right cell of the “Gross Total Assets” matrix shows that the probability that the total assets this quarter is below median but the next quarter is above median is 1.62%.

Fixed Effects Regressions (Dummy Indicators)

Table 1.6: Fixed Effects Regressions (Dummy Indicators)

	Baseline	Financial Regulations		Weak Demand	
	(1)	(2)	(3)	(4)	(5)
Bailout Exposure Indicator	-4.223*** (1.32)	-3.201*** (0.88)	-3.552*** (1.04)	-2.827*** (0.97)	-3.289*** (1.11)
Bailout Exposure Indicator × Regulation Indicator		-2.252** (1.05)	-1.019* (0.61)		
Bailout Exposure Indicator × Weak Demand Indicator				-2.643** (1.28)	-1.450** (0.71)
C-Bank Controls			✓		✓
BHC Fixed Effect			✓		✓
Observations	1456	1456	1456	1456	1456

Note: This table reports the fixed effects regressions of post-crisis commercial bank credit growth rates on the dummy indicators of parent bank holding company's put option beta (exposure to the systemic bailout factor), exposure to the securitization market (potential impact by post-crisis financial regulations), exposure to weak borrowers (potential impact by weak credit demand), as well as commercial bank level controls including asset size, leverage ratio, initial credit, systemic risk contributions (CoVaR), and non-performing loans ratio. Column (1) displays the baseline specification which estimates the additional effect on post-crisis commercial bank credit growth rates due to higher parent bank holding company put option beta. Column (2) and (4) show the results with a modified specification that take into account each commercial bank subsidiary's exposure to the securitization market and exposure to weak borrowers. Column (3) and (5) include both commercial bank level controls and bank holding company fixed effects. Standard errors are clustered at the commercial bank level. Robust t statistics are reported in parentheses. Coefficients denoted *, **, and *** are statistically significantly different from zero at the 10 percent, 5 percent, and 1 percent level, respectively.

Fixed Effects Regressions (Continuous Measure)

Table 1.7: Fixed Effects Regressions (Continuous Measure)

	Baseline	Financial Regulations		Weak Demand	
	(1)	(2)	(3)	(4)	(5)
Bailout Exposure (Beta)	-0.241*** (0.09)	-0.205*** (0.08)	-0.223*** (0.07)	-0.193*** (0.06)	-0.206*** (0.06)
Bailout Exposure (Beta)		-0.167***	-0.103*		
× Securitization Exposure		(0.06)	(0.06)		
Bailout Exposure (Beta)				-0.143**	-0.141**
× Weak Demand Exposure				(0.06)	(0.06)
C-Bank Controls			✓		✓
BHC Fixed Effect			✓		✓
Observations	1456	1456	1456	1456	1456

This table reports the fixed effects regressions of post-crisis commercial bank credit growth rates on the continuous measure of parent bank holding company’s put option beta (exposure to the systemic bailout factor), exposure to the securitization market (potential impact by post-crisis financial regulations), exposure to weak borrowers (potential impact by weak credit demand), as well as commercial bank level controls including asset size, leverage ratio, initial credit, systemic risk contributions (CoVaR), and non-performing loans ratio. Column (1) displays the baseline specification which estimates the additional effect on post-crisis commercial bank credit growth rates due to higher parent bank holding company put option beta. Column (2) and (4) show the results with a modified specification that take into account each commercial bank subsidiary’s exposure to the securitization market and exposure to weak borrowers. Column (3) and (5) include both commercial bank level controls and bank holding company fixed effects. Standard errors are clustered at the commercial bank level. Robust t statistics are reported in parentheses. Coefficients denoted *, **, and *** are statistically significantly different from zero at the 10 percent, 5 percent, and 1 percent level, respectively.

Fixed Effects Regressions (Continuous Measure, Only Incumbent Commercial Banks)

Table 1.8: Fixed Effects Regressions (Continuous Measure, Only Incumbent Commercial Banks)

	Baseline	Financial Regulations		Weak Demand	
	(1)	(2)	(3)	(4)	(5)
Bailout Exposure (Beta)	-0.239*** (0.09)	-0.201*** (0.08)	-0.220*** (0.06)	-0.195*** (0.06)	-0.211*** (0.06)
Bailout Exposure (Beta)		-0.167**	-0.098*		
× Securitization Exposure		(0.07)	(0.06)		
Bailout Exposure (Beta)				-0.145**	-0.107**
× Weak Demand Exposure				(0.06)	(0.06)
C-Bank Controls			✓		✓
BHC Fixed Effect			✓		✓
Observations	1258	1258	1258	1258	1258

This table reports the fixed effects regressions of post-crisis commercial bank credit growth rates on the continuous measure of parent bank holding company’s put option beta (exposure to the systemic bailout factor), exposure to the securitization market (potential impact by post-crisis financial regulations), exposure to weak borrowers (potential impact by weak credit demand), as well as commercial bank level controls including asset size, leverage ratio, initial credit, systemic risk contributions (CoVaR), and non-performing loans ratio. Commercial banks that are acquired after the subprime crisis are excluded from the sample. Column (1) displays the baseline specification which estimates the additional effect on post-crisis commercial bank credit growth rates due to higher parent bank holding company put option beta. Column (2) and (4) show the results with a modified specification that take into account each commercial bank subsidiary’s exposure to the securitization market and exposure to weak borrowers. Column (3) and (5) include both commercial bank level controls and bank holding company fixed effects. Standard errors are clustered at the commercial bank level. Robust t statistics are reported in parentheses. Coefficients denoted *, **, and *** are statistically significantly different from zero at the 10 percent, 5 percent, and 1 percent level, respectively.

Chapter 2

Fiscal Crises

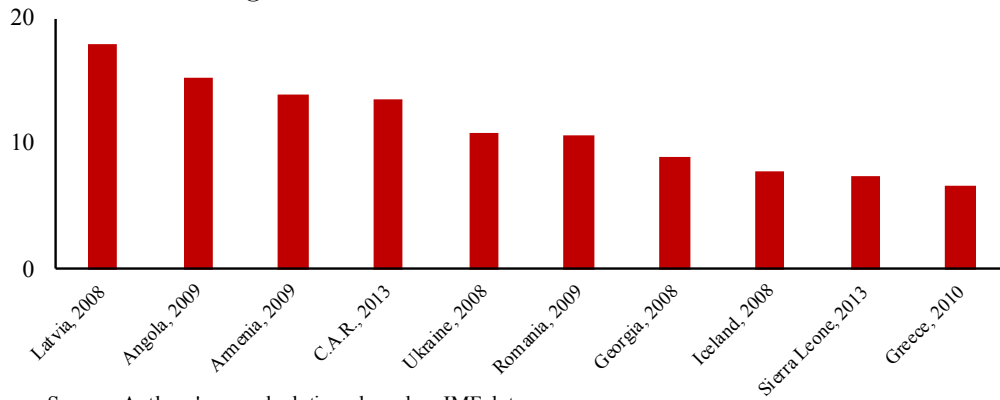
2.1 Introduction

We fear fiscal crises, but do not know much about them. The term, coined by James O'Connor (1973), came to prominence in the wake of the oil crisis and the breakdown of the Bretton Woods system to denote a "structural gap" between public revenues and expenditures when growth plummeted, and unemployment and inflation surged. Yet, fiscal crises may be triggered by other imbalances in the economy or exogenous shocks¹. In addition, in the aftermath of the global economic and financial crisis of the late 2000s, there is greater interest in how to avoid fiscal crises, including via well-designed fiscal adjustments (Mauro, 2011). However, there is little empirical research about fiscal crises. What is the frequency and duration of crisis episodes? How disruptive are they? Do they have a persistent impact on economic growth? These are just some of the questions that need answers to better understand and prevent these periods of heightened fiscal distress, which can be accompanied by large and abrupt declines in growth (Figure 2.1).

There is no consensus definition of fiscal crises, with the literature mostly focusing on

¹For example, a financial crisis may put the budget under pressure either directly due to a need to bail out banks (e.g., Ireland in 2010) or via a sharp economic deterioration and subsequent fall in tax revenues.

Figure 2.1: Ten of the Worst Crises Since 2005



Source: Authors' own calculations, based on IMF data.

Note: difference in simple averages of real GDP p.c. growth rate of the three years preceding a crisis and the three years after the onset of the crisis.

Source: Authors' own calculations, based on IMF data. Note: difference in simple averages of real GDP p.c. growth rate of the three years preceding a crisis and the three years after the onset of the crisis.

sovereign debt crises triggered by external default episodes (e.g., Detragiache and Spilimbergo, 2001; Chakrabarti and Zeaiter, 2014). While sovereign defaults are an important part of the story, they do not capture all periods of fiscal crises. Over time, the definition has been extended to cover large-scale official financing (e.g., Manasse, Roubini, and Schimmelpfennig, 2003) and, to a very limited degree, evidence on domestic public debt defaults, including via higher inflation (e.g., Reinhart and Rogoff, 2009 and 2011; Gourinchas and Obstfeld, 2012).

This paper contributes to the literature by improving the identification of fiscal crises. We take a comprehensive definition of fiscal crises, to include the different types or triggers, and build a new database of crises. We look at periods of extreme fiscal distress, when large fiscal imbalances led to the adoption of extreme measures (e.g., debt default and monetization of the deficit), partly building on the work by Baldacci and others (2011)². Our approach also allows to have a better understanding of the duration of fiscal crises, a key challenge in the literature. Another contribution of our paper is to extend the analysis of fiscal crises to

²Baldacci and others (2011) compile a set of criteria to identify fiscal crises over 1970-2010. Bruns and Poghosyan (2016) extend the dataset through 2015. These papers focus on assessing the likelihood of entering a crisis, and do not study the crisis period itself. Also, their sample is limited to advanced and emerging markets.

developing countries for the first time, as far as we know. These countries experience a larger frequency of crises with unique patterns. We expand the country coverage to 188 countries, over 1970-2015, more than double the size of the sample relative to many other studies. Our new database allows to shed light the patterns of fiscal crises and their economic impact across different country groups and crisis identification triggers. We analyze the relationship between crises and key macroeconomic variables. In particular, we are able to provide evidence on some key issues. First, we can assess the behavior of fiscal variables and ask how fiscal policy and public debt behave around the crisis period. Second, we are able to confirm that fiscal crisis are associated with severe deterioration in economic activity and higher chance of being in a recession. Third, we also assess the empirical support for the twin deficits (fiscal and external) hypothesis-that is, do fiscal and external current account deficits tend to move together? Finally, we assess whether fiscal crises have a persistent effect on output and public debt using impulse response functions (IRFs). The data suggests a negative permanent impact on real GDP across all countries, while the impact on public debt varies. Given that different crises can interact, we also study the interaction of fiscal crises with banking and currency crises. In particular, we are interested in understanding the impact on economic growth and public debt. Our analysis provides support, in line with findings by Romer and Romer (2017), that periods of twin crises (fiscal-financial) experience a deeper decline in growth than stand-alone crises at least for some country groups.

2.2 Theoretical Considerations

We use the term fiscal crisis to describe a period of heightened budgetary distress, resulting in the sovereign taking exceptional measures. In normal times, a government collects revenues and borrows to fund its expenditures. A country may experience fiscal distress, when large imbalances emerge between inflows and outflows. These imbalances may lead to a fiscal crisis if the country is not able to sufficiently adjust its fiscal position. As Bordo and Meissner

(2016) note, the canonical fiscal crisis is a debt crisis, when the government is unable to service the interest and or principle as scheduled. More concretely, this can be thought of as a disruption in the normal debt dynamics:

$$d_t = d_{t-1} \cdot (r_t - g_t)/(1 + g_t) - p_t + SF_t$$

where the debt-to-GDP ratio d_t depends on the initial stock of debt in $t - 1$, effective interest rate r_t , nominal GDP growth rate g_t , the primary balance-to-GDP ratio p_t , and a residual reflecting stock-flow adjustments SF_t . (capturing e.g., exchange rate movements or materialization of contingent liabilities).

It is important to note, however, that fiscal crises may not necessarily be associated with situations of debt defaults. The literature focuses mainly on (external) credit events, either via outright default, repudiation, or the restructuring of public debts. However, it is also acknowledged that fiscal crises can be associated with other forms of expropriation, including domestic arrears and high inflation that erodes the value of some types of debt (Reinhart and Rogoff, 2011a). In addition, countries that face severe financial conditions may opt to ask for official creditors assistance (e.g. IMF) instead of defaulting (Manasse and others, 2003).

A fiscal crisis can happen for several reasons. As the debt equation shows, there may be several factors driving a country to unsustainable fiscal positions, including policies or economic shocks. First, the buildup of large budgetary imbalances may make the debt path unsustainable and lead to a loss of market access. Second, changes in key macro-financial variables (such as the cost of borrowing, exchange rate, and economic growth) can trigger a fiscal crisis. Large fiscal imbalances can also arise due to exogenous shocks, for example arising from a banking crisis or large drops in commodity prices (see IMF, 2015a)³.

Our focus is on extreme and disruptive episodes of fiscal policy. We do not include cases

³For a discussion of factors that may help predict a period of fiscal distress see also Cottarelli (2011), IMF (2011), or Baldacci and others (2011).

where countries managed to address imbalances via large fiscal adjustments, while avoiding a fiscal crisis. While these periods may involve some distress, it would be difficult to objectively separate "normal" fiscal adjustments from the more painful ones. Even if a threshold was set, it would also be difficult to appropriately measure fiscal policy adjustments across countries and time, as variations in fiscal balances could reflect many factors that are not under the control of policymakers⁴. As such, our empirical strategy focuses on identifying the extreme cases, when countries adopt exceptional measures.

2.3 Identification Strategy and Data

In order to empirically identify fiscal crises, our focus is on periods of extreme funding difficulties. The identification strategy, partly building on Baldacci and others (2011), employs a combination of four distinctive criteria: (1) credit events associated with sovereign debt (e.g. outright defaults and restructuring); (2) recourse to large-scale IMF financial support; (3) implicit domestic public default (e.g., via high inflation rates); and (4) loss of market confidence in the sovereign. These criteria are complementary, as individual indicators may not capture all fiscal crises. This paper advances the identification methodology, and data quality, from the literature in several ways. We increase the country coverage to include 188 countries across all levels of development between 1970 and 2015. We expand the set of criteria and use new data sources⁵. We add two new sub-criteria: accumulation of domestic arrears and a measure of loss of market access. The credit event criterion is more comprehensive and takes advantage of quantitative estimates of sovereign defaults.

Identification Criteria

⁴For example, the ex-post adjustment in the fiscal balance could reflect large variations in revenue due to economic growth or commodity prices. Trying to correct for these would imply being able to assess potential GDP and identify policy measures, among others, which would be difficult given data limitations.

⁵See appendix for details on the data, coverage, and sources.

(1) Credit events

This criterion captures any year in which the actions of the sovereign reduce the present value of its debt owed to official or other creditors. That is the crisis will be triggered when the debt service is not paid on the due date or other situations when the creditor incurs losses, including when debt is restructured (see appendix). This criterion follows the literature on sovereign defaults (e.g., Detragiache and Spilimbergo, 2001; Chakrabarti and Zeaiter, 2014). However, it is not always easy to identify credit events as they can involve more complex debt operations where it may not be straightforward to identify if the creditor incurred in a loss. In addition, other common challenges across many countries include how to deal with technical defaults, which do not reflect fiscal distress, and existing defaults which may take time to resolve (Reinhart and Rogoff, 2011a)⁶. To address these challenges in identifying credit events we take into consideration data on defaulted amounts and not just if a credit event happened⁷. We use the Bank of Canada’s (BoC, 2016) annual database on the aggregated nominal stock of sovereign debt obligations in default, with the latter defined as any debt operation that inflicts an economic loss on creditors⁸. The database includes sovereign defaults to both private and official creditors (e.g., Paris Club or international financial institutions)⁹. In order to better identify the start and duration of crises we impose two additional requirements. First, we exclude small-scale technical defaults (default amounts below 0.2 percent of GDP)¹⁰. Second, we require that defaulted nominal amounts grow by

⁶Technical defaults include those related to debt payment delays due to administrative procedures and debt management capacity issues. Continued reporting of default captures those related to delayed regularizations due, for instance, to legal and negotiation reasons.

⁷Most of past literature does not use this information, focusing only whether there was a default. One exception is Trebesch and Zabel (2017) which take into account the size of haircuts when assessing the costs of sovereign defaults.

⁸We complement the database with other sources as needed. See appendix for more details.

⁹The database mainly contains external defaults on sovereign debt denominated in foreign currency.

¹⁰The threshold is relatively robust. Lowering it to 0.1 percent of GDP increases the number of fiscal crisis

more than 10 percent in a year to classify as a new credit event. This helps avoid signaling a perpetuation of a crisis only because of factors such as lengthy regularization procedures and the accumulation of late interests.

(2) Exceptionally large official financing

An alternative to outright default or other exceptional measures for countries is recourse to large official financing, captured by financial support from the IMF¹¹. This support is usually for countries that are unable to pay their international debt and have associated balance of payments problems. In many occasions, fiscal distress is behind a country's inability to keep its financial obligations. Indeed, IMF program data shows that all high-access financial arrangements had fiscal adjustment as an overarching program objective.

This criterion captures any year under an IMF financial arrangement with access above 100 percent of quota and fiscal adjustment as a program objective¹². The threshold is consistent with established IMF access rules and was also used by Baldacci and others (2011). We only include precautionary agreements when they became active with access above our threshold.

(3) Implicit domestic public debt default

Countries may also opt to default implicitly on domestic debt or their payment obligations. Data on these events are very scarce and the limited literature on this topic relies almost

episodes by 11. In contrast, increasing it to 0.25 percent of GDP lowers the number by 6.

¹¹IMF programs can have a catalytic effect, i.e. other governments and international agencies will join efforts to provide additional official financing. IMF loans typically involve lower borrowing costs.

¹²Available financing under an IMF program depends on the size and nature of a country's financing need over the course of the program period, the strength of the reform program, and the access limits. With the latter being restricted both per program request and on a cumulative basis, access also becomes a strategic choice.

exclusively on implicit defaults via inflation¹³. We adopt a similar strategy, but complement it with data on domestic arrears when available. Specifically, this criterion intends to capture periods where governments have difficulty meeting their obligations and resort either to running domestic payment arrears or printing money to finance the budget. We identify these episodes by looking at periods of (a) very high inflation (when the sovereign resorts to seigniorage to finance the fiscal deficit) and/or (b) accumulation of domestic arrears.

(3a) Very high inflation.

Following Baldacci and others (2011), we set an inflation rate threshold of 35 percent per year for AMs, based on the average haircut on their public debt (Sturzenegger and Zettelmeyer, 2006)¹⁴. We apply the same criterion to small developing states (SDSs) as their inflation patterns are similar to AMs. In contrast, we use a threshold of 100 percent yearly for EMs and LIDCs following Fischer, Sahay, and Vegh (2002). Those authors show that the relationship between the fiscal deficit and seigniorage is strong only in the high-inflation countries (inflation above 100 percent).

(3b) Domestic arrears accumulation

In the absence of consistent and readily available data, we use a steep increase of "other account payables" (OAP) as a proxy. We require the OAP-to-GDP ratio to grow more than 1 percentage point per year. The threshold is in line with evidence from Checherita-Westphal and others (2015), which shows that increased delays in public payments affect private sector liquidity and profits, and ultimately economic growth. The OAP data is available for most

¹³A rare exception is Reinhart and Rogoff (2011b), who list 42 cases of explicit domestic default. Those include not only credit events (e.g., Russia's debt default in 1989-99), but also other forms of default (e.g., Mexico's forcible conversion of USD deposits to pesos in 1982). Our database covers all their 42 cases.

¹⁴This threshold is similar to the 95th percentile of the inflation distribution and lies between the 20-40 percent thresholds in the literature (Reinhart and Rogoff, 2011; Khan and Senhadji, 2001; or Bruno and Easterly, 1995).

OECD countries at least from the early 1990s onwards.

(4) Loss of market confidence

This criterion captures any year with extreme market pressures. Our two sub-criteria catch both periods of low/no volume and sovereign yield spikes.

(4a) Loss of market access. IMF (2015b) defines market access as "the ability to tap international capital markets on a sustained basis through the contracting of loans and/or issuance of securities across a range of maturities, regardless of the currency denomination of the instruments, and at reasonable interest rates." Guscina, Sheheryar and Papaioannou (2017) compile an indicator of loss of market access (LMA): when sovereigns default or stop issuing bonds, controlling for financing needs and previous patterns of issuance. We complement the data with additional information from Gelos, Sahay, and Sandleris (2004) and rating agency reports. However, the loss of market access criterion is only applied to a country that regularly accesses international markets-i.e. it has to have enjoyed two consecutive years of market access and maintained it for at least one fourth of our sample time¹⁵.

(4b) Price of market access

We set an absolute threshold at 1,000 basis points (bps) for the spreads, which is widely seen in practice as market participants' psychological barrier (Sy, 2004; Baldacci and others, 2011). It roughly corresponds to the 95th percentile of the spreads distribution. Any other abnormally high spreads for a country, given its history, are captured by the loss of market access criterion. Where available, we consider the JPMorgan Emerging Market Bond Index (EMBI). For a smaller number of cases, we fill the data gaps with spreads estimated as the 10-year local-currency bond yield spread to the 10-year US treasury adjusted for inflation. We also look at 5- and 10-year credit default swaps (CDS) spreads to fill gaps when necessary.

¹⁵Under the precondition of maintaining market access for one fourth of the time covered by the sample for sub-criterion (4a), criterion 4 is triggered 82 times. Changing to one half of the time reduces the number to 69.

Identifying a Crisis

As discussed above, fiscal crises can be triggered by different factors. Focusing only on sovereign defaults would risk missing events. Our comprehensive approach allows to capture the start of a crisis associated with the different triggers. We consider a year to be a fiscal crisis year when at least one of the four criteria is met. To separate between crisis events, we require at least two years of no fiscal crisis between the distinct events. If only one year of no distress lies between crisis year episodes, they are lumped together in one event. This approach helps identify the start and duration of crisis episodes¹⁶. Our approach also allows to study differences between crises triggered by different criteria. Finally, we are also able to better identify tranquil times (non-crises years). In other approaches they could include fiscal crises that were not well identified. Non-crisis years are all other years for which we have data for at least two of the criteria¹⁷.

2.4 Key Characteristics of Fiscal Crises

We use our database to highlight some of the characteristics of fiscal crises across country groups, such as on frequency, triggers, duration, and overlap with financial crises.

Stylized Facts of Fiscal Crises

The database identifies 439 fiscal crisis episodes, implying that countries faced on average two crises since 1970 (Table 2.1). They occurred most often in LIDCs (with an average of 3.4 crises per country) and least often in AMs (less than 1 per country). 37 countries

¹⁶We do not assign start and end dates to episodes ongoing at both ends of the sample period. The exception is if (i) previous indicators identified start dates in 1970-71 (Baldacci and others, 2011; Cruces and Trebesch, 2013; or sovereign defaults from Laeven and Valencia, 2012) or (ii) recent data confirms end dates in 2014.

¹⁷For the large majority of the cases (more than 95 percent) we have data for at least 3 criteria.

Table 2.1: Number of Identified Fiscal Crisis Episodes (1970-2015)

	Total	AM	EM	LIDC	SDS
With start date within sample period	439	25	155	173	86
Average per country	2.3	0.7	2.2	3.5	2.6
With start and end date within sample period	403	23	144	156	80
Average per country	2.1	0.7	2.1	3.1	2.4
<u>Memorandum items:</u>					
Ongoing at sample period start	31	1	22	8	0
Ongoing at sample period end	36	2	11	17	6
Number of countries with no fiscal crisis	37	20	9	1	7

Table 2.2: Comparison of Identified Fiscal Crisis Episodes (1970-2015)

	Fiscal Crises Database (this paper)	Bruns and Poghosyan's (2016) update of Baldacci et al. (2011)	Laeven and Valencia's (2012) debt crises	Reinhart and Rogoff's (2011b) external debt crises	Reinhart and Rogoff's (2011b) domestic debt crises
Number of events	439	201	67	75	26
<i>Number of common events</i>		138	61	62	22
Number of countries	188	80	157	69	69

Note: We consider events to overlap when the start date is within one year of our start date, or the event falls within our crisis period.

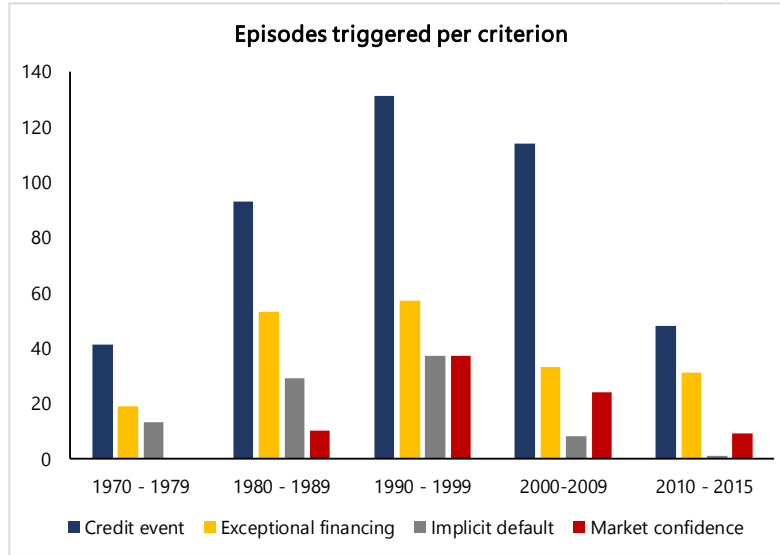
experienced no fiscal crisis at all, of which the majority were AMs. For some countries, the absence of a crisis may reflect lack of sufficient data to make an assessment. Crisis times are relatively frequent, with crisis years representing almost one third of all observations.

Compared to past studies, our sample has more than double the number of countries and crisis episodes (Table 2.2). This mainly reflects the inclusion of LIDCs and SDSs, which have been excluded from previous analyses. In addition, past studies mainly focused on sovereign debt defaults. Even when compared with Bruns and Poghosyan (2016), which are closer to our definition of crisis, we have a significantly larger number of events thanks to the larger sample of countries and new data.

A fiscal crisis lasts on average almost 6 years, albeit with sizable differences depending on countries' development stage¹⁸. Our empirical strategy allows us to reduce the number of

¹⁸LIDCs (averaging 6 and a half years), EMs (6 years), AMs (almost 4 years), and SDS (around 3 years).

Figure 2.2: Number of Crisis Criteria Triggered Per Decade (1970-2015)



very long crises relative to other countries (as we exclude countries with technical defaults). However, we still find some countries with long crises, partly reflecting "serial defaulters". The majority are LIDCs, but there are also some EMs (including Brazil, Peru, and Egypt). The common thread among many of these cases is a history of heightened political instability and weak institutions.

The most turbulent decade was the 1990s (Figure 2.2). However, the 1980s saw the largest rise in the number of crises, especially among EMs, possibly reflecting the large fall in commodity prices (many EMs being commodity exporters), as well as the rise in global interest rates in the early part of the decade. Credit events are the most frequent identifying criterion, while exceptional financing from the IMF was second.

Most crises in non-AMs are associated with credit events (Table 2.3) and tend to involve both official and private creditors. For these countries, credit events are the first criterion met almost three quarters of the time¹⁹. This could be explained by the "the original sin"

When assessing duration, we do not consider the crisis periods that are ongoing at the start (or end of the sample period), because we cannot determine the exact start (or end) date.

¹⁹For example, out of the 10 crisis episodes in AMs that start with high-access IMF programs, 3 led to credit events within the same crisis period (Greece, Ireland, and Portugal).

Table 2.3: Triggering Criteria per Country Groups

	AM	EM	LIDC	SDS
Credit event	0	85	141	71
Official financing	11	40	29	6
Implicit default	13	18	9	7
Market confidence	7	25	4	3

Source: Authors' calculations.

(Eichengreen and Hausmann, 1999), as many developing economies have difficulty borrowing in their own currency. Both official and private creditors are affected in the majority of credit events—about 90 percent of the times involved official creditors, while about two-thirds of credit events included private creditors²⁰. Strikingly, credit events never signal the start of a crisis for AMs, the crisis identification triggers are broadly equally divided among the other three criteria.

Several of the identification criteria tend to overlap during the crisis period. When looking at crisis years, at least two criteria overlap more than one quarter of the time²¹. In contrast, only about 9 percent of fiscal crisis episodes start with more than one criterion. This highlights the relevance of using the different criteria to identify crises. Crises in AMs and EMs show two or more active criteria around one third of the time, compared to a quarter of the time in LIDCs. This is relevant as the data suggest that economic growth was lower in crisis periods when more than one criterion was met.

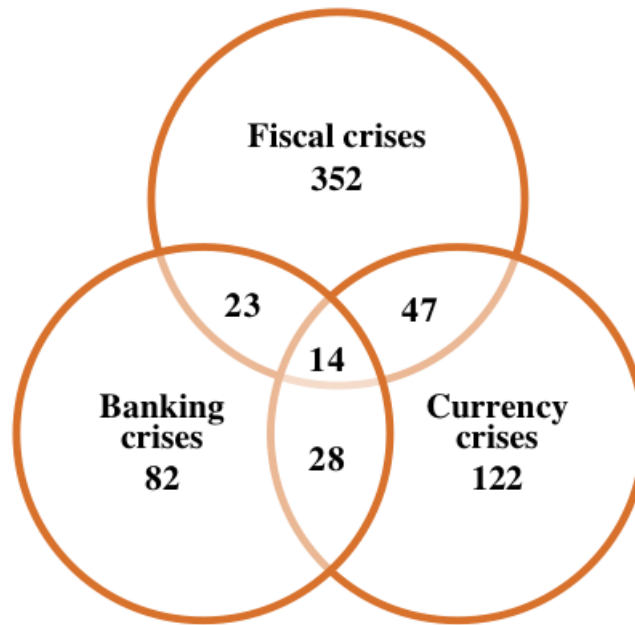
Fiscal and Financial Crises

The data also shows some overlap of fiscal and financial crises (Figure 2.3). Close to a fifth of fiscal crises happen at the same time as either a banking or currency crisis, three percent of them even coincide with both. The majority of fiscal-banking crises occurred in AMs

²⁰For example, excluding defaults involving official creditors would reduce the number of crises from 439 to 340. The fall in the number of crises is mitigated because other identification triggers would still help detect some of the crises. The official creditor-led events affect mainly SDSs and to a lesser degree LIDCs and EMs.

²¹For example, out of the 10 crisis episodes in AMs that start with high-access IMF programs, 3 led to credit events within the same crisis period (Greece, Ireland, and Portugal).

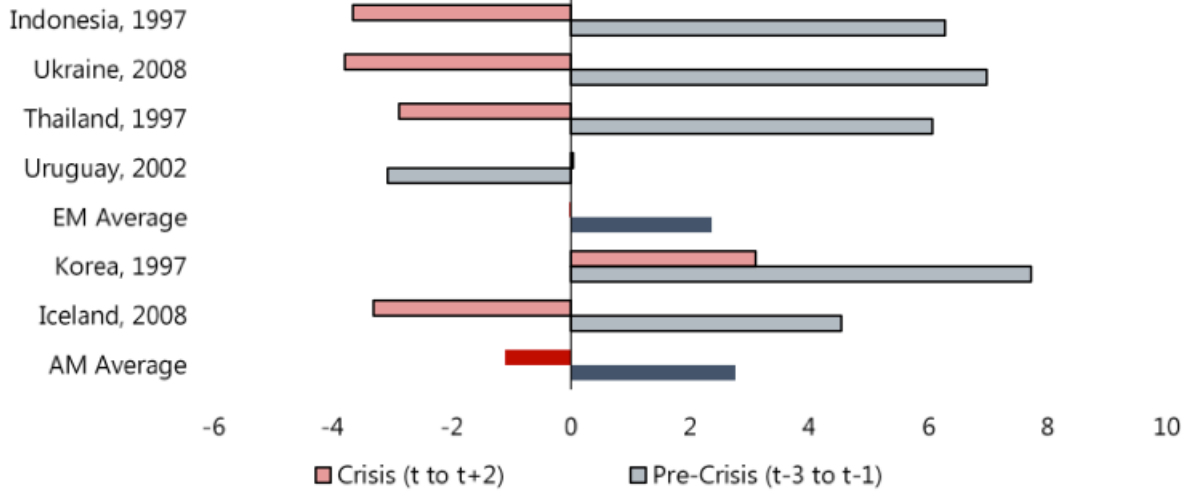
Figure 2.3: Different Crises



and EMs. This could suggest that in countries with large financial sectors, a fiscal crisis may be triggered by banking sector problems. Laeven and Valencia (2012) find that the fiscal cost of banking crises net of recoveries averages $13\frac{1}{3}$ percent of GDP. Gross fiscal outlays related to the restructuring of the financial sector can even be larger than 30 percent of crisis-year GDP (e.g., Indonesia 1997, Argentina 1980, Iceland 2008). In addition, IMF (2014) argues that banking crises have larger fiscal costs in countries with deeper and more leveraged banking sectors that rely more on external funding. On the other hand, a fiscal crisis could spill over to the banking system. Alter and Beyer (2014) find heightened risks of spillover from sovereign distress to the banking system for European countries. It is possible both effects are present (Acharya and others 2014) when government bailouts to the financial sector increase fiscal stress, in turn fueling sovereign credit risk and spreads. Our results, in the next section, show that twin crises are associated with worse economic growth outcomes.

More than half of the fiscal-currency crises occurred in EMs. Their public debt generally has a relatively high share of FX debt, exposing them to the risk of sudden stops. In addition, triple crises are associated with particularly turbulent times. AMs experienced three of those

Figure 2.4: Real GDP p.c. Growth – Before and During the Crisis (in percentage points)



Note: Simple average of real GDP p.c. growth rates with t as the start year of the crisis. Source: Authors' calculations.

triple crises, while EMs experienced the other 11. These periods tend to be accompanied by substantial declines in growth. In 6 of the cases, the fiscal crisis was signaled by more than one criterion. In most cases, they turn out to be some of the worst in terms of economic growth once the crisis started (Figure 2.3). The exception was Uruguay, where the crisis was preceded by a severe recession. In several other cases, the economy contracted at a fast pace in the first years of the fiscal crisis suggesting the overlap of crises may be particularly damaging.

2.5 Economic Outcomes and Policies Around Fiscal Crises

2.5.1 The Dynamics Around Fiscal Crises

We now use the new database to examine economic developments around fiscal crises. First, we study the behavior of macro-fiscal outcomes around fiscal crises using an event study approach. Although not necessarily implying causality, the results help understand the context

in which fiscal crises occur, particularly when differentiating along country groups and crisis identification triggers. We also study what happens to growth and debt around twin crises. Finally, we assess the long-term impact of fiscal crises on economic growth and public debt using panel impulse response functions (IRF).

Model Specification

Following the literature, we use an event study to analyze the behavior of key variables during an 11-year window around the start of the crisis by comparing the dynamics of variables within the (pre- and post-crisis) time window with that of an out-of-window normal period²². Following most closely Gourinchas and Obstfeld (2012), we specify fixed-effects panel regressions with a discrete-choice time window around the crisis start year as specified in²³:

$$y_{i,t} = \alpha_i + \sum_{j=-5}^5 \beta_j D_{t+j} + \epsilon_{i,t}$$

where $y_{i,t}$ is a list of variables of interest, α_i the country fixed-effect, D_{t+j} the 11 dummy variables taking the value of 1 in period $t + j$ (where t is the crisis start year), and β_j the conditional effects of a crisis over the event window relative to tranquil times. We set the event window around crisis episodes to 11 years so as to capture the buildup of imbalances before the crisis and time for adjustment once the crisis starts. The error term ϵ captures all the remaining variation in the realization of the variable under study.

Our analysis will focus on the conditional effect of a crisis, the β_j , on the key fiscal and macro variables as discussed in Section 2.2. This allows us to observe the year effect of the

²²There are many applications. For instance, Eichengreen and others (1995) evaluate the causes and effects of turbulent times in foreign exchange markets. Kaminsky and Reinhart (1999) assess the link between banking and currency crises. Gourinchas and Obstfeld (2012) show that domestic credit expansion and real currency appreciation precede sovereign default, banking, and currency crises.

²³We do not find evidence for time-variant factors (like in Gourinchas and Obstfeld, 2012).

crisis relative to tranquil times (non-crisis years). We also analyze if the conditional effects vary between country groups and type of triggers. For example, it is likely that crises have different impacts in emerging markets and low-income countries given the different characterizes of their economies and market access.

Results

We start by studying the behavior of fiscal variables. As Appendix Figure 2.6 shows (middle row), in the run-up to the crisis, real expenditure growth grows above tranquil times. Once the crisis begins, there is a sharp contraction in expenditure growth indicating fiscal policy is procyclical as economic conditions are weaker during this period. The adverse environment could also explain why budget revenues grow at a weaker pace and the fiscal balance remains worse than tranquil times after the crisis starts. However, the behavior of fiscal variables varies considerably across country groups (Appendix Figure 2.7). Expenditure policy tends to be more procyclical especially among AMs, and to a lesser degree in EMs, in the period around the crisis. The primary balance deterioration in crisis years is strongest in EMs. AMs and SDSs face a more temporary deterioration in the primary balance around the time of the crisis, which they are able to undo at a faster pace thanks to a large upfront deceleration in expenditure growth. In addition, crises signaled by credit events and implicit defaults are associated with the largest increases in post-crisis budget deficits as expenditure growth tends to react less (initially) than in other types (Appendix Figure 2.8).

We next turn to public debt. Our results show that on average public debt as share of GDP is not systematically higher, relative to tranquil times, before the onset of the crises; however, debt levels do rise and remain elevated during the first years of the crisis (Appendix Figures 2.6). This is particularly the case for advanced and emerging economies (Appendix Figure 2.7). While these results may seem counterintuitive, one would expect high debt levels preceding crisis and a fall afterwards, they are consistent with findings by others²⁴. Some

²⁴See for example Gourinchas and Obstfeld (2012) and Bruns and Poghosyan (2016).

possible explanations for the rise in debt after the onset of the crisis include the contraction in GDP growth (the debt ratio increases), effects of exchange rate movements of foreign currency denominated debt, as well as the fact that fiscal crises could be accompanied by other crises and the need to bail out private sector (more on this below). In contrast, in LIDCs, public debt tends to fall even before the start of the crisis (from levels above tranquil times), in many cases reflecting debt defaults. Crises associated with credit events where official creditors dominate show the most pronounced fall in public debt. While public debt tends to remain elevated during the first years of the crisis, this appears to be mainly driven by events involving private creditors (Appendix Figure 2.8). Most credit events involve both private and public creditors, but in the cases where only public creditors are affected, the debt levels usually fall quickly-possibly showing that debtor countries manage to obtain better conditions in such cases. On the other hand, debt levels remain significantly higher when crises are signaled by a loss of market confidence and only start declining a few years later.

We now investigate the impact on economic activity. In the crisis run-up, economic growth is generally higher than in normal times (Appendix Figure 2.6, bottom row), suggesting the economy is growing above potential. As the crisis starts, economic growth declines sharply. This is a similar pattern found for other types of crises (Gourinchas and Obstfeld, 2012; Romer and Romer 2017). Surprisingly, AMs experience the largest fall in real growth in the first two years of the crisis. EMs have the second largest fall (Appendix Figure 2.7). The fall in growth for these two groups varies between 2 and 5 percentage points in the first two years of the crisis. Almost half of AMs and EMs experience negative growth in the first and second year of the crisis (Appendix Table 2.5). While LIDCs have the highest frequency of crises, the observed adverse effects on the real economy are milder although a third of the countries still face negative growth in the first year of the crisis. A possible explanation may be that LIDCs receive more international support to weather the crisis²⁵.

²⁵Although LIDCs' credit events involve in most cases both private and public creditors, they have been

Fiscal crises triggered by implicit default come with a more severe deterioration in economic growth than all others (Appendix Figure 2.8). This may be because periods of very high inflation can be particularly damaging for domestic activity (Fischer and others, 2002). We also find that the growth pattern for credit events is mainly driven by the cases when private creditors are involved (whether official creditors also participate or not). When only public creditors are involved, the decline in growth from pre-crisis years is much smoother and growth quickly converges to normal times (Appendix Figure 2.8, panel E). We also investigate the behavior of current account deficits. As past literature notes, fiscal imbalances are many times accompanied by external imbalances, the so-called twin deficits hypothesis²⁶. Our results, confirm this tends to be the case. Twin deficits tend to worsen in the crisis run-up, signaling growing imbalances (Appendix Figure 2.6). This pattern dominates in AMs and EMs, with the post-crisis adjustment in the current account being largest in AMs (Appendix Figure 2.7). Among EMs, many are resource-rich countries that suffer from dramatic losses in resource exports, making their current account adjustment more difficult. Not surprisingly, the pattern of twin deficits is more pronounced when crises are identified by access to IMF programs or a loss of market confidence. IMF programs involve a substantial upfront effort to reduce public expenditure growth and there is a large improvement in the external current account (Appendix Figure 2.8). After rising at the crisis onset, post-crisis public debt ratios stabilize around the average for normal periods. Possibly reflecting the larger imbalances (twin deficits), the drop in economic growth is larger than for credit events, but less pronounced relative to other triggers (Appendix Figure 2.8). Crises associated with a loss of market confidence tend to be similar. However, when market confidence falters, economic growth declines more sharply.

beneficiaries of significant international support in periods of distress, including debt relief operations.

²⁶Bluedorn and Leigh (2011) estimate that a 1 percent of GDP fiscal consolidation raises the current account balance-to-GDP ratio by about 0.6 percentage point, supporting the twin deficits hypothesis.

2.5.2 Twin Crises

As noted above, in some cases, fiscal crises are accompanied by other types of crises. The effect of such twin crises could have significantly different impact on the economy. As discussed in Section 2.4, fiscal and banking crises can interact leading to a worse outcome. For example, Romer and Romer (2017) find that the impact of financial crises on economic growth depends on the size of fiscal space that countries have for a sample of advanced economies. Namely, countries with lower debt at the start of a financial crises can better manage the potentially large costs of bailing out the financial system and adopt counter-cyclical policies. We turn now to investigate the existence of an amplification effect of twin fiscal-financial crises on macro-fiscal variables in our larger sample.

Model Specification

We apply a fixed-effect model à la Gourinchas and Obstfeld (2012) and Reinhart and Rogoff (2011) with two separate crisis dummies to identify the interactions. Specifically, we follow the fixed-effect difference-in-difference (DID) analysis with the banking crisis dummy B_i and the currency crisis dummy C_i :

$$y_{i,t} = \alpha_i + \sum_{j=-5}^5 \beta_j D_{t+j} + \sum_{j=-5}^5 \gamma_j D_{t+j} B_i + \sum_{j=-5}^5 \delta_j D_{t+j} C_i + \epsilon_{i,t}$$

where, during an 11-year time window around a fiscal crisis, γ_i indicates an additional effect as a result of twin fiscal-banking crises, and δ_i a similar effect caused by twin fiscal-currency crises.

Results

Our results suggest that fiscal crises that overlap with other crises are accompanied by a more pronounced decline in economic growth, in line with the results for Romer and Romer (2017). As Appendix Figure 2.9 shows, the decline in economic growth is magnified in twin

fiscal-currency crises. Growth is lower by an additional 3 percentage points on average for fiscal-currency crises in the first two years of the crisis. This is driven by the experience of EMs and some AMs²⁷. In LIDCs, the economic behavior is quite different, as twin crises tend to be preceded by economic turbulence as discussed above. We found similar effects for fiscal-banking crises. Sovereigns' indebtedness levels also tend to rise more steeply during twin fiscal-currency crises than during stand-alone fiscal crises (Appendix Figure 2.9). In fiscal-currency crises, debt rises by around an additional 10 percent of GDP relative to a fiscal crisis, but the effect tends to dissipate after some years. While the rise in public debt is common to all country groups, the pattern and size vary significantly. LIDCs usually see a large buildup of public debt in the pre-crisis years.

2.5.3 The Long-Term Growth and Debt Impact

Fiscal crises are associated with lower economic growth and public debt tends to be above normal periods, but are these trends persistent or are they transitory? Some countries indeed do not go back to their pre-crisis trend (Figure 2.5). Some have not only faced a deep recession, but have also remained unable to recover to pre-crisis growth rates in the aftermath of fiscal crises, while others have recovered partially from the crisis and returned to similar growth rates over time. In addition, countries appear to struggle to contain (and reverse) the rise in public debt. We now examine if fiscal crises have long-term effects.

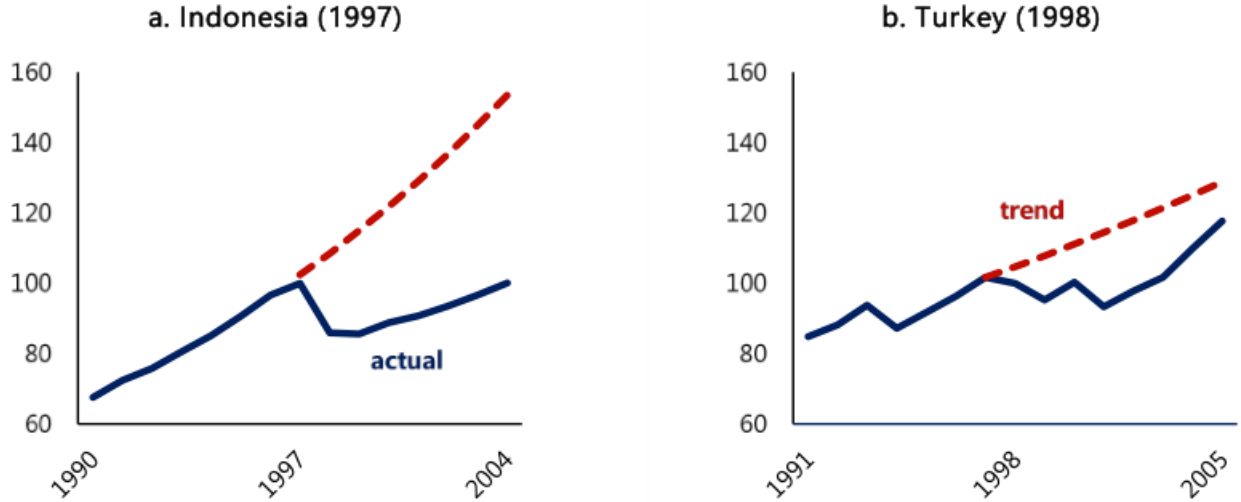
Model Specification

We specify an impulse response function (IRF) analysis à la Cerra and Saxena (2008)²⁸ to estimate a fixed-effect AR(p) model that accounts for both lagged dependent variables $y_{i,t-j}$

²⁷Examples of twin fiscal-currency crises in AMs include Israel (1975), Iceland (1975, 2008), Portugal (1983), Estonia (1991), Latvia (1991), Lithuania (1991), and Korea (1997).

²⁸Cerra and Saxena (2008) derive the cumulative changes in real GDP p.c. in the aftermath of financial and political crises to show that output fails to catch up with the pre-crisis real GDP trend.

Figure 2.5: Actual Deviation of Real GDP p.c. from Trend (normalized to 100 in the crisis start year)



Note: The Figure plots actual deviations of real GDP p.c. from the long-term trend over the 7-year time window after the onset of 2 fiscal crises episodes (i.e. Indonesia 1997 and Turkey 1998). The projected long-term trend is based on the pre-crisis growth rate that is the average growth during $[t - 5, t - 1]$ where t is the start year of a fiscal crisis. The value of real GDP p.c. is normalized to 100 in year t .

and lagged exogenous shocks $D_{i,t-s}$:

$$y_{i,t} = \alpha_i + \sum_{j=1}^p \beta_j y_{i,t-j} + \sum_{s=0}^q \delta_s D_{i,t-s} + \epsilon_{i,t}$$

Note that $y_{i,t}$ denotes the public debt ratio or real GDP p.c. growth depending on the specification, so that the cumulative deviations in the growth rate from the pre-crisis path represent the permanent loss in real GDP p.c. We derive the IRFs with a one-standard-error band drawn from a thousand Monte Carlo simulations. For our exercise, we set $p = 1$ and $q = 4$ ²⁹

.

²⁹To capture the output variable's dependence on its previous values, we choose 1 lag (i.e. $p = 1$) for the dependent variable and 4 lags for the independent variable (i.e. $q = 4$). This is broadly robust with other choices of p and q (such as Cerra and Saxena's, 2008, choice of $q = 4$ and $p = 4$).

Results

The impact on public debt ratios varies across country groups, but on average, public debt returns to similar levels as the pre-crisis trend (Appendix Figure 2.10). This average masks differences across country groups. In AMs, the public debt ratio rises by around 10 percentage points of GDP at the onset of a fiscal crisis. In the long-term, the ratio remains about 4 percentage points of GDP above the pre-crisis level. In contrast, EMs experience a rise in public debt, but eventually converge to the pre-crisis level. In LIDCs and SDSs, public debt first falls but also returns to levels similar to pre-crisis periods. The results suggest fiscal crises are associated with a permanent loss of real GDP of around 2 percent (Appendix Figure 2.10). While AMs and EMs experience greater output losses during a fiscal crisis, they tend to recover half of the initial output losses. LIDCs and SDSs, on the other hand, face a more gradual fall in GDP, but no recovery, converging to pre-crisis growth rates over time. These results show an impact somewhat lower than what Cerra and Saxena (2008) find for financial crises³⁰.

2.6 Conclusion

This paper provides a new comprehensive database and highlights some of the insights it can provide on the dynamics and costs of fiscal crises. Our work advances the research in some areas. We provide a comprehensive list of fiscal crises that go beyond sovereign debt defaults, the focus of past literature, and our identification criteria excludes small events (e.g. technical defaults) which helps reduce misidentification of crises years. Finally, we extend significantly the country coverage allowing for the analysis of crises across all levels of economic development. This is especially relevant as LIDCs are most prone to crisis, but their crises have very different characteristics than those of advanced or emerging economies.

³⁰They find that the output impact of a banking crisis is nearly twice as large ($7\frac{1}{2}$ percent loss) as a currency crisis.

We also used the data to highlight some other patterns associated with a fiscal crisis. While the findings do not necessarily imply causality, they provide insight on how policies and key economic variables evolve around these exceptional periods. We find that fiscal policy appears to be procyclical, especially in AMs and EMs. Crises are preceded by loose fiscal policy, as expenditures grow above average. Once the crisis starts, countries tighten expenditure growth as economic conditions deteriorate. Second, economic growth tends to sharply decline at the onset of the crisis and there seems to be a permanent decline in GDP. AMs and EMs face the deepest contraction in growth and about half of them experience recessions. The decline in economic growth is particularly large when crises are triggered by high inflation. Third, public debt tends to rise and remain elevated during the first years of the crisis. An exception is when the crisis is identified by credit events that only involve official creditors. Fourth, fiscal crises are usually associated with both fiscal and external imbalances. The data also show that fiscal-financial twin crises experience a deeper decline in growth than stand-alone fiscal crises.

The new database could contribute to future research and better understanding of fiscal crises and how to prevent them or mitigate their impact. Our paper raised several specific issues that will require further analysis, but future research could also focus on better identifying the economic and policy factors that lead to a crisis, including developing early warning indicators. Lastly, it is important to acknowledge that the identification and analysis of fiscal crises remains hampered by limited data. This is especially relevant regarding data on domestic debt defaults and arrears by governments to contractors. The experience of individual countries suggests these are important signals of fiscal distress, however, more work is needed. We expect that future work will address some of these limitations.

2.7 Appendix

2.7.1 Database

The database covers 188 countries (Appendix Table 1) and 46 years (1970-2015). We group countries in advanced economies, non-small emerging economies, non-small low-income developing economies, and small developing states. Most variables come from the IMF (WEO and Historical Public Debt Database).

The remainder data are from: ” Sovereign defaults database is from Bank of Canada’s CRAG: As discussed in Beers and Chambers (2006), BoC (2016) considers that a sovereign default occurs ”when debt service is not paid on the due date (or within a specified grace period), payments are not made within the time frame specified under a guarantee, or, absent an outright payment default, in any of the following circumstances where creditors incur material economic losses on the sovereign debt they hold: (i) agreements between governments and creditors that reduce interest rates and/or extend maturities on outstanding debt; (ii) government exchange offers to creditors where existing debt is swapped for new debt on less-economic terms; (iii) government purchases of debt at substantial discounts to par; (iv) government redenomination of foreign currency debt into new local currency obligations on less-economic terms; (v) swaps of sovereign debt for equity (usually relating to privatization programs) on less-economic terms; (vi) conversion of central bank notes into new currency of less-than-equivalent face value.” The database covers 136 countries from 1970-2015. Data gaps were closed by identifying countries that never defaulted using rating agency reports and by deriving lower bound estimates of sovereign debt in default from available components of BoC’s data. Those include, for instance, restructured amounts from Cruces and Trebesch (2013), rescheduled and relieved amounts from the World Bank. ”

IMF financial program data are from an IMF database from 1952 to 2015. The other account payables (OAP) data (proxy for arrears) are from Eurostat and the OECD. ”

Yields data are from IFS. EMBI are from Reuters Datastream. CDS Spreads are from

Table 2.4: Sample Countries

AMs (35)	EMs (70)		LICs (50)		SDS (33)
Australia	Albania	Kosovo	Afghanistan	Madagascar	Antigua & Barbuda
Austria	Algeria	Kuwait	Bangladesh	Malawi	Bahamas, The
Belgium	Angola	Lebanon	Benin	Mali	Barbados
Canada	Argentina	Libya	Burkina Faso	Mauritania	Belize
Cyprus	Armenia	Macedonia, FYR	Burundi	Moldova	Bhutan
Czech Republic	Azerbaijan	Malaysia	C.A.R.	Mozambique	Cape Verde
Denmark	Bahrain	Mexico	Cambodia	Myanmar	Comoros
Estonia	Belarus	Mongolia	Cameroon	Nepal	Djibouti
Finland	Bolivia	Morocco	Chad	Nicaragua	Dominica
France	Bosnia & Herzegovina	Namibia	Congo, Dem. Rep. of	Niger	Fiji
Germany	Botswana	Nigeria	Congo, Republic of	Papua New Guinea	Grenada
Greece	Brazil	Oman	Cote D'Ivoire	Rwanda	Guyana
Iceland	Brunei Darussalam	Pakistan	Eritrea	Senegal	Kiribati
Ireland	Bulgaria	Panama	Ethiopia	Sierra Leone	Maldives
Israel	Chile	Paraguay	Gambia, The	Somalia	Marshall Islands, Rep.
Italy	China, Mainland	Peru	Ghana	South Sudan	Mauritius
Japan	Colombia	Philippines	Guinea	Sudan	Micronesia
Korea, Rep. of	Costa Rica	Poland	Guinea-Bissau	Tajikistan	Montenegro
Latvia	Croatia	Qatar	Haiti	Tanzania	Palau
Lithuania	Dominican Republic	Romania	Honduras	Togo	Samoa
Luxembourg	Ecuador	Russian Federation	Kenya	Uganda	São Tomé & Príncipe
Malta	Egypt	Saudi Arabia	Kyrgyz Republic	Uzbekistan	Seychelles
Netherlands	El Salvador	Serbia	Laos	Yemen	Solomon Islands
New Zealand	Equatorial Guinea	South Africa	Lesotho	Zambia	St. Kitts and Nevis
Norway	Gabon	Sri Lanka	Liberia	Zimbabwe	St. Lucia
Portugal	Georgia	Syria			St. Vincent & the Grenadines
San Marino	Guatemala	Thailand			Suriname
Singapore	Hungary	Tunisia			Swaziland
Slovak Republic	India	Turkey			Timor Leste
Slovenia	Indonesia	Turkmenistan			Tonga
Spain	Iran	U.A.E.			Trinidad & Tobago
Sweden	Iraq	Ukraine			Tuvalu
Switzerland	Jamaica	Uruguay			Vanuatu
United Kingdom	Jordan	Venezuela			
United States	Kazakhstan	Vietnam			

Bloomberg. For criterion 4 we prioritize the use of EMBI spreads when available. ”

Loss of market access dummies are from Guscina, Sheheryar, and Papaioannou (2017), for 57 countries from 1990 onwards. For years prior to 1990 and missing observations, we use Gelos, Sahay, and Sandleris (2004) database for 140 countries from 1980 through 2000.

”

Currency and banking crises are taken from Laeven and Valencia (2012).

Table 2.5: Percent of Episodes with Negative Real GDP p.c. Growth

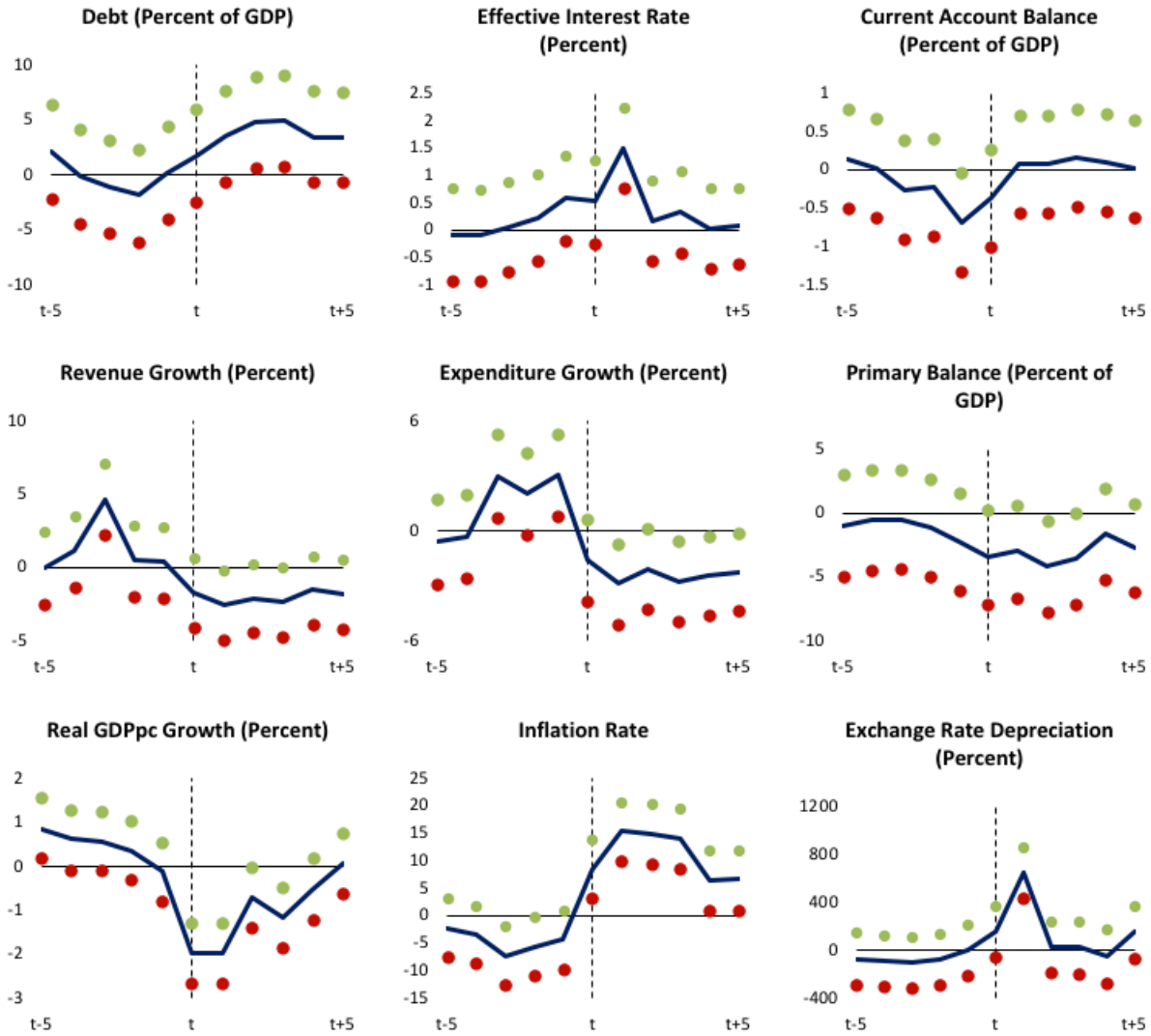
	Total crisis episodes	Percent of country group episodes with negative real GDP per capita growth					
		t-3	t-2	t-1	t	t+1	t+2
Total	439	24.8	25.3	28.5	40.8	34.4	29.8
AM	25	12.0	28.0	28.0	48.0	60.0	48.0
EM	155	22.6	20.6	29.7	50.3	40.6	29.0
LIDC	173	29.5	28.3	27.7	33.5	29.5	30.1
SDS	86	23.3	26.7	27.9	36.0	25.6	25.6

Source: Authors' calculations.

Source: Author's calculations.

2.7.2 Figures

Figure 2.6: Event Study-Key Macro-Fiscal Variables



Note: The Figure plots the estimates of β_j for each variable during the 11-year time window (solid line), together with the 95 percent confidence interval (dotted lines). Following Gourinchas and Obstfeld (2012), we measure the difference between values during the 11-year time window and "normal" period average. The x-axis is the time distance to the start of fiscal crises. We drop one outlier (i.e. Zimbabwe 2000).

Figure 2.7: Event Study Along Country Groups

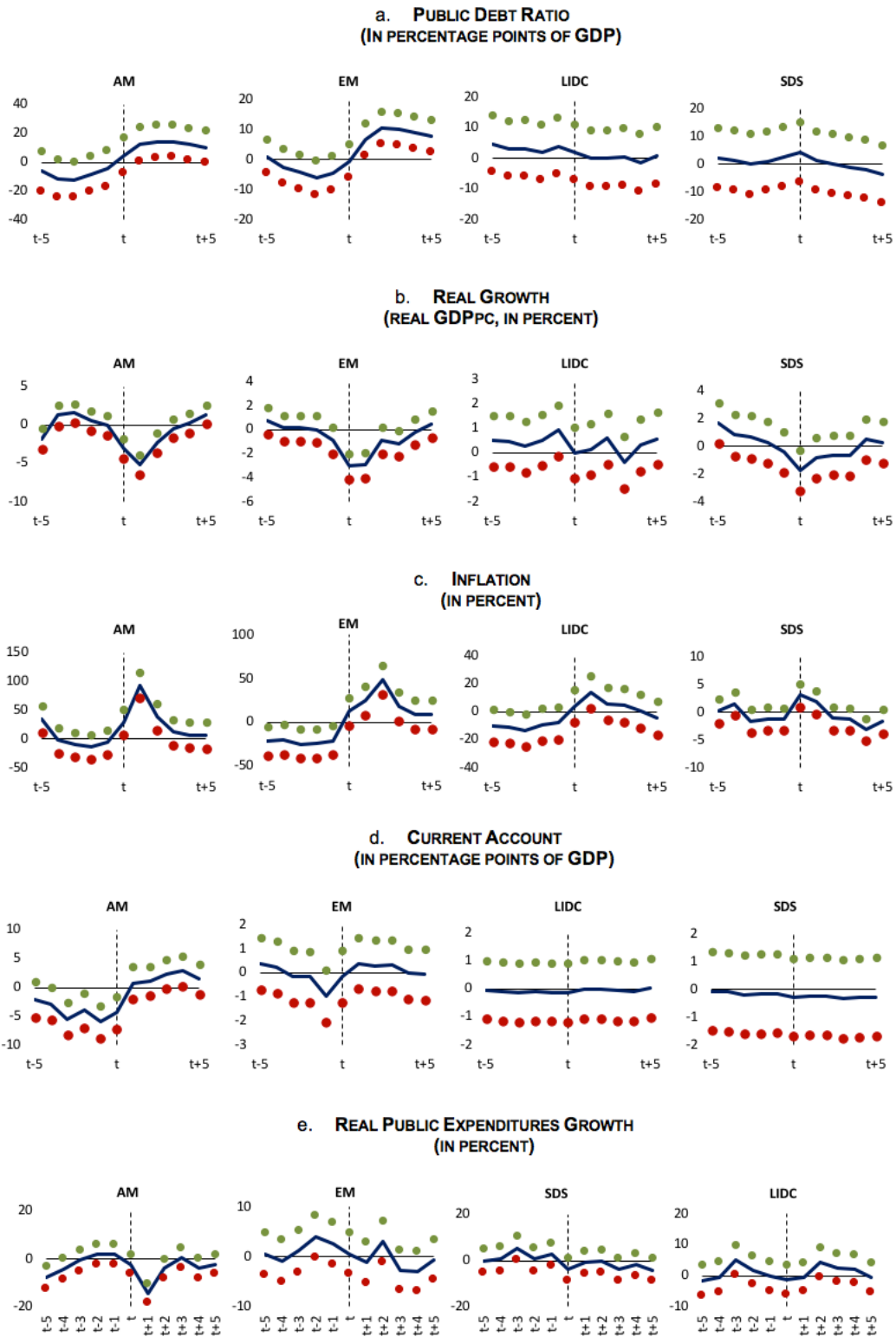


Figure 2.8: Event Study Along Crisis Criteria

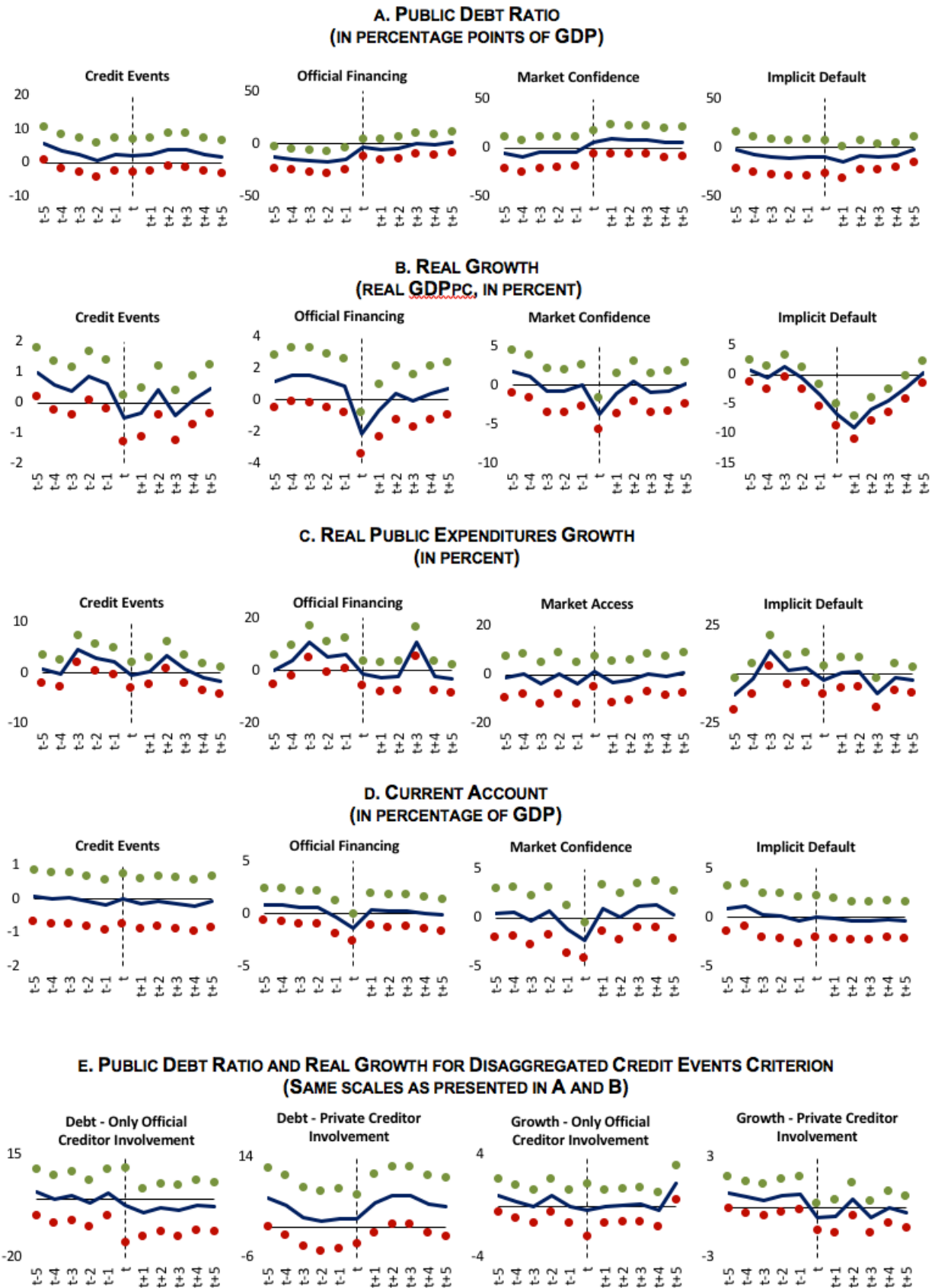


Figure 2.9: Twin Fiscal-Currency Crises—Public Debt and Growth

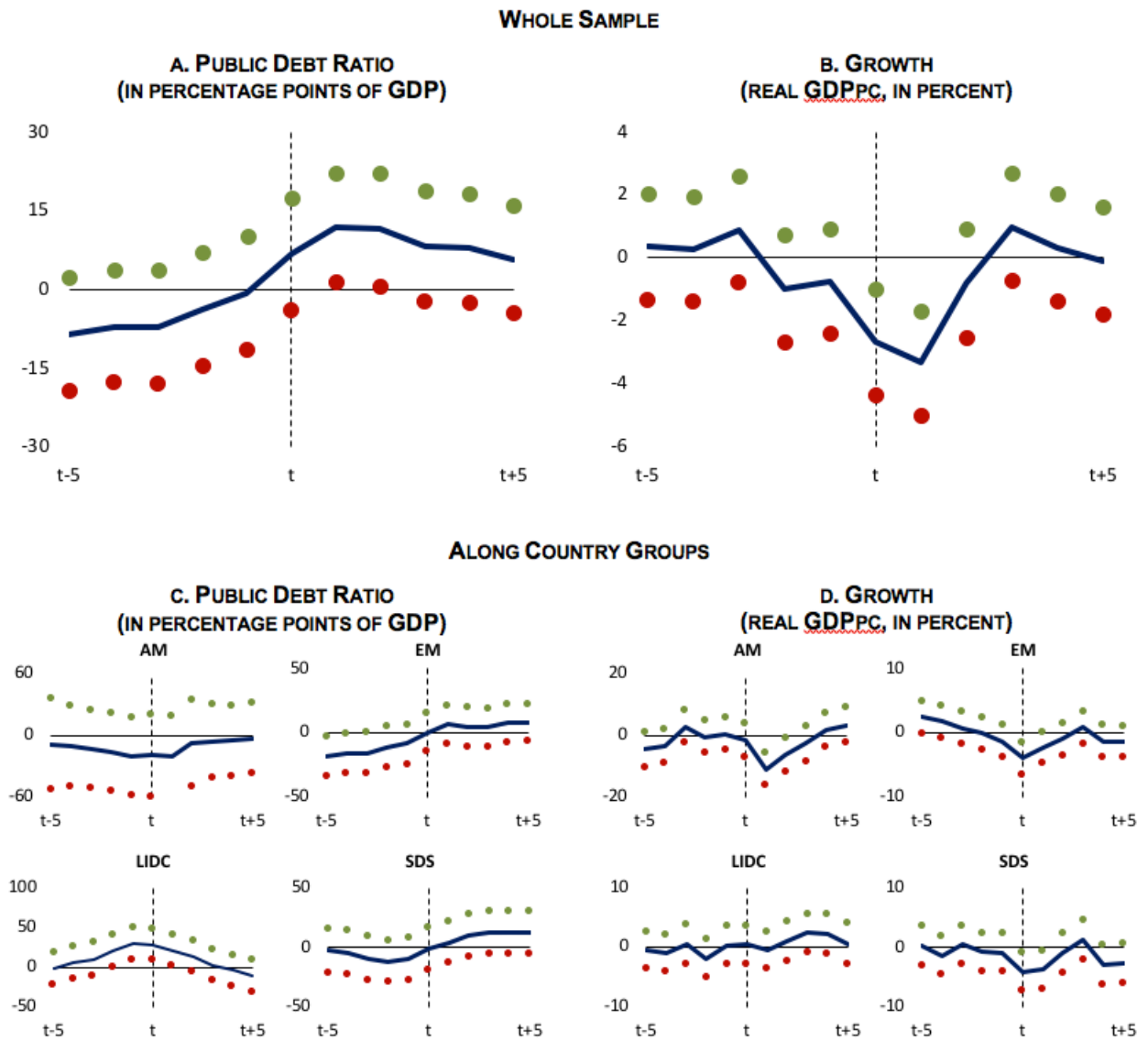
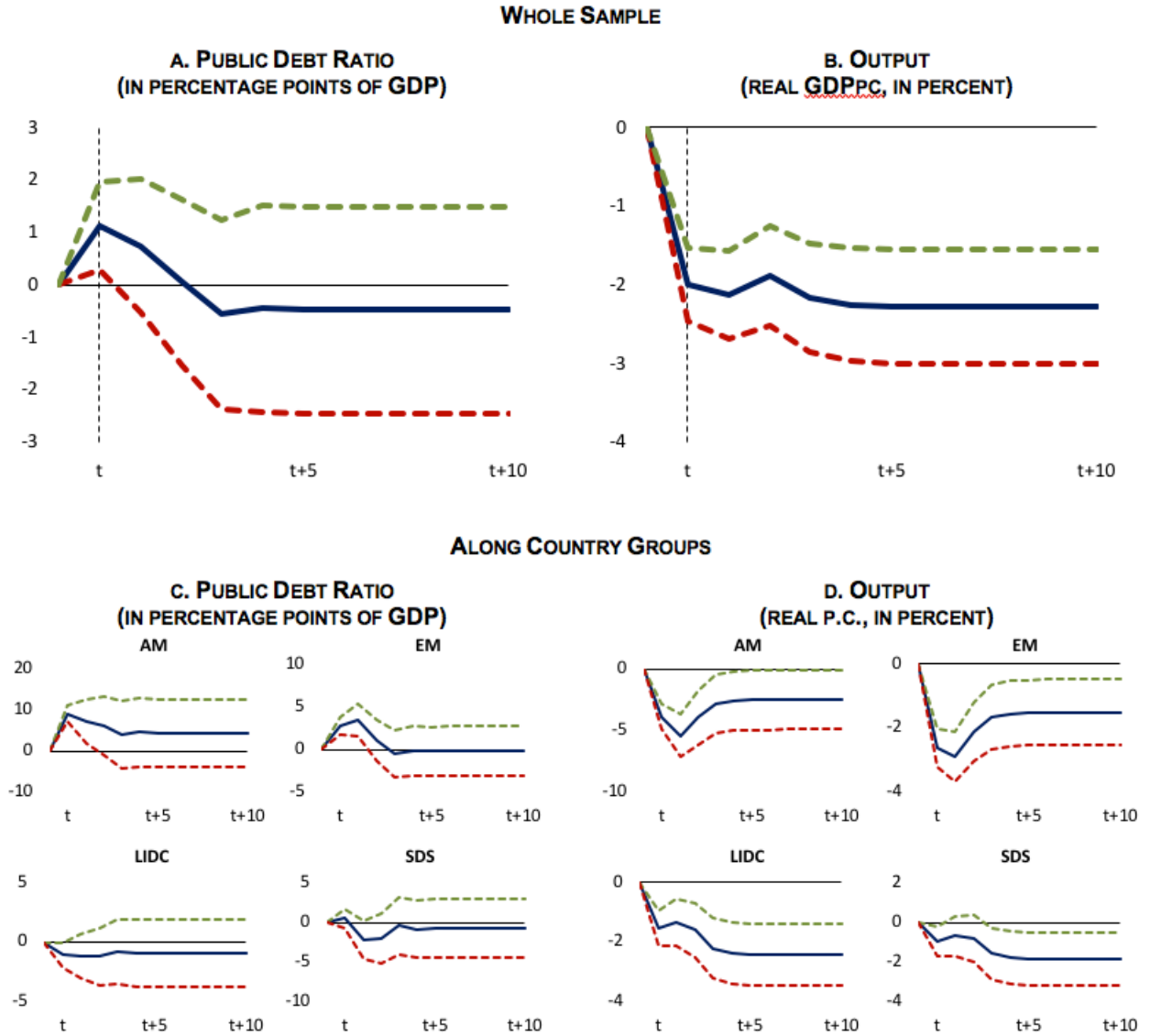


Figure 2.10: Fiscal Crisis Response—Changes in Public Debt and Output



Note. This figure plots the response of public debt ratio and real GDP per capita to one period exogenous fiscal crisis shock after Monte Carlo simulations. We follow Cerra and Saxena (2008) in estimating a fixed-effect AR(p) model to simulate the impulse response functions. The figure presents the mean of simulations, together with a one standard deviation corridor.

Chapter 3

Non-Performing Loan Resolutions and Economic Recoveries

3.1 Introduction

The recent global financial crises and prolonged economic recoveries gave new prominence to some old questions. Is government post-crisis fiscal spending on resolving banking sector non-performing loans necessary? If so, what are the short-term costs and what are the medium-term benefits? On the one hand, countries with extremely high debt levels during the years leading up to the banking crises ended up with little to no fiscal policy space for clearing up banking sector non-performing assets (Romer and Romer, 2018; Kose et al., 2017; IMF, 2015 and 2018). On the other hand, excessive fiscal outlays related with resolving non-performing loans triggered default risks of sovereign bonds, which stroke back to the banking sector through the bank-sovereign nexus (Acharya et al., 2012; Bordo and Meissner, 2016; Farhi and Tirole 2016). Such painful experience left questions for people in terms of how costly concurring banking-fiscal crises are comparing with stand-alone banking crises, and what are the policy implications from the experience in the past decades.

In this paper, we begin by constructing novel data set on government fiscal costs associated with resolving banking sector non-performing loans. Such new data set is an extension of Laeven and Valencia (2008, 2012) because it not only takes into account of costs related

with recapitalizations and liquidity support documented in literature, but also includes the amount of asset purchase by government or state-owned asset management companies. Following the narrative approach in Romer and Romer (1989), we read IMF country reports and central banks' post-crisis reports in order to find exogenous announcement related with non-performing assets purchased by government. In addition, we extend the existing non-performing loans data backwards to 1990 so that our empirical analysis covers banking crises in many emerging market economies during 1990s. Our second main data sets are indicators of banking and fiscal crises. We follow the dating strategies of Laeven and Valencia (2008, 2012) for systemic banking crises and Gerling et al. (2017) for fiscal distress.

We first show that concurring banking-fiscal crises are very costly to countries in both short-term and medium term. Event studies around banking-fiscal crises show that countries experiencing such twin crises are usually suffering from an additional output loss, non-performing loans accumulations, and sovereign default risk increase. In the medium term, local projections *a la* Jorda (2005) show that higher fiscal spending on clearing up non-performing loans contributes to a significant increase in output and credit growth especially after stand-alone banking crises. However, such growth difference between high fiscal spending country group and the rest of the countries appear to be insignificant after banking-fiscal twin crises. In addition, we investigate if countries that managed to reduce a substantial portion of banking sector non-performing loans experience significant growth change after banking-fiscal twin crises. Perhaps surprisingly, higher actual reduction in non-performing loans stimulates output growth to an even larger extent after twin crises. Taking these two pieces of evidence together, one may conclude that countries experiencing twin crises are facing some fiscal constraints when resolving non-performing loan issues, but would benefit from higher growth if the fiscal costs are materialized as reduction in non-performing loans.

In the second half of this paper, we address the questions on what fiscal constraints dampen the growth effect by fiscal spending on resolving non-perform loans after banking-fiscal twin crises. We conclude that the timing of fiscal crises and banking crises matters

for the fiscal limitation of resolving non-performing loans issue. If a country is experiencing fiscal distress and happens to confront banking crises at the same moment, the government might find itself without enough fiscal policy space to restructure the banking system and stimulate growth. With fixed-effects panel regressions, we find that for the countries experiencing “fiscal-to-banking” type twin crises, improving primary balance or reducing public debt burden are important in restoring fiscal policy space and enhancing medium-term growth. However, if a fiscal crisis follows a banking crisis, what dampens the growth impact is the bank-sovereign nexus. Higher fiscal spending on resolving non-performing loans eventually feedback to higher sovereign default risks and higher loss to the banking system which tends to hold more domestic sovereign bonds. Our empirical analysis confirms such channel. When countries experience “banking-to-fiscal” type twin crises, properly reducing sovereign default risk and regaining access to international capital markets would help countries escape from the “doom loop”.

3.2 Data and Summary Statistics

3.2.1 Data

We build a country-level unbalanced panel data set that includes the information on government fiscal costs on resolving non-performing loans, banking sector non-performing loans ratio, and sovereign spreads, and many other macro and fiscal conditions. In addition, we merge this data set with the systemic banking crises database in Laeven and Valencia (2008 and 2012) and the fiscal crises database in Gerling et al. (2017). The annual data ranges from 1990 to 2016, providing over 4800 country-years. Here we elaborate on the key variables used in this paper.

The starting year of a systemic banking crisis is defined as the time when there are 1) significant signs of financial distress in the banking system, and 2) significant banking policy intervention measures in response to significant losses in the banking sector (Laeven

and Valencia, 2012). Based on these two criteria, our sample period includes 147 systemic banking crises. A fiscal crisis is recorded when one of the following four criteria is met (Gerling et al., 2017). They are 1) credit events associated with sovereign debt, 2) recourse to large-scale IMF financial support with a fiscal adjustment purpose, 3) implicit domestic public default (e.g. high inflation rate), and 4) loss of market confidence in the sovereign. In total, we document 283 fiscal crises in the sample period¹. We define a “twin crisis” as an episode when a fiscal crisis happens in a 5 year event window around a systemic banking crisis. Such definition leads to a subsample of 104 banking-fiscal twin crises.

We measure government fiscal costs on resolving banking sector non-performing loans based on different policy responses: liquidity support, recapitalization, and direct asset purchase. These three resolution policies are most commonly used in the past decades and have been extensively used in many developed countries during the onset of the recent global financial crises. By definition, they target to three components of banks’ balance sheet: liabilities, capital, and assets. Liquidity support is usually in the form of central bank or treasury claims on the banking sector. More specifically, such policy requires the central bank to function as a lender of the last resort and government to provide deposit insurance. As such, liquidity support is the mostly used policy among the three. Recapitalization takes place when a government injects capital stocks into commercial banks for writing off non-performing loans. This policy improves banks’ capital conditions when they face increasing capital requirement or deteriorating capital ratio. Direct asset purchase led by state-owned asset management companies has been implemented in many emerging market countries in the past decades and some advanced market countries (e.g. Ireland) in the recent crises. Asset purchase, which separates non-performing loans from banks’ balance sheet, has been proved very effective in improving financial conditions of the banking sector. However, it often comes with a large fiscal costs due to the very low haircut when purchasing non-performing loans. We borrow

¹Fiscal crises are more frequent than banking crises mainly because the former are very common in low income countries where explicit sovereign default or debt rescheduling is very frequent but the banking sector is relatively less developed.

the data of liquidity support and recapitalization from Laeven and Valencia (2012). However, the amount of asset purchase as well as the corresponding haircut is not well documented in literature. Therefore, we turn to IMF country reports and central banks' reports for countries that have experienced systemic banking crises. Our narrative approach is in line with Romer and Romer (1989) but is focused on the announcement of government direct asset purchase programs that are not part of their safety net. In other words, we document implicit bailouts that have been actually implemented by governments. We record the amount of asset purchase within 3 years after the onset of a banking crisis (from T to $T + 3$, where T is defined as the starting year of a banking crisis). In total, 24 countries' central government purchased non-performing loans and transferred them from troubled banks to state-owned asset management companies.² In addition to the book values of purchased non-performing loans, we also report the actual transfer prices of non-performing loans after taking into account of the haircut. Among the 24 countries that purchased non-performing loans 3 years immediately after banking crises, 14 of them purchased with zero haircut (transferred at book value). This confirms that government purchase has been utilized to stabilize asset price in the financial market but could be very costly to the public.

Another key cross-country time series in our data set is the non-performing loans to total credit ratio. The Global Financial Development (GFD) from the World Bank provides the non-performing loans ratio back to 2000. However, a significant number of banking crises and fiscal crises do not present in the limited non-performing loans time series. Thus, we complement the non-performing loans time series of GFD with our own collection of non-performing loans ratio in most countries that have experienced a systemic banking crises during 1990s. These countries include Nordic countries around 1991 (Sweden, Norway, and

²In the other countries, either their governments had not purchased and stripped non-performing loans from the banking system, or the authorities divided the troubled banks into good banks and bad banks and left all the non-performing loans on the bad banks' balance sheets (different from government direct purchase). For instance, KA Finanz in Austria was split from Kommunalkredit Austria AG after the 2008 banking crisis, in which no assets were transferred by government. UK Asset Resolution (UKAR) was established to hold two bad banks (Northern Rock and Bradford & Bingley), which did not involve non-performing loans purchase.

Finland), Latin American countries around 1995 (Mexico, Argentina, Brazil, and Paraguay), Emerging European countries around 1995 (Latvia, Lithuania, Poland, Russia, Slovak Republic, and Ukraine), and Southeast Asian countries around 1997 (China, Indonesia, Japan, Korea, Malaysia, and Thailand). However, since the definitions of non-performing loans are various across countries (Balgova et al., 2016; Caballero et al., 2008)³, we mitigate this caveat by considering the changes in non-performing loans ratio instead of the level.

3.2.2 Summary Statistics

We present summary statistics of different government non-performing loans resolution costs to crisis-year GDP ratio, non-performing loans to total credit ratio, as well as the other interested macro-fiscal variables in Table 3.1. Those macro-fiscal variables include dependent variables in our analyses such as growth rate of real GDP per capita and growth rate of total credit to private sectors, indicators of fiscal conditions such as public debt to GDP ratio and primary balance to GDP ratio, indicators of sovereign risk such as 10 year sovereign CDS spreads, and other macro variables such as investment share, inflation rate, effective interest rate, total population, net export to GDP ratio, and current account ratio. The median non-performing loans ratio in our sample is around 5% (5% is the common threshold for the warning sign of banking sector non-performing loan issues), which implies that high non-performing loan ratio in the banking sector is a very frequent issue. The resolution costs on resolving non-performing loan issues amount to an average ratio of 12.35% of crisis year GDP and an median of 6.55% of crisis year GDP, implying that cleaning up accumulated non-performing loans after banking crises is very costly to the government.

³In a generally recognized definition according to International Monetary Fund, “A loan is non-performing when payments of interest and principal are past due by 90 days, or at least 90 days of interest payments have been capitalized, refinanced or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons to doubt that payments will be made in full”. However, many countries may define non-performing loans in different ways. For instance, Japan implemented a loose assessment of non-performing loans during late 1990s. In contrast, Sweden established a very strict disclosure requirement since Nordic banking crisis.

3.3 Economics Impact of Resolutions and Fiscal Distress

What are the short-term patterns of a country’s macro-fiscal conditions if the country experiences a systemic banking crisis and, at the same time, is fiscally distressed (i.e. banking-fiscal twin crisis). What is the medium term impact of non-performing loan resolution plans on the economic recovery if a country suffers from a banking-fiscal twin crisis. In this section, we investigate these questions with the newly constructed data set.

3.3.1 Short-Term Patterns: An Event Study Analysis

The event study approach allows us to understand the patterns of macro and fiscal conditions during a short time window around crisis onsets. Following Gourinchas and Obstfeld (2012) and Catao and Milesi-Ferretti (2014), we run the following fixed-effects panel regressions with a discrete-choice time window around a crisis start year (banking or fiscal):

$$y_{i,t} = \alpha_i + \alpha_t + \sum_{j=-5}^5 \beta_j D_{t+j} + \epsilon_{i,t}$$

where $y_{i,t}$ is one of a list of macro-fiscal variables that we investigate, α_i and α_t are crisis and time fixed-effects, and D_{t+j} is a time dummy variable taking the value of 1 in period $t + j$ (where t is the crisis start year). Thus, the estimates of β_j indicate the conditional effects of a crisis over the event window relative to out-of-window tranquil times. We study the short-term dynamics of macro-fiscal conditions that are closely related with countries’ economic recoveries, banking system, and fiscal conditions. Our results display the short-term analysis of 6 variables, which include real GDP per capita growth rate, real bank credit growth rate, non-performing loans to total credit ratio, public debt to GDP ratio, primary balance to GDP ratio, and 5 year sovereign CDS spreads.

Figure 3.1 in the appendix shows the short-term dynamics of macro-fiscal variables as well

as the 95 percent confidence interval around start years of banking crises and fiscal crises. The two panels on the top display that both banking crises and fiscal crises are disruptive to the growth of real GDP per capita and total bank credit. In fact, banking crises may cause more significant short-term damage to the real GDP and total credit growth, but are associated with faster recoveries. In terms of the non-performing loans ratio in the banking system, it is without doubt that such ratio has increased substantially after the onset of banking crises. Surprisingly, the banking sector non-performing loans ratio after fiscal crises has also increased significantly, which is likely driven by a considerable number of twin-crises in the sample. For the short-term patterns of fiscal conditions, both crisis types feature significant increases in the public debt ratio after the onsets of crises. In addition, the increase in the public debt ratio following the start year of banking crises is notably larger, which is possibly attributed to the sudden increase in the contingent public debt as a result of government responses to bailout or guarantee the distressed banking sector. The primary balance of a country deteriorates after both banking and fiscal crises, with the impact stronger and longer during the recovery periods of banking crises. One might relate this with the a substantial increase in government fiscal expense after banking crises. Finally, fiscal crises are followed by an immediate increase in the sovereign CDS spreads hike, indicating the fiscal distress of a country. Perhaps surprisingly, the sovereign CDS spreads were significantly increased only after 3 years since banking crises. As will be argued in the following sections, this provides evidence of the banking-fiscal nexus following an extensive government bailout guarantees to the banking sector.

When a banking crisis is concurring with a fiscal crisis, would the disruptive impact on macro-fiscal conditions be amplified? We modify the baseline specification with a dummy indicator of twin crises. Thus, we use the following fixed-effect difference-in-difference (DID) analysis:

$$y_{i,t} = \alpha_i + \alpha_t + \sum_{j=-5}^5 \beta_j D_{t+j} + \sum_{j=-5}^5 \gamma_j D_{t+j} \cdot Twin_i + \epsilon_{i,t}$$

where $Twin_i$ is a dummy variable that indicates whether a banking crisis i is accompanied

with a fiscal crisis during a 5-year event window, and γ_j estimates an additional effect as a result of twin crises. Figure 3.2 displays such additional short-term impact conditional on the dynamics of banking crises alone. As the first panel shows, a banking-fiscal twin crisis leads to an additional 5 percentage points downward effect on the real GDP growth one year after the crisis onset. Moreover, Non-performing loans ratio, which is an indicator of the banking sector's health, follows an additional 5 percentage points increase immediately after the crisis start year. This pattern showcases the fact that a fiscally distressed central government might find it difficult to address banking sector non-performing loan issues. When comparing twin crises with cases of banking crises alone, we observe deteriorating primary balance and higher sovereign risk. It is worth noting that the additional hike in sovereign CDS spreads takes place 4 years after twin crises, reflecting that the shift from bank default risk to sovereign default risk may take several years to materialize.

3.3.2 Medium-Term Impact: A Local Projection Analysis

In the short-term, a banking-fiscal twin crisis tends to be more disruptive to real output. Moreover, given large fiscal costs in addressing non-performing loan issues, a twin crisis may restrict government's capability to contain non-performing loans and may trigger sovereign default risk through bank-sovereign nexus. In this section, we investigate if government's non-performing loan resolution plans would lead to different medium-term impact on economic recoveries after a banking-fiscal crisis and a stand-alone banking crisis. We estimate the medium term impulse responses using Jorda (2005) local projections (LP) approach. As our analysis compares the medium term impulse response of non-performing loans resolution plans with different fiscal costs after twin crises and stand-alone banking crises respectively, we choose the local projections approach that easily allows for the inclusion of interactions between fiscal costs and the "twin crisis" dummy. In particular, with the following specification, we estimate the LP impulse responses to fiscal costs on resolving non-performing loans

for $h + 3$ years after the onset of crises:

$$\Delta_h y_i = \alpha^h + \beta^h C_i \cdot Twin_i + \gamma^h C_i + \sum_{j=1}^5 X_{t+3-j} \cdot \Gamma_{i,j}^h + \sum_{j=1}^5 \eta_j^h \cdot y_{i,t+3-j} + \epsilon_i^h$$

where t is the crisis start year, y_i is the n growth rates of real GDP per capita or total credit for countries with different fiscal costs on non-performing loan resolutions (high fiscal costs group minus low fiscal costs group), $\Delta_h y_i$ is the cumulative growth of y_i up to h years after $t + 3$, C_i is a dummy that indicates whether total fiscal costs related with resolving non-performing loans is above the sample median, $Twin_i$ is a dummy for twin-crises, and X_{t+3-j} is a vector of control variables including real investment per capita, CPI inflation, effective real interest rate, total population, net export to GDP ratio, and current account to GDP ratio, which are all measured at $t + 3 - j$. The parameters that we are interested in are γ^h and $\beta^h + \gamma^h$. The estimate of γ^h shows the difference in impulse responses due to different fiscal costs on resolving non-performing loans during the stand-alone banking crises recovery periods, while the estimate of $\beta^h + \gamma^h$ showcases such difference during the twin crises recovery periods.

Estimates are reported in Table 2 and Table 3 of appendix. The full sample includes 147 systemic banking crises since 1990 that are documented in Laeven and Valencia (2012). Local projection estimations show that countries with higher total fiscal costs on non-performing loans resolutions experience faster recoveries in real GDP and total credit. However, such pattern is true only after a stand-alone banking crisis and becomes much weaker if a systemic banking crisis is accompanied with a fiscal crisis. Eight years after a banking-fiscal twin crisis, the difference in real GDP per capita for such two groups of countries is more than 10 percentage points lower relative to a stand-alone banking crisis. Moreover, the difference in total credit after a banking-fiscal twin crisis is more than 50 percentage points lower than after a stand-alone banking crisis. Figure 3.3 and 3.4 display the the same results of Table 3.2 and 3.8.2. In summary, banking-fiscal twin crises feature more disruptive recoveries in

output and credit even after high fiscal costs on resolving banking sector non-performing loans.

In the analysis above, we split the two samples of stand-alone banking crises and banking-fiscal twin crises into two subsamples respectively based on the fiscal costs on non-performing loan resolutions (i.e. fiscal costs during $[T, T+3]$ were above or below the median). However, such comparison comes with a caveat, as the relation between fiscal costs on non-performing loans resolutions and the subsequent recovery speed might not be linear. Thus, we pursue a more ambitious specification in which the fiscal cost on resolving non-performing loans is a continuous ratio. Instead of splitting the sample at the median, we replace the fiscal cost dummy variable C_i by a continuous measure defined as the fiscal cost to crisis year GDP ratio $Cost_i$. In particular, we follow the specification in Jorda et al. (2017) and include the relative value of $Cost_i$ to the subsample means after banking crises ($Cost_i - \overline{Cost_i}$). We then estimate the following set of local projections:

$$\begin{aligned} \Delta_h y_i &= \alpha^h + \beta^h (Cost_i - \overline{Cost_i}) \cdot Twin_i + \gamma^h (Cost_i - \overline{Cost_i}) \\ &+ \sum_{j=1}^5 X_{t+3-j} \cdot \Gamma_{i,j}^h + \sum_{j=1}^5 \eta_j^h \cdot y_{i,t+3-j} + \epsilon_i^h \end{aligned}$$

for $h = 1, \dots, 5$, where γ^h estimates the response of recovery path difference due to one percent increase in fiscal cost ratio $3+h$ years after stand-alone banking crises, and $\gamma^h + \beta^h$ estimates the response $3+h$ years after banking-fiscal twin crises. The results are presented in Table 3.4. As the table displays, countries with 1 percentage higher fiscal costs on resolving non-performing loans would enjoy a significant medium-term recovery after a stand-alone banking crisis (on average 2.48 percent higher 8 years after banking crises). However, such pattern disappears for the medium-term recovery periods after twin banking-fiscal crises.

In another exercise, instead of focusing on the fiscal cost on non-performing loans resolutions and comparing its medium term impact after stand-alone banking crises and banking-fiscal twin crises, we study the growth impact of actual non-performing loans reductions

during $[T, T + 3]$ regardless of its related fiscal cost. We conduct this exercise because we expect countries experiencing banking-fiscal twin crises might have faced more binding fiscal constraints on cleaning up non-performing loans. Thus, with same units of non-performing loans being cleaned up, the marginal benefit for recovery from a banking-fiscal crisis are expected to be greater than that for a stand-alone banking crisis. In other words, a larger reduction in non-performing ratio within three years after a banking crisis is followed by a faster recovery, and more importantly, such pattern should be stronger after a banking-fiscal twin crisis. Figure 3.8.1 and Figure 3.8.1 display the recovery speed differences for stand-alone banking crises and banking-fiscal twin crises respectively, in which each sample is split according to reductions in non-performing loans ratio during $[T, T + 3]$. As the table shows,

3.4 Theory

The results in Section 3 based on event studies and local projections both reveal that a concurring fiscal distress during the aftermath of banking crises could be very disruptive for the short-term and medium term recoveries in output and credit. In particular, fiscal distress dampens the positive recovery effect formed by higher fiscal costs on resolving banking sector non-performing loans. But in what channel does fiscal stress amplifies the negative impact by banking crises and dampens the positive impact by government bailout guarantees? In this section, we discuss existing theories that help explain the disruptive recovery impact due to fiscal distress. We categorize the theories into two broad groups: those relate fiscal policy space with post-crisis economic performance, and those reinforce the bank-sovereign nexus. These theories provide insights for our empirical analysis in the next section.

One may naturally attribute the weak economic recovery to the lack of fiscal policy space when a country enters the banking crisis phase with high public debt burden. In fact, high public debt ratio leaves the government with little space to resolve banking sector non-performing loans issues given that either capital injections or asset purchase could be

fiscally very costly. Cross-country data has shown that there is a negative relation between general government debt-to-GDP ratio and the fiscal stabilization coefficient, an indicator that measures how much a country's overall budget balance changes in response to a change in economic slack (IMF Fiscal Monitor, April 2015 and April 2018).

Such pattern is echoed by many recent studies on post-crisis macroeconomic policies. Based on data of 24 advanced economies in the postwar periods, Romer and Romer (2018) find that the degree of monetary and fiscal policy space prior to financial distress greatly affects the aftermath of crises. According to a cross-country panel of advanced economies with longer time periods, Jorda et al. (2016) show that even though financial stability risks have mostly come from private sector credit booms, high levels of public debt have tended to exacerbate the post-crisis deleveraging effect and lead to more prolonged periods of economic depression. Using a data set covering emerging market economies, Bernardini and Forni (2017) find that such effect is very pronounced in emerging markets as well. In a New Keynesian model framework, Corsetti et al. (2012) include an additional set-up that private credit spreads positively relate to sovereign risks. This model provides an implication that fiscal distress amplifies the transmission of shocks to aggregate demand through the private sector funding cost, and dampens the stimulus effects by contractionary or unconventionally monetary policies⁴.

Another interpretation of the disruptive effect caused by fiscal distress is that the economic recovery is accompanied with the “doom loop.” In such a vicious cycle, bank distress would likely trigger government bailouts to the creditors, which subsequently could drive up the sovereign yield spreads. As a feedback effect, higher sovereign yield spreads deteriorate domestic banks' balance sheet, since i) domestic banks hold large amount of sovereign bonds when their risk appetite is low during the recovery periods, and ii) an increase in long-term

⁴One might think of the unconventionally monetary policy as a large scale distressed asset purchase directed by central banks. Even though central banks usually target to assets instead of specific banks, the underlying mechanism works similar as asset purchase programs conducted by stated-owned asset management companies in many countries.

interest rates leads to faster contractions in banks' asset value rather than contractions in liabilities⁵.

Such kind of vicious cycle is particularly prominent after the recent global financial crisis. For instance, immediately after the government of Ireland announced its guarantee program on September 30, 2008, the cost of purchasing Irish banks' credit default swaps (CDS) fell overnight from around 400 basis points (bps) to around 150 bps, indicating that the banking system had become much less risky. However, the cost of purchasing Irish sovereign CDS increased from less than 100 bps to around 350 bps in the following 6 months, as the large fiscal cost associated with the guarantee problem triggers sovereign default risk. Perhaps surprisingly, this is accompanied with an even larger increase in the bank CDS costs, reflecting that the sovereign risks might strike back to bank risks.

Acharya et al. (2013) are the first to formally document such bank-sovereign nexus, in which they compare the correlations of bank credit default swaps (CDS) spreads hike versus the sovereign credit default swaps spreads hike during different periods. They find a very strong and positive correlation between these two kinds of CDS spreads (a 10% increase in the level of sovereign CDS is associated with a 0.9% increase in the level of bank CDS) only after the post-bailout episodes, even though the initial purpose of the bailouts is to lower the financial sector's credit risk. Theoretical models have provided implications of the "doom loop" under different set-ups. For instance, Cooper and Nikolov (2013) argue that the existence of the loop is due to banks' strong incentives of holding sovereign bonds instead of issuing equity. Farhi and Tirole (2017) consider a "double-decker bailout" in which not only domestic government can bailout banks, foreign government can bailout domestic government as well. In this model set-up, domestic government can strategically decide whether to bailout domestic banks. Moreover, Balke (2017) models a more indirect channel of the "doom loop" through employment costs of sovereign default in the labor market.

⁵Because commercial banks' business model is reliant on using short-term debt or deposits to finance long-term investment, an increase in long-term interest rate would translate to faster market value decline in securities with longer maturities.

3.5 Fiscal Policy Space and Post-Crisis Recoveries

The two theories elaborated in Section 4 appear to be irrelevant, but one may realize that timing could be an important factor in deciding which theory plays a dominant role. On one hand, countries that are lack of fiscal policy space after banking crises have already experienced high public debt level during the crisis run-up (IMF 2018). On the other hand, the bank-sovereign nexus is usually triggered by an sudden increase in bank default risks (Acharya et al. 2012). In the rest of the paper, we use cross-country panel data to empirically test if timing of banking crises and fiscal crises determines how fiscal distress leads to disruptive recovery from banking crises.

3.5.1 Hypothesis and Empirical Method

We argue that high public debt level before banking crises restricted government’s fiscal policy space in resolving many issues in distressed banking system (e.g. non-performing loans). Thus, we hypothesize that if a fiscal crisis has preceded a banking crisis, the “fiscal space channel” may dominate the disruptive recovery during the aftermath of a banking-fiscal crises. In order to test the presence of such channel, we focus our empirical analysis on the how post-crisis fiscal conditions drive output and credit recoveries. According to the hypothesis, if the distressed sovereign is facing limited fiscal policy space, faster adjustment in fiscal conditions would be transmitted to faster economic recoveries. Given this argument, we test the existence of the “fiscal space channel” with the following fixed-effects panel regression:

$$\Delta \log(\% \Delta y_{i,t}) = \alpha_i + \alpha_t + \beta Twin_i + \sum_{j=1}^4 \gamma_j FC_{i,t-j} \times Twin_i + \sum_{j=1}^4 X_{i,t-j} \Gamma_j + \epsilon_{i,t}$$

where $\% \Delta y_{i,t}$ is the percentage change in real GDP per capita or total credit, $Twin_i$ is a dummy taking a value of 1 if the banking crisis i is concurring with a fiscal crisis, and $FC_{i,t-j}$ is the indicator of fiscal conditions and is represented by the primary balance ratio

and distance to debt ceiling⁶. We use these two measures to proxy a country’s fiscal condition because the increase in fiscal policy space could be directly due to reduced public debt level and indirectly due to the contribution of primary balance surplus. To absorb the lagged impact and mitigate endogeneity, we include the fiscal condition indicator and other control variables up to 4 years prior to the observation year t . We consider post-crisis periods for our regressions, where $t \in [T + 1, T + 10]$ where T is the banking crisis start year⁷. To illustrate the idea, we regress for two subsamples, in which the first subsample excludes the twin crises with fiscal crises following banking crises and the second subsample exclude the twin crises with fiscal crises preceding banking crises. We expect that in the first subsample the estimates of γ_j should be significantly positive for both measures of fiscal conditions $FC_{i,t-j}$, so that improved fiscal conditions pass through to strengthened economic growth.

3.5.2 Results

Table 3.5 in the appendix presents regression results when we use the primary balance ratio to represent fiscal conditions. As mentioned above, we run regressions for two different types of samples. We name the two types of twin crises as “fiscal-to-banking” type twin crises and “banking-to-fiscal” twin crises. For Column (1) and (2), we compare the “fiscal-to-banking” type twin crises with stand-alone banking crises. For Column (3) and (4), we compare the “banking-to-fiscal” type twin crises with stand-alone banking crises. In Column (1)-(4), we estimate the impact of improved primary balance on the medium-term growth in output and credit. The estimates provide implications on whether lack of fiscal policy space is the main reason for weaker recoveries after twin banking-fiscal crises. We repeat our exercise in Column (5)-(8) by using distance to debt ceilings to gauge fiscal conditions of a country. In

⁶Distance to debt ceilings is defined as the difference between a country’s debt ceiling and its actual public debt ratio. The debt ceiling is documented by the IMF fiscal rule database that computes countries’ debt ceilings based on their own fiscal rules.

⁷For many European countries where banking crises start at 2008, our sample covers only up to 2016.

addition, we report the lagged effects up to 4 years prior to the current year t .

Our reported results in Table 3.5 can be summarized as following. First, the results confirm that banking-fiscal twin crises are more disruptive on output and credit recoveries than stand-alone banking crises are. The first row of the table shows that, all else equal, a twin crisis is followed by around 2.5 percentage points loss in real GDP per capita growth rate and around 4 percentage points loss in credit growth growth. Second, for the “fiscal-to-banking” type twin crises, the medium-term recovery after banking crises benefits more from improved primary balance. In particular, as we can observe by comparing Column (1) and (3) (or by comparing Column (2) and (4)), comparing with a stand-alone banking crises, one percentage point increase in primary balance ratio after the a “fiscal-to-banking” type twin crisis is followed by an additional 0.83 percentage point increase in output growth in the next year and an additional 1.53 percentage point increase in credit growth in the next year. However, such effects are almost halved if we move focus to the comparison between “banking-to-fiscal” type twin crises and stand-alone banking crises. Third, such additional medium term impact following improving fiscal conditions lasts longer after “fiscal-to-banking” type twin crises. Improvement in primary balance ratio could be transmitting to an additional growth in output and credit even three year afterwards for “fiscal-to-banking” type twin crises. However, such additional impact after “banking-to-fiscal” type twin crises is only significant for 1 year⁸. Finally, we can replicate the similar pattern when replacing primary balance ratio by distance to debt ceilings as another measure of a country’s fiscal condition. Since fiscal ceilings are formed based on adapted fiscal rules, the last finding lends evidence that anchoring fiscal rules help understand a country’s fiscal policy space (Romer and Romer, 2018; IMF 2018).

⁸The second and third findings seems contradicting the fact that improving primary balance requires tax hike and fiscal spending contractions, and is usually at the cost of slowing growth. However, since our focus is only for medium-term after banking crises, we abstract from patterns along long-term cycles.

3.6 Bank-Sovereign Nexus and Post-Crisis Recoveries

3.6.1 Hypothesis and Empirical Method

As the theory of bank-sovereign nexus predicts, government bailouts to the distressed banking system (such as fiscal costs on resolving non-performing loans) could trigger sovereign risks, which further contributes to an additional loss to banks who usually hold a large portion of domestic sovereign bonds. How to empirically verify such bank-sovereign nexus after banking-fiscal twin crises? This section describes the hypothesis as well as the empirical results. Our assumption in the empirical tests is that the solution for sovereigns to break the bank-sovereign nexus (or “doom loop”) is immediately building up market confidence and obtaining international capital market access for rolling over existing sovereign bonds or issue new bonds. Thus, an improvement in international capital market conditions for domestic sovereign bonds is crucial medium-term recoveries, especially the ones associated with bank-sovereign nexus. We hypothesize that for the “banking-to-fiscal” type twin crises are more likely to feature bank-sovereign nexus. In other words, recoveries in market conditions of domestic sovereign bonds are expected to be more beneficial for the “banking-to-fiscal” type twin crises during the medium-term. In order to gauge market conditions of domestic sovereign bonds, we follow Gerling et al. (2017) by two indicators: sovereign credit spreads and sovereign bonds market access. We use 5 year sovereign credit default swap yield spreads ⁹and loss-of-market-access (LMA) indicator published by IMF¹⁰ to gauge medium-term market conditions for domestic sovereign bonds. With the same fashion of empirical tests in Section 5, the fixed-effects regression specification is as following:

⁹All the results in the Section 6.2 is robust when using 10 year sovereign CDS spreads, which implies that medium-term sovereign default risk is closely related with market conditions of domestic sovereign bonds.

¹⁰The LMA indicator is a dummy variable which takes a value of 1 when the sovereign losses the access to the international capital markets. According to IMF (2015), market access is defined as “the ability to tap international capital markets on a sustained basis through the contracting of loans and/or issuance of securities across a range of maturities, regardless of the currency denomination of the instruments, and at reasonable interest rates.”

$$\Delta \log(\% \Delta y_{i,t}) = \alpha_i + \alpha_t + \beta Twin_i + \sum_{j=1}^4 \gamma_j MC_{i,t-j} \times Twin_i + \sum_{j=1}^4 X_{i,t-j} \Gamma_j + \epsilon_{i,t}$$

where, all else are defined in the previous section, $MC_{i,t-j}$ is the market condition of domestic sovereign bonds after crisis i and at year $t - j$. If higher $MC_{i,t-j}$ indicators more favorable market conditions for domestic sovereign bonds (lower CDS credit spreads or loss-of-market-access indicator equals 0), we expect the estimates of γ_j are significantly positive, especially for the case of comparing “banking-to-fiscal” type twin crises with stand-alone banking crises.

3.6.2 Results

Table 3.6 in the appendix reports the estimates of the above-mentioned fixed-effects regressions in the same fashion as Table 5. These two tables have multiple similarities not only in the way they are structured, but also the reflection of slower recoveries after banking-fiscal crises based on the estimates of β in the first row. Below, we only elaborate on the distinctions revealed in Table 3.6, which might be consistent with our expectations.

The first distinction between Table 3.6 and Table 3.5 is the much weaker lagged effects on output and credit growth by recoveries in improving domestic sovereign bonds market conditions. In Column (3) and (4), the percentage increase in output and credit growth at t by 1 percentage reduction in CDS credit spreads at $t - 2$ is only around a quarter of the effects by same reduction in CDS spreads at $t - 1$. Second, the lagged effects on growth by improving market conditions are short-lived. As Column (3) and (4) manifest, we do not observe any significant transmissions to output and credit recoveries by sovereign bonds market improvement beyond 2 years prior to t . To grasp the intuition, one may relate this to the fragile sentiment in the market for sovereign bonds after a country experienced fiscal distress. In fact, the definition of fiscal crises in Gerling et al. (2017)¹¹ are all related with significant

¹¹Kose et al. (2017), Bordo and Meissner (2016), and Trebesch and Zabel (2017) all documented such

turmoil in sovereign bonds market and usually followed by prolonged sell-off of domestic assets. As such, the effects on growth by regaining confidence in the international capital market is very transitory and requires sustained improvement in debt service capability. The last distinction of Table 6 is the small distinction in growth enhancing effect by previous year market conditions between “banking-to-fiscal” type twin crises and “fiscal-to-banking” type twin crises. Comparing Column (1) versus Column (3) and Column (5) versus Column (7), the difference is much smaller than the counterparts in Table 5. This pattern reveals that accessing international capital market benefits not only the countries experiencing doom-loop, but also the ones have lack enough fiscal space for banking crises resolutions.

3.7 Conclusion

In this paper, we present a new data on various fiscal spending on resolving banking sector non-performing loan issues. In addition to the costs on recapitalization and liquidity support documented in Laeven and Valencia (2008, 2012), we also include announcement of non-performing asset purchase by government in line with Romer and Romer (1989).

Our second contribution is the documenting the disruptive effects of banking-fiscal twin crises. Based on our new data set and a cross-country database for 147 banking crises during 1990-2016, we find fiscal distress around systemic banking crises dampens the positive growth impact of fiscal stimulus plans that focus on clearing up banking sector non-performing loans. Through empirical analysis, we draw the conclusions that banking-fiscal twin crises are closely related with lacking fiscal policy space and the bank-sovereign nexus, which limit the growth impact of fiscal spending on resolving banking sector non-performing loans.

Our empirical results shed light on the policy implications on how countries increase effectiveness of fiscal stimulus during the medium-term. First, restoring fiscal policy space

turmoil in the sovereign bonds market after fiscal crises, even though their definition of fiscal distress is mostly different from the one that we use.

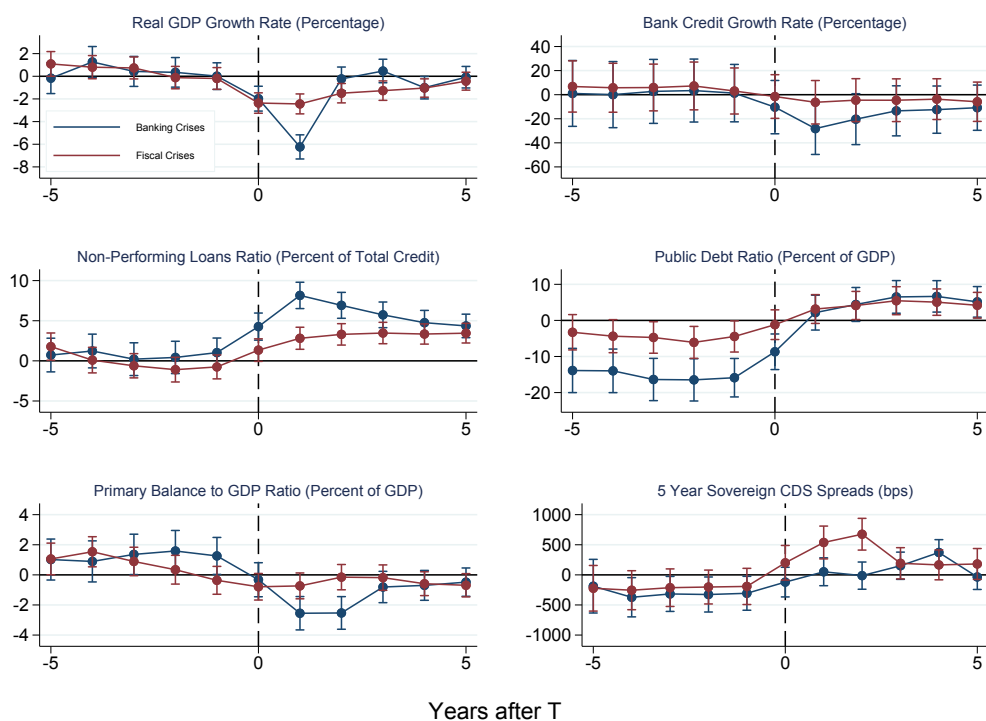
through increasing primary balance and containing public debt level could mitigate the disruptive effects after “fiscal-to-banking” type twin crises. Second, effectively containing sovereign default risks or regaining access to the international capital market help the countries escape from the vicious loop of bank-sovereign nexus after “banking-to-fiscal” type twin crises.

3.8 Appendix

3.8.1 Figure

Event Studies of Banking Crises and Fiscal Crises

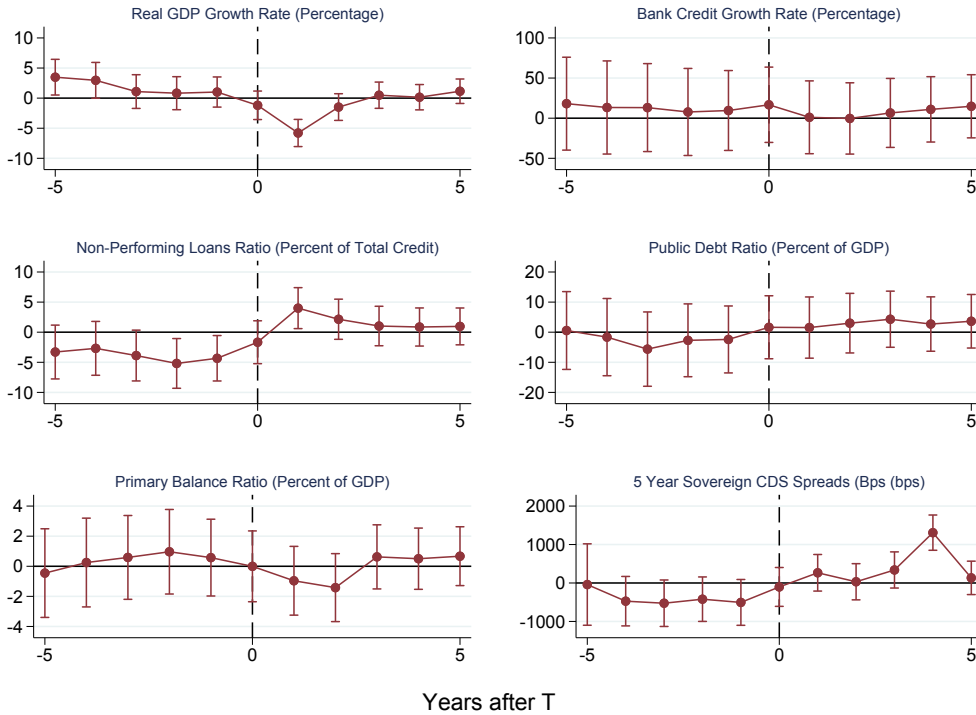
Figure 3.1: Event Studies of Banking Crises and Fiscal Crises



Note. This figure uses the event study approach to show the variations of 6 variables (i.e. real GDP per capita growth rate, total credit growth rate, non-performing loans to total lending ratio, public debt to GDP ratio, primary balance to GDP ratio, and 5 year sovereign CDS spreads) over a 11-year event window around banking crises or fiscal crises. We report the estimates as well as 90 percent confidence interval in the figure.

Event Studies of Banking-Fiscal Crises

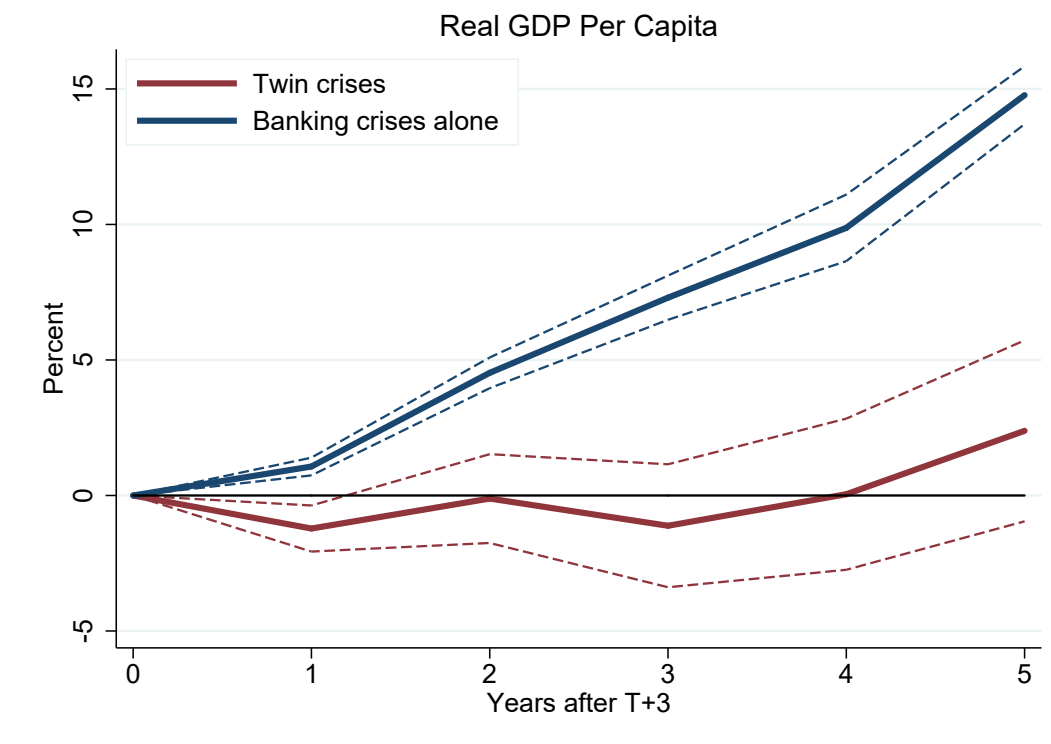
Figure 3.2: Event Studies of Banking-Fiscal Crises



Note. This figure uses the event study approach to show the additional variations of 6 variables (i.e. real GDP per capita growth rate, total credit growth rate, non-performing loans to total lending ratio, public debt to GDP ratio, primary balance to GDP ratio, and 5 year sovereign CDS spreads) over a 11-year event window around banking-fiscal twin crises. We report the estimates as well as 90 percent confidence interval in the figure.

Local Projections of Growth Difference in Real GDP Per Capita During Recovery Periods (High Fiscal Costs Minus Low Fiscal Costs)

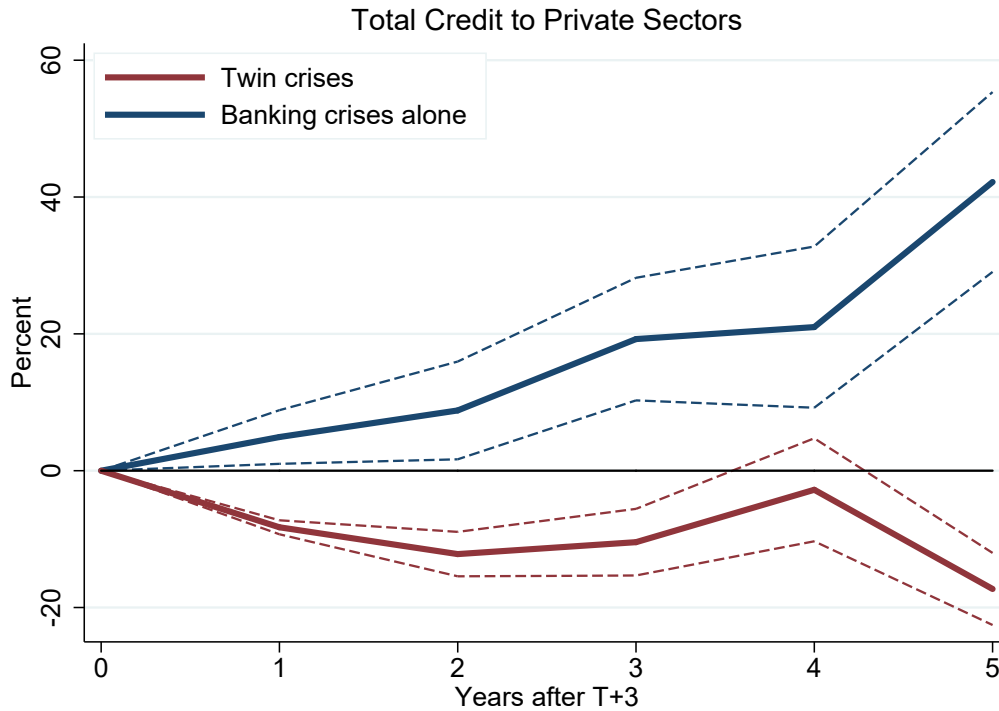
Figure 3.3: Local Projections of Growth Difference in Real GDP Per Capita During Recovery Periods (High Fiscal Costs Minus Low Fiscal Costs)



Note. This figure uses Jorda (2005) local projection approach to show the impulse response of real GDP per capita growth difference after stand-alone banking crises and banking-fiscal twin crises, respectively. The growth difference is defined as the growth in high fiscal costs (on non-performing loans resolutions) minus the growth in low fiscal costs. The regression specification and variable definitions are in the text. The figure reports the estimation of the impulse response as well as the 90% confidence interval up to 5 years after $T + 3$, where T is the start year of a banking crisis.

Local Projections of Growth Difference in Total Credit During Recovery Periods (High Fiscal Costs Minus Low Fiscal Costs)

Figure 3.4: Local Projections of Growth Difference in Total Credit During Recovery Periods (High Fiscal Costs Minus Low Fiscal Costs)

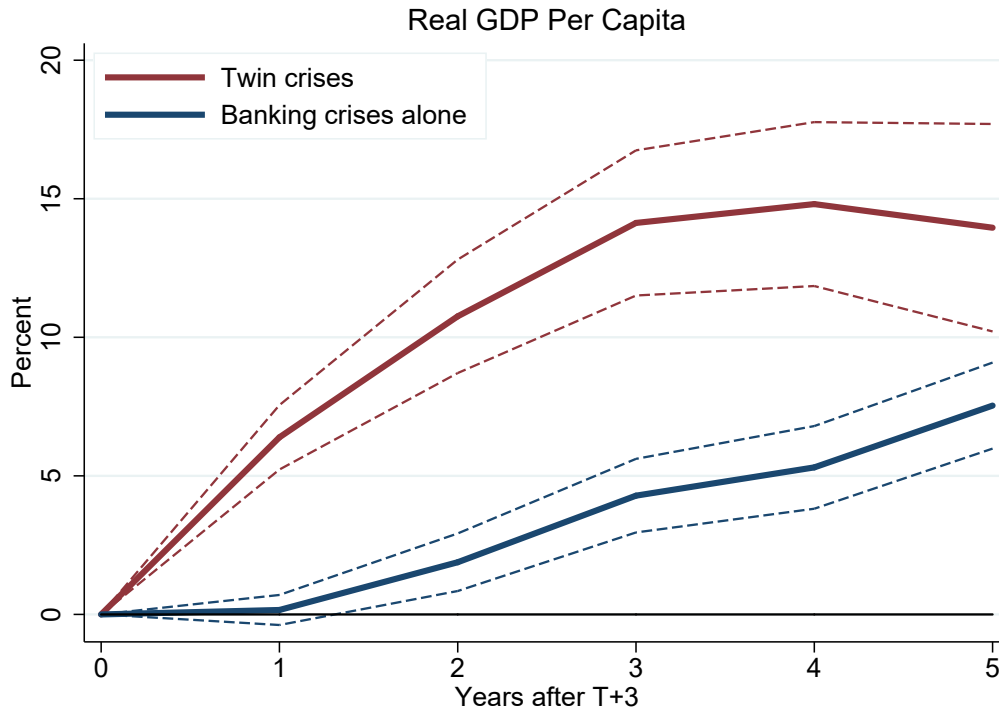


Note. This fig-

ure uses Jorda (2005) local projection approach to show the impulse response of real GDP per capita growth difference after stand-alone banking crises and banking-fiscal twin crises, respectively. The growth difference is defined as the growth in high fiscal costs country group (on non-performing loans resolutions) minus the growth in low fiscal costs country group. The regression specification and variable definitions are in the text. The figure reports the estimation of the impulse response as well as the 90% confidence interval up to 5 years after $T + 3$, where T is the start year of a banking crisis.

Local Projections of Growth Difference in Real GDP Per Capita During Recovery Periods (High NPLs Reductions Minus Low NPLs Reductions)

Figure 3.5: Local Projections of Growth Difference in Real GDP Per Capita During Recovery Periods (High NPLs Reductions Minus Low NPLs Reductions)

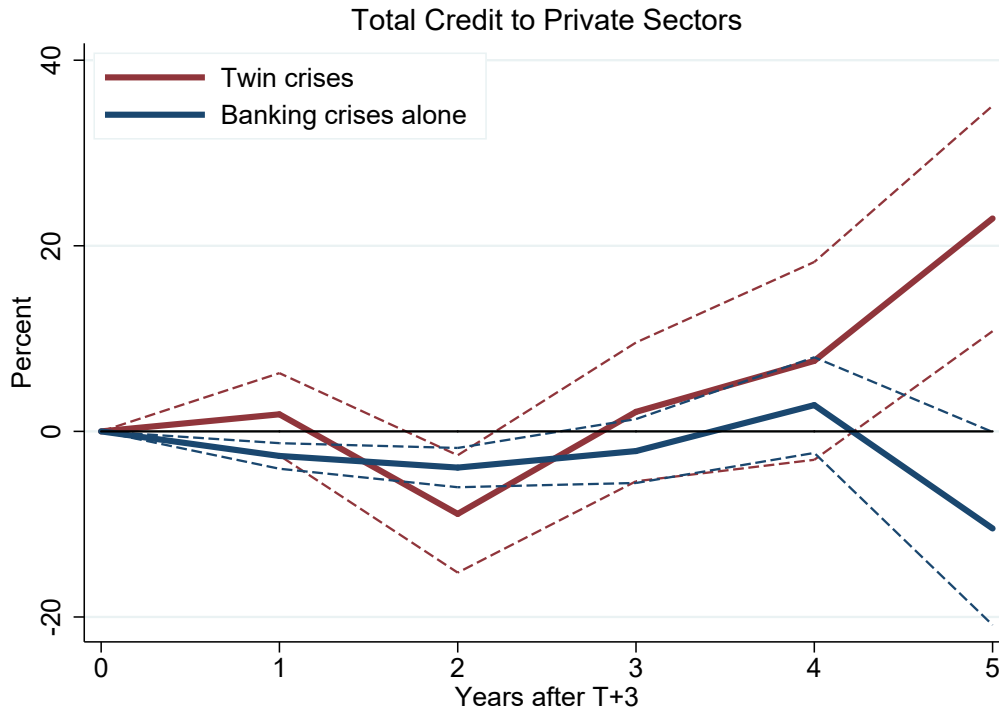


Note. This fig-

ure uses Jorda (2005) local projection approach to show the impulse response of total credit to private sectors growth difference after stand-alone banking crises and banking-fiscal twin crises, respectively. The growth difference is defined as the growth in high non-performing loans reduction country group (from the crisis onset to 3 years afterwards) minus the growth in low non-performing loans reduction country group. The regression specification and variable definitions are in the text. The figure reports the estimation of the impulse response as well as the 90% confidence interval up to 5 years after $T + 3$, where T is the start year of a banking crisis.

Local Projections of Growth Difference in Total Credit During Recovery Periods (High NPLs Reductions Minus Low NPLs Reductions)

Figure 3.6: Local Projections of Growth Difference in Total Credit During Recovery Periods (High NPLs Reductions Minus Low NPLs Reductions)



Note. This fig-

ure uses Jorda (2005) local projection approach to show the impulse response of total credit to private sectors growth difference after stand-alone banking crises and banking-fiscal twin crises, respectively. The growth difference is defined as the growth in high non-performing loans reduction country group (from the crisis onset to 3 years afterwards) minus the growth in low non-performing loans reduction country group. The regression specification and variable definitions are in the text. The figure reports the estimation of the impulse response as well as the 90% confidence interval up to 5 years after $T + 3$, where T is the start year of a banking crisis.

3.8.2 Tables

Summary Statistics

Table 3.1: Summary Statistics

	Unit	N	Mean	Median	Std. Dev.	Max	Min
Resolution costs to GDP	%	147	12.35	6.55	13.26	56.8	0
ln (RGDP p.c.)	ln (\$1000)	4808	3.87	3.54	2.43	10.47	-4.53
$\Delta\%$ RGDP p.c.	%	4795	1.98	2.07	7.06	139.84	-70.17
ln (Credit)	ln (\$1000)	4065	-3.57	-3.51	1.01	-1.16	-8.53
$\Delta\%$ Credit	%	3998	5.23	2.78	55.15	322.60	-96.73
NPLs to credit	%	2099	7.58	4.87	7.68	74.10	0.01
Public debt to GDP	%	4113	57.64	47.42	48.55	789.83	0.09
Primary balance to GDP	%	4161	-1.99	-1.10	31.28	96.07	-98.78
Sovereign CDS Spreads	bps	646	235.86	121.33	546.56	10037.35	2.08
Investment to GDP	%	4555	23.10	21.68	12.07	339.05	0.04
CPI inflation rate	%	4667	34.16	4.74	244.63	-71.33	7481
Effective interest rate	%	3464	-0.04	-0.03	0.43	24.16	-0.80
Total population	Million	4878	33.13	6.55	125.83	1374.62	0.01
NX to GDP	%	4737	37.46	-0.06	1454.9	64142	-8036
Current account to GDP	%	4620	-7.99	-0.04	157.41	938.3	-6781

Note. Table 1 contains all variable definitions. The resolution costs to GDP ratio is the total fiscal costs on recapitalization, NPLs purchase, and liquidity injections to crisis start year GDP ratio. We use 5 year sovereign CDS spreads in our empirical analyses, and there is neglectable changes if we use 10 year sovereign CDS spreads. The effective interest rate is the difference between real interest rate and real GDP growth rate, which is crucial for the accumulation of a country's debt.

Local Projections of Real GDP p.c. Growth Divergence

Table 3.2: Local Projections of Real GDP p.c. Growth Divergence

Stand-alone banking crises vs. twin banking-fiscal crises					
	(1)	(2)	(3)	(4)	(5)
Years after $T + 3$	Year 1	Year 2	Year 3	Year 4	Year 5
Stand-alone banking crisis (γ^h)	1.07*** (0.19)	4.52*** (0.44)	7.30*** (0.49)	9.87*** (0.74)	14.77*** (0.60)
Twin banking-fiscal crisis ($\gamma^h + \beta^h$)	-1.22*** (0.50)	-0.11 (0.99)	-1.12 (1.13)	0.05 (0.69)	2.39 (2.03)
R^2	0.23	0.23	0.24	0.24	0.23
Observations	147	147	147	147	147

Note. Standard errors (clustered by country) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the cumulative change in the growth difference of real GDP per capita. The growth difference is obtained from the group with high fiscal costs on resolving non-performing loans and the group with low fiscal costs on resolving non-performing loans.

Local Projections of Total Credit Divergence

Table 3.3: Local Projections of Total Credit Divergence

Stand-alone banking crises vs. twin banking-fiscal crises

	(1)	(2)	(3)	(4)	(5)
Years after $T + 3$	Year 1	Year 2	Year 3	Year 4	Year 5
Stand-alone banking crisis (γ^h)	4.92** (2.38)	8.81** (4.44)	19.24*** (5.44)	20.99*** (7.16)	42.20*** (7.96)
Twin banking-fiscal crisis ($\gamma^h + \beta^h$)	-8.27*** (0.62)	-12.2*** (1.97)	-10.45*** (2.96)	-2.79 (4.56)	-17.3*** (3.20)
R^2	0.45	0.31	0.34	0.32	0.38
Observations	147	147	147	147	147

Note. Standard errors (clustered by country) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the cumulative change in the growth difference of total credit. The growth difference is obtained from the group with high fiscal costs on resolving non-performing loans and the group with low fiscal costs on resolving non-performing loans.

Local Projections of Real GDP p.c. Growth Divergence (Continuous Measure)

Table 3.4: Local Projections of Real GDP p.c. Growth Divergence (Continuous Measure)

Stand-alone banking crises vs. twin banking-fiscal crises (continuous fiscal cost measure)					
	(1)	(2)	(3)	(4)	(5)
Years after $T + 3$	Year 1	Year 2	Year 3	Year 4	Year 5
Stand-alone banking crisis (γ^h)	0.25** (0.12)	0.74*** (0.25)	1.36*** (0.45)	1.97*** (0.56)	2.48*** (0.69)
Twin banking-fiscal crisis ($\gamma^h + \beta^h$)	-0.08* (0.04)	-0.11 (0.09)	0.09 (0.23)	0.28 (0.73)	0.89 (1.45)
R^2	0.45	0.48	0.35	0.36	0.41
Observations	147	147	147	147	147

Note. Standard errors (clustered by country) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the cumulative change in the growth difference of real GDP per capita. The growth difference is obtained from two countries with 1 percentage difference in fiscal costs on resolving non-performing loans. In other words, we use a continuous measure of fiscal cost ratio in the local projection regression.

Fiscal Policy Space and Post-Crisis Recoveries (Primary Balance)

Table 3.5: Fiscal Policy Space and Post-Crisis Recoveries (Primary Balance)

	$MC_{i,t-j}$: Sovereign CDS credit spreads				$MC_{i,t-j}$: Loss of market access indicator			
	Fiscal→Banking		Banking→Fiscal		Fiscal→Banking		Banking→Fiscal	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RGDP	Credit	RGDP	Credit	RGDP	Credit	RGDP	Credit
$Twin_i$	-2.53*** (0.65)	-2.94*** (0.67)	-2.50*** (0.72)	-3.20*** (0.86)	-2.27*** (0.53)	-3.80*** (0.92)	-2.49*** (0.68)	-4.12*** (0.41)
$MC_{i,t-1} \times Twin_i$	-0.94*** (0.34)	-1.97*** (0.56)	-0.86** (0.24)	-1.53*** (0.42)	-0.72*** (0.26)	-1.21*** (0.37)	-0.65*** (0.21)	-1.03*** (0.47)
$MC_{i,t-2} \times Twin_i$	-0.21** (0.10)	-0.35*** (0.08)	-0.22 (0.14)	-0.33* (0.18)	-0.15** (0.07)	-0.35** (0.17)	-0.18 (0.25)	-0.22 (0.53)
$FC_{i,t-3} \times Twin_i$	-0.53 (0.96)	-1.78 (1.90)	-0.32 (0.30)	-0.29 (0.72)	-0.23 (0.89)	-0.15 (1.23)	-0.22 (0.23)	-0.79 (0.63)
$FC_{i,t-4} \times Twin_i$	-0.93 (1.36)	0.65 (0.90)	-0.23 (0.29)	-0.88 (0.59)	0.32 (0.92)	-0.77 (0.92)	-0.21 (0.52)	-0.29 (0.46)
Country Controls	✓	✓	✓	✓	✓	✓	✓	✓
Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.05	0.08	0.06	0.08	0.04	0.07	0.04	0.06
Observations	1142	1142	1186	1186	1142	1142	1186	1186

Note. This table reports the regression estimates of the impact of fiscal condition recoveries on output and credit recoveries following banking-fiscal twin crises. Our estimations are based on the following fixed-effects panel regression: $\Delta \log(\% \Delta y_{i,t}) = \alpha_i + \alpha_t + \beta Twin_i + \sum_{j=1}^4 \gamma_j FC_{i,t-j} \times Twin_i + \sum_{j=1}^4 X_{i,t-j} \Gamma_j + \epsilon_{i,t}$, in which α_i and α_t are respectively banking crisis and time fixed effects, $\% \Delta y_{i,t}$ is the percentage change in real GDP p.c. or credit, $Twin_i$ is a twin crisis dummy for the banking crisis i , $FC_{i,t-j}$ measures a country's fiscal conditions (primary balance ratio or distance to debt ceilings) at $t-j$, and $X_{i,t-j}$ includes a vector of control variables mentioned in text. In addition, we consider two subsamples. In the first subsample, we compare the “fiscal-to-banking” type twin crises with stand-alone banking crises. In the second subsample, we compare the “banking-to-fiscal” type twin crises with stand-alone banking crises. Reported R^2 values are from within-country variations. Standard errors (clustered by country) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Bank-Sovereign Nexus and Post-Crisis Recoveries (Public Debt Ratio)

Table 3.6: Bank-Sovereign Nexus and Post-Crisis Recoveries (Public Debt Ratio)

	$FC_{i,t-j}$: primary balance ratio				$FC_{i,t-j}$: distance to debt ceilings			
	Fiscal→Banking		Banking→Fiscal		Fiscal→Banking		Banking→Fiscal	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RGDP	Credit	RGDP	Credit	RGDP	Credit	RGDP	Credit
$Twin_i$	-2.42***	-3.83***	-2.76***	-4.22***	-2.11***	-4.03***	-2.32***	-4.24***
	(0.89)	(0.78)	(0.89)	(1.32)	(0.53)	(0.76)	(0.74)	(0.68)
$FC_{i,t-1} \times Twin_i$	0.83***	1.53***	0.43*	1.22**	0.39**	1.25***	0.24**	1.01*
	(0.27)	(0.43)	(0.28)	(0.57)	(0.19)	(0.47)	(0.11)	(0.57)
$FC_{i,t-2} \times Twin_i$	0.53**	0.82***	0.20	0.53*	0.155**	0.43**	0.23	0.52*
	(0.26)	(0.22)	(0.20)	(0.29)	(0.07)	(0.21)	(0.45)	(0.28)
$FC_{i,t-3} \times Twin_i$	0.33*	1.12**	0.43	0.82	0.14*	0.32	-0.26	0.55
	(0.17)	(0.55)	(0.39)	(0.96)	(0.08)	(0.45)	(0.53)	(0.42)
$FC_{i,t-4} \times Twin_i$	-0.43	0.92	0.35	0.12	0.24	-0.42	0.23	0.22
	(0.31)	(0.56)	(0.82)	(0.45)	(0.20)	(0.53)	(0.43)	(0.34)
Country Controls	✓	✓	✓	✓	✓	✓	✓	✓
Fixed Effect	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.03	0.08	0.03	0.07	0.04	0.08	0.03	0.08
Observations	1142	1142	1186	1186	1142	1142	1186	1186

Note. This table reports the regression estimates of the impact of fiscal condition recoveries on output and credit recoveries following banking-fiscal twin crises. Our estimations are based on the following fixed-effects panel regression: $\Delta \log(\% \Delta y_{i,t}) = \alpha_i + \alpha_t + \beta Twin_i + \sum_{j=1}^4 \gamma_j MC_{i,t-j} \times Twin_i + \sum_{j=1}^4 X_{i,t-j} \Gamma_j + \epsilon_{i,t}$, in which α_i and α_t are respectively banking crisis and time fixed effects, $\% \Delta y_{i,t}$ is the percentage change in real GDP p.c. or credit, $Twin_i$ is a twin crisis dummy for the banking crisis i , $MC_{i,t-j}$ measures a country's market conditions for sovereign bonds issuance (5 year sovereign CDS spreads or loss of market access indicator) at $t - j$, and $X_{i,t-j}$ includes a vector of control variables mentioned in text. In addition, we consider two subsamples. In the first subsample, we compare the “fiscal-to-banking” type twin crises with stand-alone banking crises. In the second subsample, we compare the “banking-to-fiscal” type twin crises with stand-alone banking crises. Reported R^2 values are from within-country variations. Standard errors (clustered by country) in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Bibliography

- [1] **Acharya, Viral, Deniz Anginer, and Joseph Warburton.** 2016. “The End of Market Discipline? Investor Expectations of Implicit Government Guarantees.” Working Paper. NYU Stern.
- [2] **Acharya, Viral, Philipp Schnabl, and Gustavo Suarez.** 2013. “Securitization Without Risk Transfer.” *Journal of Financial Economics* 107 (3): 515-536.
- [3] **Acharya, Viral, Hyun Song Shin, and Tanju Yorulmazer.** 2011. “Crisis Resolution and Bank Liquidity.” *Review of Financial Studies* 24 (6): 2166-2205.
- [4] **Acharya, Viral, and Tanju Yorulmazer.** 2008. “Cash-in-the-Market Pricing and Optimal Resolution of Bank Failures.” *Review of Financial Studies* 21 (6): 2705-2742.
- [5] **Adrian, Tobias, Adam Ashcraft, Hayley Boesky, and Zoltan Pozsar.** 2010. “Shadow Banking.” FRB New York Staff Reports.
- [6] **Adrian, Tobias, and Markus Brunnermeier.** 2016. “CoVaR.” *American Economic Review* 106 (7): 1705-1741.
- [7] **Adrian, Tobias, and Hyun Song Shin.** 2014. “Procyclical Leverage and Value-at-Risk.” *Review of Financial Studies* 27 (2): 373-403.
- [8] **Alter, Adrian, and Andreas Beyer.** 2014. “The dynamics of spillover effects during the European sovereign debt turmoil.” *Journal of Banking and Finance*, 42: 134-153.

- [9] **Ashcraft, Adam, and Til Schuermann.** 2008. "Understanding the Securitization of Subprime Mortgage Credit." Federal Reserve Bank of New York Staff Reports.
- [10] **Baldacci, Emanuele, James McHugh, and Iva Petrova.** 2011. "Measuring Fiscal Vulnerability and Fiscal Stress: A Proposed Set of Indicators." IMF Working Paper.
- [11] **Baldacci, Emanuele, Iva Petrova, Nazim Belhocine, Gabriela Dobrescu, and Samah Mazraani.** 2011. "Assessing Fiscal Stress." IMF Working Paper.
- [12] **Balgova, Maria, Michel Nies, and Alexander Plekhanov.** 2016. "The Economic Impact of Reducing Non-Performing Loans." EBRD Working Paper.
- [13] **Balke, Neele.** 2017. "The Employment Cost of Sovereign Default." Working Paper.
- [14] **Bank of Canada (BoC).** 2016. "Database of Sovereign Defaults, 2016." available via the internet: <http://www.bankofcanada.ca/2014/02/technical-report-101/>.
- [15] **Beers, D. and J. Mavalwalla.** 2016. "Database of Sovereign Defaults." Bank of Canada Technical Report No. 101.
- [16] **Begenau, Juliane, and Tim Landvoigt.** 2017. "Financial Regulation in a Quantitative Model of the Modern Banking System." Working Paper. Harvard Business School.
- [17] **Begenau, Juliane, Saki Bigio, and Jeremy Majerovitz.** 2017. "What Can We Learn from the Financial Flows of the 2008-09 Crisis?" Working Paper. UCLA.
- [18] **Bernardini, Marco, and Lorenzo Forni.** 2017. "Private and Public Debt: Are Emerging Markets at Risk." IMF Working Paper.
- [19] **Bianchi, Javier.** 2016. "Efficient Bailouts?" *American Economic Review* 106 (12): 3607-3659.

- [20] **Bluedorn, John and Daniel Leigh.** 2011. "Revisiting the Twin Deficits Hypothesis: The Effect of Fiscal Consolidation on the Current Account." *IMF Economic Review*. 59(4): 582-602.
- [21] **Bordo, Michael, Christopher Meissner.** 2015. "Fiscal and Financial Crises." NBER Working Paper
- [22] **Bruno, Michael and William Easterly.** 1995. "Inflation Crises and Long-Run Growth." NBER Working Paper.
- [23] **Bruns, Martin and Tigran Poghosyan.** 2016. "Leading Indicators of Fiscal Distress: Evidence from the Extreme Bound Analysis," IMF Working Paper.
- [24] **Caballero, Ricardo, Takeo Hoshi, and Anil Kashyap.** 2008. "Zombie Lending and Depressed Restructuring in Japan." *American Economic Review*. 98 (5): 1943-1997.
- [25] **Catao, Luis, and Gian Milesi-Ferretti.** 2014. "External Liabilities and Crises." *Journal of International Economics*, 94 (1): 18-32.
- [26] **Cerra, Valerie, and Sweta Saxena.** 2008. "Growth Dynamics: The Myth of Economic Recovery." *American Economic Review*. 98(1): 439-457.
- [27] **Chakrabarti, Avik, and Hussein Zeaiter.** 2014. "The Determinants of Sovereign Default: A Sensitivity Analysis." *International Review of Economics and Finance*. 33: 300-318.
- [28] **Checherita-Westphal, Cristina, Alexander Klemm, and Paul Viefers.** 2015. "Governments' Payment Discipline: The Macroeconomic Impact of Public Payment Delays and Arrears." IMF Working Paper.
- [29] **Cooper, Russell, and Kalin Nikolov.** 2017. "Government Debt and Banking Fragility: The Spreading of Strategic Uncertainty." NBER Working Paper.

- [30] **Corsetti, Giancarlo, Keith Kuester, Andre Meier, and Gernot J. Mueller.** 2012. "Sovereign Risk, Fiscal Policy, and Macroeconomic Stability." IMF Working Paper.
- [31] **Cottarelli, Carlo.** 2011. "The Risk Octagon: A Comprehensive Framework for Assessing Sovereign Risks" presented in University of Rome "La Sapienza," January. Available via the internet: www.imf.org/external/np/fad/news/2011/docs/Cottarelli1.pdf.
- [32] **Covitz, Daniel, Nellie Liang, and Gustavo Suarez.** 2009. "The Evolution of a Financial Crisis: Runs in the Asset-Backed Commercial Paper Market." Board of Governors of the Federal Reserve System, Working Paper No. 2009-36.
- [33] **Cruces, Juan, and Christoph Trebesch.** 2013. "Sovereign Defaults: The Price of Haircuts," *American Economic Journal: Macroeconomics*. 5(3): 85-117.
- [34] **Detragiache, Enrica, and Antonio Spilimbergo.** 2001. "Crises and Liquidity: Evidence and Interpretation." IMF Working Paper.
- [35] **Duchin, Ran, and Denis Sosyura.** 2014. "Safer Ratios, Riskier Portfolios: Banks' Response to Government Aid." *Journal of Financial Economics*. 113: 1-28.
- [36] **Eichengreen, Barry, Andrew Rose, and Charles Wyplosz.** 1995. "Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks." *Economic Policy: A European Forum*. 21: 249-296.
- [37] **Eichengreen, Barry, and Ricardo Hausmann.** 1999. "Exchange Rates and Financial Fragility." NBER Working Paper.
- [38] **Farhi, Emmanuel and Jean Tirole.** 2012. "Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts." *American Economic Review* 102 (1): 60-93.
- [39] **Farhi, Emmanuel, and Jean Tirole.** 2016. "Dadly Embrace: Sovereign and Financial Balance Sheets Doom Loops." Working Paper.

- [40] **Fischer, Stanley, Ratna Sahay, and Carlos Vegh.** 2002. "Modern Hyper- and High Inflations." *Journal of Economic Literature*. 40: 837-880.
- [41] **Gandhi, Priyank, and Hanno Lustig.** 2015. "Size Anomalies in U.S. Bank Stock Returns." *Journal of Finance* 70 (2): 733-768.
- [42] **Gelos, Gaston, Ratna Sahay, and Guido Sandleris.** 2004. "Sovereign Borrowing by Developing Countries: What Determines Market Access?" IMF Working Paper.
- [43] **Gennaioli, Nicola, Andrei Shleifer, and Robert W. Vishny.** 2013. "A Model of Shadow Banking." *Journal of Finance* 68 (4): 1331-1363.
- [44] **Gerling, Kerstin, Paulo Medas, Tigran Poghosyan, Juan Farah-Yacoub, and Yizhi Xu.** 2017. "Fiscal Crises." IMF Working Paper.
- [45] **Ghosh, Atish, and Uma Ramakrishnan.** 2006. "Do Current Account Deficits Matter?" *Finance and Development*: 43(4).
- [46] **Gorton, Gary, and Andrew Metrick.** 2012. "Securitized Banking and the Run on Repo." *Journal of Financial Economics* 104 (3): 425-451.
- [47] **Gorton, Gary, and Lixin Huang.** 2004. "Liquidity, Efficiency, and Bank Bailouts." *American Economic Review* 94 (3): 455-483.
- [48] **Gourinchas, Pierre-Olivier, and Maurice Obstfeld.** 2012. "Stories of the Twentieth Century for the Twenty-First." *American Economic Journal: Macroeconomics*, 4 (1): 226-265.
- [49] **Guscina, Anastasia, Malik Sheheryar, and Michael Papaioannou.** 2017. "Assessing Loss of Market Access: Conceptual and Operational Issues." IMF Working Paper.

- [50] **Hett, Florian, and Alexander Schmidt.** 2017. “Bank Rescues and Bailout Expectations: The Erosion of Market Discipline During the Financial Crisis.” *Journal of Financial Economics*, Forthcoming.
- [51] **Huang, Ji.** 2016. “Banking and Shadow Banking.” 2016. Working Paper. National University of Singapore.
- [52] **Huang, Ji.** 2017. “A Tale of Two Items Sent Off Balance Sheet: Securitization and Loan Commitment.” Working Paper. National University of Singapore.
- [53] **IMF,** 2018. “Capitalizing on Good Times.” *Fiscal Affairs Department Fiscal Monitor*.
- [54] **IMF.** 2015a. ”The Commodities Roller Coaster-A Fiscal Framework for Uncertain Times.” *Fiscal Monitor*, October 2015.
- [55] **IMF.** 2015b. ”The Fund’s Lending Framework and Sovereign Debt-Further Considerations.” *MCM Board Paper*.
- [56] **IMF,** 2015c. “Now is the Time: Fiscal Policies for Sustainable Growth.” *Fiscal Affairs Department Fiscal Monitor*.
- [57] **IMF.** 2014, ”From Banking to Sovereign Stress: Implications for Public Debt.” *MCM Board Paper*.
- [58] **IMF.** 2011. ”Shifting Gears: Tackling Challenges of the Road to Fiscal Adjustment.” *Fiscal Monitor*, April 2011.
- [59] **Ivashina, Victoria, and David Scharfstein.** 2010. “Bank Lending During the Financial Crisis of 2008.” *Journal of Financial Economics*. 97: 319-338.
- [60] **Jimenez, Gabriel, Steven Ongena, Jose-Luis Peydro, and Jesus Saurina.** 2012. “Credit Supply and Monetary Policy. Identifying the Bank Balance-Sheet Channel with Loan Applications.” *American Economic Review* 102 (5): 2301-2326.

- [61] **Jimenez, Gabriel, Steven Ongena, Jose-Luis Peydro, and Jesus Saurina.** 2014. “Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?” *Econometrica* 82 (2): 463-505.
- [62] **Jorda, Oscar.** 2005. “Estimation and Inference of Impulse Responses by Local Projections.” *American Economic Review* 95 (1): 161-182.
- [63] **Jorda, Oscar, Moritz Schularick, and Alan Taylor.** 2015. “Sovereigns Versus Banks: Credit, Crises, and Consequences.” *Journal of European Economic Association*, 14 (1): 45-79.
- [64] **Kacperczyk, Marcin, and Philipp Schnabl.** 2010. “When Safe Proved Risky: Commercial Paper during the Financial Crisis of 2007-2009.” *Journal of Economic Perspectives* 24 (1): 29-50.
- [65] **Kacperczyk, Marcin, and Philipp Schnabl.** 2013. “How Safe are Money Markets Funds?” *Quarterly Journal of Economics* 128 (3): 1073-1122.
- [66] **Kaminsky, Graciela and Carmen Reinhart.** 1999. “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems.” *American Economic Review* 89(3): 473-500.
- [67] **Kalantzis, Yannick, Romain Ranciere, and Aaron Tornell.** 2015. “Asset Price Support Policy During Crises: How Aggressive Should it Be?” Working Paper. UCLA.
- [68] **Kelly, Bryan, Hanno Lustig, and Stijn Van Nieuwerburg.** 2016. “Too-Systemic-to-Fail: What Option Markets Imply about Sector-Wide Government Guarantees.” *American Economic Review* 106 (6): 1278-1319.
- [69] **Khan, Mohsin and Abdelhak Senhadji.** 2001. “Threshold Effects in the Relationship Between Inflation and Growth.” IMF Working Paper.

- [70] **Khwaja, Asim, and Atif Mian.** 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *American Economic Review*. 98 (4): 1413-1442.
- [71] **Kose, Ayhan, Sergio Kurlat, Franziska Ohnsorge, and Naotaka Sugawara.** 2017. "A Cross-Country Database of Fiscal Space." World Bank Policy Research Working Paper.
- [72] **Laeven, Luc, and Fabian Valencia.** 2012. "Systemic Banking Crises Database; An Update." IMF Working Paper.
- [73] **Laeven, Luc, and Fabian Valencia.** 2008. "Systemic Banking Crises: A New Database." IMF Working Paper.
- [74] **Loutskina, Elena.** 2011. "The Role of Securitization in Bank Liquidity and Funding Management." *Journal of Financial Economics* 100 (3): 663-684.
- [75] **Manasse, Paolo, Nouriel Roubini, and Axel Schimmelpfennig.** 2003. "Predicting Sovereign Debt Crises." IMF Working Paper.
- [76] **Mauro, Paolo.** 2011. *Chipping away at Public Debt* (Hoboken: Wiley & Sons, Inc.).
- [77] **O'Connor, James.** 1973. *The Fiscal Crisis of the State* (New York: St. Martin's Press).
- [78] **Parlour, Christine, and Guillaume Plantin.** 2008. "Loan Sales and Relationship Banking." *Journal of Finance* 63 (3): 1291-1314.
- [79] **Pennacchi, George.** 1988. "Loan Sales and the Cost of Bank Capital." *Journal of Finance* 43 (2): 375-396.
- [80] **Philippon, Thomas.** 2015. "Has the US Finance Industry Become Less Efficient? On the Theory and Measurement of Financial Intermediation." *American Economic Review* 105 (4): 1408-1438.

- [81] **Piazzesi, Monika, and Martin Schneider.** 2006. "Equilibrium Yield Curves." NBER Working Paper.
- [82] **Plantin, Guillaume.** 2015. "Shadow Banking and Bank Capital Regulation." *Review of Financial Studies* 28 (1): 146-175.
- [83] **Purnanandam, Amiyatosh.** 2011. "Originate-to-distribute Model and the Subprime Mortgage Crisis." *Review of Financial Studies* 24 (6): 1881-1915.
- [84] **Ranciere, Romain, Aaron Tornell, and Frank Westermann.** 2008. "Systemic Crises and Growth." *Quarterly Journal of Economics* 123 (1): 359-406.
- [85] **Ranciere, Romain, and Aaron Tornell.** 2011. "Was the US Crisis a Financial Black-Hole?" *IMF Economic Review* 59 (2): 271-305.
- [86] **Ranciere, Romain, and Aaron Tornell.** 2016. "Financial Liberalization, Debt Mismatch, Allocative Efficiency, and Growth." *American Economic Journal: Macroeconomics* 8 (2): 1-44.
- [87] **Reinhart, Carmen and Kenneth Rogoff.** 2011a. "From Financial Crash to Debt Crisis." *American Economic Review* 101(5): 1676-706.
- [88] **Reinhart, Carmen and Kenneth Rogoff.** 2011b. "The Forgotten History of Domestic Debt." *Economic Journal* 121 (552): 319-350.
- [89] **Reinhart, Carmen and Kenneth Rogoff.** 2009. *This time is different: Eight centuries of financial folly* (Princeton, NJ: Princeton University Press).
- [90] **Romer, Christina and David Romer.** 2017. "Why some times are different: Macroeconomic policy and the aftermath of financial crises." NBER Working Paper
- [91] **Romer, Christina, and David Romer.** 1989. "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz." *NBER Macroeconomics Annual*, 4: 121-170.

- [92] **Schneider, Martin, and Aaron Tornell.** 2004. "Balance Sheet Effects, Bailout Guarantees and Financial Crises." *Review of Economic Studies* 71 (3): 883-913.
- [93] **Schularick, Moritz, and Alan Taylor.** 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008." *American Economic Review*, 102 (2): 1029-1061.
- [94] **Shin, Hyun Song.** 2009. "Reflections on Northern Rock: The bank run that heralded the global financial crisis." *Journal of Economic Perspectives* 23: 101-120.
- [95] **Sturzenegger, Federico and Jeromin Zettelmeyer.** 2006. *Debt Defaults and Lessons from a Decade of Crises* (Cambridge: MIT Press).
- [96] **Trebesch, Christoph and Michael Zabel.** 2017. "The output cost of hard and soft sovereign default." *European Economic Review*, vol. 92: 416-432.
- [97] **Tsemelidakis, Zoe, and Robert Merton.** 2013. "The Value of Implicit Guarantees." Working Paper. University of Oxford.