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Essays on the Composition and Quality of Banks' Assets

Essays on the Composition and Quality of Banks' Assets

By

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Abstract

The past decade changed how we perceive the risks connected with the composition of bank's assets and their quality. This thesis provides insights into two topics that gained prominence during this period, namely the sovereign debt and non-performing loans.

The second chapter investigates the role of country characteristics as the determinants of banks' sovereign debt exposures. It finds that banks' sovereign debt exposures are related to the quality of political institutions, monetary policy framework, ownership structure of banking sector, regulatory and supervisory environment; even after controlling for differences in wealth across countries. The banks overexposed to the sovereign risk are found to increase the cost of banking crisis, create a potential bank-sovereign nexus and contract credit supply during recessions.

The third chapter presents stylised facts about the episodes of high non-performing loans (NPLs) and policies deployed to reduce NPLs. It provides insights on the effectiveness of different policy packages dealing with NPLs at a country-level and uses an event study methodology to evaluate the impact of reducing the bad debt burden on subsequent economic performance. We provide evidence that a combination of the establishment of asset management companies (AMCs) and government bailout of ailing banks is the most effective approach to resolving an average NPL crisis. Once a sharp reduction in NPL ratios occurs, economic growth improves by more than 1.5 percentage points a year over several years. This is reflected in higher investment and consumption growth and lower unemployment rate.

The fourth chapter investigates the question of cross-border spillovers from reducing non-performing loans. The global banking system is a complex network of foreign subsidiaries that facilitates spillover of risks. We exploit this multinational dimension to investigate the importance of credit risk transmission. Firstly, we show that changes in the NPL stock of a parent bank affect the non-performing exposures of its foreign subsidiary banks. Secondly, as a result of this transmission, policies aimed at reducing NPLs can have detectable cross-border effects. We find that in particular the establishment of asset management companies (AMCs) in the jurisdiction of parent bank has a positive effect on the NPLs reduction of the foreign subsidiaries; where the estimated treatment effect is a 12 percent decline in the stock of non-performing loans.

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Marta Skrzypińska

Author's declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: Marta Skrzypińska ..... DATE: 21st October 2019

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Chapter 1

Introduction

The global financial crisis of 2007 and the subsequent Eurozone sovereign debt crisis had not only major consequences for the global economic performance but also revealed a large gap in our understanding of financial intermediation. Such extreme events may happen relatively rarely but allow the academic community to re-evaluate the underlying fundamental theories and raise a number of important research questions. This thesis addresses two topics that gained more prominence in the aftermath of the aforementioned crises.

Firstly, this thesis explores the topic of interconnectedness between banking and sovereign risk. Some observers have suggested that the Eurozone debt crisis has been particularly severe and difficult to resolve because of the institutional characteristics of the monetary union. Indeed, this thesis provides evidence that the strength of political and economic institutions may nudge banks to increase their exposure to sovereign debt and in turn affect aggregate credit conditions.

Secondly, over a decade since the two major global crises, balance sheets of banks in many advanced economies and emerging markets remain clogged by non-performing loans, often also referred to as toxic, bad or impaired. The persistence of bad loans has brought it to the forefront of the political debate, with countries around the world implementing various policy packages. Despite the importance of non-performing loans and the potential costs to the taxpayers of addressing this problem, there remains a large literature gap that this thesis aims to address.

This thesis is a collection of three essays on the two aforementioned topics, which gained importance in the past decade. Importantly, this work takes a global perspective on the issue of bank's sovereign bondholdings and non-performing loans in contrast to a vast majority of related literature. Due to the importance of Eurozone in the global economy and data availability, most studies exploring the topic of bank's exposures to sovereign risk focus on the

countries that were the most affected, during the 2010-2012 episode, such as Greece, Spain or Italy. Similarly, prior research on non-performing loan exposures typically explores particular events of sudden increases in toxic assets in case study settings. As the three chapters of this thesis demonstrate, the experience of European countries in the past ten years is by no means unique from a global perspective and there are important lessons to be learned from taking a more holistic view of these two issues in banking regulation.

The first essay investigates the role of country characteristics as the determinants of banks' sovereign debt exposures. It finds that banks' sovereign debt exposures are related to the quality of political institutions, the monetary policy framework, the ownership of banking sector, the regulatory and supervisory environment; even after controlling for differences in wealth across countries. Excessive bank exposures to the sovereign risk are found to increase the cost of banking crisis and create a potential bank-sovereign nexus. Furthermore, the chapter explores more granular data and finds that banks with large sovereign bondholdings contract credit supply more during recessions, thus also further exacerbating the economic growth. However, bank supervisory power can to some extend reduce this procyclicality. The chapter provides insight into the potential effectiveness of various policies to prevent or break the vicious sovereign-bank feedback loop.

The second essay presents stylised facts about the episodes of high non-performing loans (which in the remainder of this work will be referred to as NPLs for short) since 1990, in a large global sample, as well as about policies deployed to reduce NPLs. This chapter takes a two stage approach: (i) it provides insights on the effectiveness of various policies dealing with NPLs and (ii) it uses an event study methodology to evaluate the impact of reducing the bad debt burden on economic performance. It relies on novel dataset combining prior work on financial sector bailouts, deployment of asset management companies, use of macroprudential policies with hand-collected data on policy actions. The paper finds that a combination of the establishment of asset management companies (AMCs) and government bailout of ailing banks is the most effective approach to resolving an average NPL crisis. The analysis reveals a complex nature of interactions between sovereign bond holdings and effectiveness of policies

aimed at reducing NPLs, especially in the case of government bailouts of ailing banks. A typical policy-assisted NPL reduction episode starts with a sudden decline in stock of NPLs and is followed in the subsequent years with a revival of the credit growth. Once a steep drop in NPLs occurs, economic growth improves by more than 1.5 percentage points a year over several years. This is reflected in higher investment and consumption growth and lower unemployment rate.

The third essay seeks to answer the question of cross-border spillovers from reducing non-performing loans. The global banking system is a complex network of foreign subsidiaries that facilitates spillover of risks. We exploit this multinational dimension to investigate the importance of credit risk transmission. Firstly, this chapter documents how changes in the NPL stock of a parent bank affects the behaviour of its foreign subsidiary banks and presents evidence that this transmission is driven by the workings of internal capital markets, application of consolidated supervision principle and knowledge transfers. Secondly, as a result of this transmission, policies aimed at reducing NPLs can have detectable cross-border effects. We find that in particular the establishment of asset management companies (AMCs) in the jurisdiction of parent bank has a positive effect on the NPLs reduction of the foreign subsidiaries; where the estimated effect is a 12 percent decline in the stock of non-performing exposures as compared to control banks. The results are highly relevant for the ongoing debate in the EU on the establishment of a potential pan-European AMC, suggesting that the returns to such policy action may be bigger than previously thought - on account of the positive cross-border spillovers.

This thesis is structured as follows. Chapter 2 covers the topic of bank's exposure to sovereign bondholdings and institutional characteristics, Chapter 3 introduces the topic of non-performing loans at a macro-level and analyses the economic costs of legacy problem loans and effectiveness of policies used to address the NPLs. Chapter 4 covers in more detail the non-performing loan problem from the perspective of individual banks and with a focus on the interconectedness of global banking networks. Chapter 5 summarises the main results, sets out policy implications, limitations of the research and lists avenues for future work.

Chapter 2

Determinants and Consequences of Banks' Sovereign Debt Exposure:

The Role of Country Characteristics

Abstract

This paper studies the determinants and consequences of banks' sovereign debt holdings in a cross-country setting, including both developed and developing countries. Banks tend to have large exposures to domestic government debt, which can reinforce the sovereign-bank nexus. We find that the quality of political institutions, monetary policy framework, ownership structure of the banking sector, regulatory and supervisory environment are all related to banks' sovereign debt exposure, even after controlling for, among other factors, differences in income across countries. We also find that during recessions banks with larger exposures lend less. Importantly, bank regulation and supervision are correlated with both sovereign debt exposure, and the extent to which bank loan growth is slower for banks with large exposures. Our results inform about the potential effectiveness of various policies to prevent and/or break the sovereign-bank nexus.

Keywords: government bonds, sovereign-bank nexus, bank lending, bank regulation

JEL codes: F3, G15, G21, G28, H63

2.1. Introduction

Banks' domestic sovereign debt exposures have been identified as a significant source of instability during the European sovereign debt crisis[1]. Such exposures tighten the link between bank and sovereign solvency by creating large (realized or unrealized) losses for banks when government default risk increases. Additionally, some observers have suggested that the crisis has been particularly severe and difficult to resolve in the Euro-zone because of institutional characteristics of the monetary union. Specifically, political factors, the conduct of monetary policy, a fragmented banking sector and a lack of adequate bank regulation and supervision might have made breaking out of the bank-sovereign feedback loop especially difficult.

A less transparent and accountable government might use their power to influence banks to hold more sovereign debt[2]. During crises, ineffective governance and political instability may further defer the resolution of a sovereign-banking crisis, as the experience in Greece suggests (both domestic political factors and the difficulties to negotiate with other Euro-zone members). Similarly, the lack of independent monetary policy might have contributed to the sovereign debt crisis in certain Euro-zone countries, because these countries could not rely on inflationary/expansionary policies to manage their sovereign debt.

Third, the European banking sector is highly fragmented, consisting of mainly national banking systems, making it relatively costly for any government to default on their debt, given the domestic banking sector's large exposure to government debt. Finally, the lack of effective and coordinated European bank supervision[3], and in particular bank resolution framework, made it difficult to deal with insolvent banks, which were then unable to sufficiently support the economy.

In this paper we study the relationship between the banks' sovereign debt exposures and country-level institutional characteristics[4]; and their effect on the cost of banking crises and

[1]Becker and Ivashina (2018); Popov and Van Horen (2015); Acharya et al. (2016)

[2]Becker and Ivashina (2018); De Marco (2018); Langfield and Pagano (2015); Horváth et al. (2015); Ongena et al. (2016)

[3]Prior to the establishment of the Single Superisory Mechanism in 2014.

[4]Those institutional characteristics are grouped in four categories: political institutions, monetary policy and regime, structure of banking sector and supervisory power

bank lending. While there are several papers analysing the causes and consequences of banks' sovereign debt exposures, most of these papers study European banks during the sovereign debt crisis. Since there is little variation in many of these key country characteristics within Europe, one has to rely on a larger sample of countries to study their roles in the sovereign-bank nexus. Surprisingly, there is little evidence about banks' sovereign debt exposures in a cross-country setting including both advanced and emerging markets. In this paper we aim to fill this gap by studying a large, global sample of banks.

Our main findings are as follows. Using country-level regressions we find that all four groups of country characteristics are correlated with banking sector's exposures to sovereign debt. In particular, using regressions including both emerging and advanced countries, we find that the quality of political governance, as proxied by the World Governance Index (WGI), is negatively correlated with banking sector's government bond holdings after controlling for, among factors, economic development (measured by GDP per capita). This is consistent with governments using their power to nudge banks to buying domestic sovereign debt especially when government accountability and transparency is relatively low. Interestingly, the correlation between WGI and banking sectors' bond holdings is positive among emerging countries after controlling for all the other country characteristics we study, suggesting that a marginal improvement in the quality of governance might improve governments ability to influence banks' portfolio decisions.

Among the other country characteristics, capital controls and supervisory power are the only variables, that robustly predict banks' bond holdings, after controlling for WGI, across developing and advanced countries. Banks in countries with capital controls might be more exposed to sovereign debt (as the regressions suggest), because they are less able to diversify their investments and choose to hold relatively more safe assets, or because of a potentially lower availability of alternative high quality securities. In addition, having strong supervisors in a country might be positively correlated with bond holdings (again, consistent with the evidence), if governments rely on supervisors to exert their power to cajole banks' into buying government debt.

The next set of our results is related to the cost of banking crises. Large sovereign debt

portfolios, especially if they consist mostly of domestic government debt, create a potential negative feedback loop between bank and government solvency: The failure of domestic banks endangers government solvency, because of explicit and implicit bailout guarantees, which in turn lowers the value of banks' government bonds, exacerbating the initial problems in the banking sector. We find only weak support for this channel from regressions of GDP losses and fiscal costs of banking crises on measures of banks' (domestic) sovereign debt exposure. In addition, we do not find robust results for the role of country characteristics in the relationship between the cost of banking crises and sovereign debt exposure.

The last set of regressions relate bank-level loan growth to bank's bond holdings, its interactions with country characteristics and variables capturing macroeconomic recessions and sovereign defaults. Confirming our expectations, we find that bond holdings are negatively correlated with loan growth in years of a downturn or a sovereign default, consistent with banks experiencing higher funding costs due to their holdings of government bonds. In addition, supervisory power dampens this relationship, possibly because strong supervisors curb bank risk-taking and mitigate the effect of bond holdings on funding costs; while activity restrictions and capital constraints reinforce the negative relationship between bond holdings and loan growth during downturns, possibly by tightening capital constraints and restricting banks' possibilities to diversify their risks.

Our results have to be interpreted with caution. In particular, we do not exploit exogenous shocks in bank sovereign debt holdings, and as a result, we cannot confidently claim that all of our results reflect causal effects, despite our efforts to tackle various endogeneity concerns. Nonetheless, our results are useful in identifying possible policies that can be used to break the bank-sovereign nexus. In particular, supervisory power is a robust predictor of exposure, as well as a factor that influences the relationship between loan growth and bond holdings, and as such it highlights bank supervisors' role in mitigating the risks associated with banks' sovereign debt exposures.

We contribute to a recent literature on the causes and consequences of the home bias in banks' government debt portfolios. Several papers test the main theories behind the home bias

using European data. Some papers[5] find evidence for governments actively persuading banks to buying domestic sovereign debt (moral suasion). Others[6] find support for banks voluntarily exposing themselves to sovereign default risk anticipating that the cost of default would be borne by bank debt holders and/or (possibly foreign) taxpayers (risk shifting). Becker and Ivashina (2018); Acharya et al. (2016); Popov and Van Horen (2015) show that banks exposed to the debt of ailing Euro-zone countries reduced their lending during the European sovereign debt crisis more. All of these papers, however, use European data. We thus contribute to this strand of the literature by studying sovereign debt exposure on a sample that includes a much wider set of countries.

The most closely related papers to ours are Gennaioli et al. (2014) and Gennaioli et al. (2018). Gennaioli et al. (2014) use country-level data and find evidence for a decline in private credit to GDP following a government default in countries where banks hold more sovereign debt on a sample that includes both developed and developing countries. Gennaioli et al. (2018) find additional evidence of a relatively large decline in lending for banks exposed to government debt using bank level data, also in a global sample. We add to these papers by systematically studying the roles of country characteristics as both determinants, and as factors that influence the effect of bond holdings on bank lending.

We proceed in the next section by summarising the literature on banks' sovereign debt holdings. In Section 2.3 we describe how various country characteristics might influence banks' incentives to hold (domestic) sovereign debt, and how these factors might strengthen or weaken the relationship between government bond holdings and loan growth during recessions and sovereign default. In the same section we also describe the data we use. In Section 2.4 we presents the main results and in Section 2.6 we provide a discussion of the main results and conclude.

[5]Becker and Ivashina (2018); De Marco (2018); Langfield and Pagano (2015); Horváth et al. (2015); Ongena et al. (2016)

[6]Acharya and Steffen (2015); Acharya et al. (2016); Drechsler et al. (2016); Horváth et al. (2015)

2.2. Literature Review

Standard portfolio management theory suggests that an investor is best protected against an idiosyncratic risk by holding a diversified portfolio of assets. Bank managers and risk officers are responsible for diversifying away the idiosyncratic risk in their equity, loan or derivative portfolios. Despite of this, it is still very common to hold sovereign debt of only one country, the one where the bank is located in. The standard finance literature often assumes that sovereign debt is virtually risk-free and can act as a storage technology while delivering the "*risk free*" return. Perhaps the chronic underdiversification of the sovereign debt portfolio can be attributed to this common simplifying assumption, therefore not requiring diversification or active risk management on the side of bank managers. This assumption does not allow to study the effects of the sovereign-bank interconectedness and therefore it is abandoned for the purpose of this thesis.

There are two sources of incentive distortion - banks and government. This section begins with detailed theoretical and empirical discussion of the prior research on risk shifting and moral suasion channels. It then proceeds to explain the theoretical mechanism behind the negative feedback loop between banks and sovereigns and presents the empirical consequences of large domestic sovereign debt exposures for the macroeconomy and in particular lending activity.

2.2.1. Risk Shifting

The classical asset substitution problem occurs when managers invest in a high-risk project that will yield returns for shareholders and transfer the risk to debt holders. Highly-levered firms are particularly prone to this type of agency cost (Jensen and Meckling, 1976). This is especially true in financial industry, where banks tend to have high leverage while debt holders and depositors bear the majority of downside risk. From the perspective of bank equity holders, risky domestic sovereign debt delivers relatively high return without increasing substantially the probability of default. Since the original exposures to domestic government are relatively high, sovereign default would inevitably lead to banks insolvency in any case. Therefore, large

domestic debt exposure increases loss given sovereign default but not the probability of bank's insolvency. It is a voluntary profit-maximising strategy pursued by banks.

Diamond and Rajan (2011) claim that banks may intentionally synchronise their default with the domestic sovereign to ensure bailout especially if corporate governance is shareholder friendly (Horváth et al., 2015). There are number of papers that give further empirical support to the risk shifting theory. Acharya and Steffen (2015) show that European banks in 2007-2012 undertook on a large scale carry trades, by taking long position in risky peripheral sovereign bonds and shorting safer German bunds, effectively betting on the EU's economic convergence. When the spread between the peripheral and the EU core sovereign bonds persisted for longer than expected, banks realised losses on both legs of the trade. They show that this behaviour was particularly strong for banks with large risk shifting incentives, ie. banks with high leverage.

Acharya et al. (2016) show that mainly weakly-capitalised banks with low credit ratings engaged in such behaviour which contributed to the severity of the crisis. Battistini et al. (2013) show that peripheral banks in response to the rise in the country-idiosyncratic risk increased their exposures to domestic sovereign debt which is consistent with both risk shifting and moral suasion theories, thanks to the zero-risk weights.

2.2.2. Moral suasion

In contrast to voluntary asset substitutions, an under-diversified portfolio can be a result of government political pressure on banks to load on domestic sovereign debt. In return the government can offer implicit bail-out guarantees, lenient regulation or preferential access to short-term liquidity funding.

Banks with majority government ownership, ex-politicians appointed as board members or banks with prior experience of bailout intervention are more likely to increase their sovereign exposures than other banks (De Marco, 2018; Ongena et al., 2016; Langfield and Pagano, 2015; Becker and Ivashina, 2018). De Marco and Macchiavelli (2015) find that especially true for the GIIPS countries because they are more responsive to political nudging. Our contribution is to find the reason why some countries are more likely to experience moral suasion or risk shifting, while others are more immune to it at an aggregated level.

Moral suasion is reported to be particularly strong when government has the need to rollover large amounts of maturing debt (Ongena et al., 2016). Asonuma et al. (2015) give evidence that governments may in fact benefit from pursuing such strategy, because it reduces the costs of borrowing and allows the government to issue more central debt, both in advanced and emerging countries without significantly increasing service costs. Such myopic behaviour can cause negative long-term consequences due to unsustainable debt levels and is rarely internalised due to political cycles. Ongena et al. (2016) also document strategic government targeting of weaker and government-owned banks in their moral suasion policy.

Both risk shifting and moral suasion are possible because of the zero risk weight attached to any sovereign bonds, even those with sub-investment rating, regardless of country's credit rating. Therefore, banks are allowed to invest in sovereign bonds without the need to put aside additional capital reserves. If we consider the case when sovereign risk is elevated, the return on such bonds can prove to be an attractive investment, in comparison with the standard bank activities such as loan-granting; thus creating regulatory arbitrage opportunity (see for example discussion of carry-trades during the Eurozone debt crisis by Acharya and Steffen 2015).

Under Basel III regulation banks not only can invest in sovereign bonds without putting aside capital reserves (thanks to zero-risk weights) but also are actively encouraged to hold such assets for the purpose of liquidity management. Banks are required to hold sufficient stock of high quality liquid assets (HQLA) to cover 100% of 30 day total net cash outflows[7] to promote the short-term resilience to funding shocks. Even though Basel III specifies that the stock of HQLA should be well diversified within different asset classes, the regulation gives a specific exception for "*sovereign debt of the bank's home jurisdiction or from the jurisdiction in which the bank operates, central bank reserves, central bank debt securities, and cash*". This adds a secondary regulatory arbitrage motive to banks, as sovereign bonds can help to ease both liquidity and capital requirement constraints[8].

An alternative to moral suasion would be if a government pressured banks to increase lending to domestic small and medium enterprises (SME) and households, however this would

[7]HQLA requirement was gradually phased in to reach 100% in 2019.

[8]Details on the HQLA regulation can be found at BIS website http://www.bis.org/publ/bcbs238.pdf

involve additional RWA capital on part of banks. Gropp et al. (2014) shows that bailout guarantees in Germany were associated with inefficient allocation of credit and larger risk-taking incentives of banks, thus it can be particularly hard to disentangle the two channels.

2.2.3. Consequences

The most important real consequence of the sovereign bank nexus is a credit crunch. The higher the share of domestic bondholdings, the less credit is supplied to the economy. If private credit markets were frictionless, the sovereign bonds acquired by domestic banks could be financed by borrowing from foreign creditors. As a result, purchases of government debt by domestic creditors replace the investment in productive sector and is referred to as the *crowding-out* effect (Broner et al., 2013). Becker and Ivashina (2018); De Marco (2018); De Marco and Macchiavelli (2015); Asonuma et al. (2015); Ongena et al. (2016); Gennaioli et al. (2014) and Bocola (2016) all report that increased government bond holdings contributed to a crowding-out effect of corporate lending. Productive firms can try to substitute bank lending with corporate bonds, however, the condition of credit markets is also likely to be negatively influenced by the sovereign risk. The literature consensus is that in times of heightened sovereign risk, bank lending contracts more when bank's are heavily exposed to sovereign bonds.

Acharya et al. (2016) show that the unbalanced sovereign debt portfolio has broader macroeconomic consequences as it negatively affects also investment spending, job creation and sales growth of firms affiliated with home-biased banks mainly through the risk shifting channel. Since the banking sector is highly connected, and when banks engage in similar behaviour it can also increase the systemic risk (Langfield and Pagano, 2015). All of those knock-on effects lead to potentially a long-term deterioration of economic growth prospects and distortions in capital allocations, especially in countries with limited access to credit markets, for example in developing countries, or with traditionally high bank dependence, as for example in Europe.

The previously mentioned empirical literature is also supported by Chari et al. (2018), who propose a theoretical model showing that moral suasion is never optimal from the perspective of a forward-looking government pursuing commitment strategy, because binding collateral constraints on banks mean that there will necessarily be crowding-out of lending. Uhlig (2013)

argues that regulators in risky countries have an incentive to allow their banks to hold domestic risky bonds, while regulators in other "safe" countries will impose tighter regulation.

This paper is also related to the literature on institutional quality and development. Institutions are important because they shape the incentives of key economic agents and they help to allocate resources to their most efficient uses. They traditionally determine economic outcomes such as distribution of income, physical and human capital, etc. (Acemoglu et al., 2005). Here in particular we are interested in how institutional quality affects the incentives of bankers to shift risk and incentives of government to financially repress banks. The two determine the transmission of risk in the economy, the probability and severity of financial crisis as well as lending activity. We can differentiate between political and economic institutions. Both banks and governments have incentives to engage in home bias, this chapter investigates whether high institutional quality allows them to act upon those distorted incentives.

Some researcher papers have looked at how selected institutional characteristics affect home bias but none of them focused on this point from a more systematic perspective. Gennaioli et al. (2014) examined empirically the importance of creditor rights, Horváth et al. (2015) investigated the role of shareholders rights, Uhlig (2013) focused on the regulatory power in a theoretical setting and a few other papers studied the role of the ownership structure of banking sector and the political connections of bank's board members. Our contribution to the literature is to combine this varied literature in a systematic study of economic and political institutions role for the bank's sovereign bondholdings choice and credit growth in a global setting to allow policy evaluation.

2.2.4. Sovereign-bank feedback loop

Home bias distorts the incentives of banks in structuring the socially optimal sovereign bond portfolio. This overexposure in turn transmits sovereign risk shocks to banks and vice versa. A negative sovereign risk shock, for example due to unanticipated credit rating cut, is instantly acknowledged by the active secondary market. The new information is reflected in a lower price of domestic bonds that are held by home-biased banks. This happens because in an event of default only part of the bad debt will be recoverable due to the costly state verification

that is associated with legal and financial fees (Townsend, 1979). The marked-to-market value of banks' assets decline leading to the reduction in required capital ratio as depicted by the schematic representation of nexus in Figure 2.1.

[Insert Figure 2.1]

In order to meet the Basel III capital regulation banks may need to deleverage by cashing some of the assets in a fire-sale. The additional consequence of deleveraging could be a contraction of credit supply. Banks following deleveraging losses will curtail their lending activity due to precautionary motives, therefore leading to spillover effects to the non-financial sectors. Since the fire-sales are associated with haircuts it will feed back into lower price of bonds and higher bond yields. This in turn means that government will find it more expensive to service the rolled-over debt or in extreme circumstances may not be able to issue new debt at all. This cycle is repeated and can amplify significantly the initial shocks to either sovereigns or the banks.

As the vicious cycle continues, the weakening financial position of banks can trigger any implicit or explicit bail-out costs, hence further undermining the fiscal position of government, pushing cost of public debt up and potentially forcing cuts in public spending. Gennaioli et al. (2014) propose a model of costly non-discriminatory government default that causes spillover effects to the domestic banking sector and show that large exposure to domestic sovereign debt indeed leads to a credit crunch. This amplification cycle is similar to the financial accelerator mechanism in the dynamic stochastic general equilibrium type of models even though they do not model the over-exposure phenomenon explicitly (Christiano et al., 2010; Del Negro et al., 2014; Gilchrist et al., 2014).

2.3. Hypotheses and data

In this section we discuss our main hypotheses and describe the data we use. We start by describing the potential roles that political institutions, the monetary policy framework, the ownership structure of the banking sector and bank regulation and supervision play in banks' demand for sovereign debt and in influencing the effect of bond holdings on credit growth and cost of banking crises. We then proceed to describe our measures of banks' sovereign debt exposures, and finally, the economic outcome variables, such as credit growth and the output and fiscal costs of banking crises.

2.3.1. The role of country characteristics

Our starting point is two findings by prior studies: (i) banks tend to hold more (domestic) sovereign debt in developing and riskier countries (Gennaioli et al., 2014) and in countries where government ownership of banks is higher (Gennaioli et al. 2018 and De Marco and Macchiavelli 2015) and (ii) banks' sovereign debt exposures have a negative impact on bank lending following a sovereign default (De Marco, 2018; Gennaioli et al., 2014, 2018).

We build our hypotheses around these findings. The first set of our hypotheses thus relates to whether country characteristics in addition to controls for country risk can explain banks' sovereign debt holdings at a country-level. The second set of hypotheses is about the relationship between these country characteristics and the relationship between banks' sovereign debt exposure and their lending behaviour during economic slowdowns and the effectiveness of (banking) crisis resolution. We group the country characteristics in four categories: (i) political institutions, (ii) monetary policy, (iii) ownership structure of banking sector and (iv) regulation and supervision.

First, we study the role of political institutions as a determinant of banks' exposure to domestic sovereign debt. In countries where the rule of law is stronger, corruption is more controlled and politicians are more accountable, we would expect that banks are less subject to political pressure to increase their government debt holding, suggesting a negative relationship between the quality of political institutions and sovereign debt exposure. It can also be expected

that countries, whose political institutions are better, resolve crises faster, to the extent that these countries' governments operate a more efficient bureaucracy. Alternatively, a strong system of checks and balances may impede a government's ability to intervene in a timely manner, potentially exacerbating the negative effect of banks' domestic sovereign debt holdings on the sovereign-bank entanglement. Thus, the effect of political institutions on the impact of sovereign debt exposure on crisis resolution and bank lending is ex ante ambiguous.

We proxy the quality of political institutions by the World Governance Index, which is an equally-weighted average of six governance indicators: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption; with higher values of the index reflecting more effective, transparent, democratic government. The World Governance Index is available for the 1996-2014 period, and has a mean of 0.502 and ranges between 0.002 and 0.897 as shown in Table 2.3. World Governance Index data is obtained from the International Monetary Fund's International Financial Statistics (IFS) database.

In the second group of country characteristics we study the role of monetary system. This is an interesting characteristic for understanding the role of sovereign debt exposures, since governments can attempt to reduce the nominal value of their liabilities by allowing higher inflation. In such a situation banks suffer a loss in the value of their sovereign debt holdings, but simultaneously, the government might be able to recapitalise banks easier by allocating resources from households to the banking sector. We use four variables to capture the features of the monetary policy framework in a country. The first of these is Central Bank Independence. An independent central bank may be more reluctant to allow a high level of inflation in order to finance government expenditure. In this case, and if the government is reluctant to increase taxes or reduce expenditure, a sovereign debt crisis might be prolonged, and overall costlier to resolve. Alternatively, a more independent central bank may have more credibility, and might enable the government to borrow at a lower cost by lowering future expected inflation. In this case, a higher level of government debt might be sustainable, allowing a larger government debt exposure by banks without triggering a sovereign-bank crisis. Our proxy, Central Bank Inde-

pendence (CBI), is from Dincer and Eichengreen (2014) and is constructed using government reforms to central bank independence for the 1998-2010 period. As Table 2.3 shows CBI has a mean of 0.522 in our sample and ranges between 0.1 and 0.83.

Next, a country loses its ability to carry out independent monetary policy if it wishes to maintain a fixed exchange rate regime while allowing international capital flows. Thus its ability to rely on higher inflation to reduce the real value of government debt is diminished. As above, this suggests that crisis resolution will be more difficult when banks hold large amounts of domestic sovereign debt, and the government maintains a fixed exchange rate. In addition, governments often choose to be indebted in foreign currency, especially when domestic bond markets are underdeveloped. When a significant amount of this foreign-denominated debt is owned by domestic banks, giving up the fixed exchange rate regime might not help resolve a sovereign-bank crisis because the likely depreciation lowers the value of banks' sovereign debt, leading to tighter capital constraints and lending conditions. A benevolent and forward-looking government may thus limit banks' sovereign debt exposure when the country maintains a fixed exchange rate regime.

Alternatively, a flexible exchange rate regime might help transmit foreign credit supply shocks, possibly further tightening already binding financing constraints (Bruno and Shin, 2015; Demirgüç-Kunt et al., 2017). We capture a country's exchange rate regime with a dummy variable, Exchange rate flexibility, which is one if a country maintains a flexible exchange regime based on the classification in Ilzetzki et al. (2017) (see the precise definition of this variable in Table 2.2). Table 2.3 shows that about 65.5% of our observations are from countries that maintain flexible exchange rates.

Finally, capital controls also affect domestic banking sectors' willingness to hold sovereign debt. If a country has tight capital controls, banks have limited opportunity to internationally diversify their portfolios and may choose to hold relatively more safe assets, such as government bonds. This suggests a positive relationship between capital controls and banks' sovereign debt exposures, and especially domestic sovereign debt exposure, on account of their reduced ability to buy foreign assets.

Additionally, in a crisis capital restrictions may stop capital flight, and may thus mitigate the negative effects of large domestic sovereign debt exposure. Our measure of capital controls is an index, Capital Controls, that is an overall measure of restrictions on capital inflows and outflows. This measure is from Fernández et al. (2016), and is constructed using the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, awarding an additional point for a restriction on any one asset category, which is then normalised to be between zero and one. Higher values of Capital Controls thus reflect tighter restrictions on the inflows and outflows of a broader set of asset categories. Table 2.3 shows that the average value of Capital Controls is 0.369 in our sample.

The third set of variables captures certain characteristics of the banking sector. The recent experience during the European sovereign debt crisis suggests that the geographic segmentation of the European banking sector might have played an important role, since most Euro-zone countries have predominantly domestic banks. A geographically more diversified banking sector would possibly have allowed ailing governments to write down some of their debt[9] without imposing large losses on the domestic banking sector, potentially restricting credit growth and suppressing aggregate demand. Furthermore, foreign banks are likely to be more resistant to the influence of the government and have weaker incentives to shift the risk of a government default onto creditors, because they are less likely to fail when the host government fails. Under these circumstances governments may force domestic banks to hold more domestic government debt. To capture geographic diversification we use Foreign owned banks, which is the ratio of the assets of foreign owned banks to the assets of all banks in a country. Table 2.3 shows that on average 39% of banks' total assets are foreign owned in our sample.

Government ownership might also be important to explain both banks' sovereign debt holdings and lending behaviour during banking/sovereign debt crises, because ownership gives the government more direct control over the portfolio decisions of the bank. Hence we expect that higher government ownership is associated with higher sovereign debt exposure due to moral suasion. During crises government-owned banks may reduce their lending less if they have a large sovereign debt exposure, because these banks may maintain lending due to political

[9] assuming a possibility of discriminatory default

pressure (e.g. Bertay et al. 2015 show that lending by state banks is less cyclical). Our measure of government ownership comes from the World Bank database, and is defined as the ratio of the assets of government owned banks relative to the assets of all banks in a country, with a sample mean of 16.2% (as seen in Table 2.3).

Next, we study whether the extent to which bank deposits are insured matters for the determinants of sovereign debt exposure and the transmission of sovereign debt shocks through these exposures. Deposit insurance induces bank's risk taking (Ioannidou and Penas, 2010), thus banks may choose to hold more domestic sovereign debt especially when the banking sector is weakly capitalised and sovereign default risk is high (risk shifting).

We measure the extent of deposit insurance in a country by the maximum deposit insurance coverage as a fraction of GDP per capita. Data about deposit insurance coverage comes from Demirgüç-Kunt et al. (2014). We also winsorised this variable at the 1st and 99th percentiles to limit the effect of outliers, and standardised by the standard deviation of the thus obtained data. After these adjustments Deposit Insurance has a sample average of .025 (Table 2.3).

Finally, the last set of country characteristics we study are bank regulation and supervision. These factors might directly influence banks' willingness to hold sovereign debt and ability to provide loans at times when financing constraints are tight. Powerful supervisors are expected to be able to persuade banks more easily to buy sovereign debt even if it is a suboptimal portfolio choice (moral suasion). Similarly, stronger supervisors might curb banks' risk taking in traditionally risky assets and encourage investment in relatively less risky and more liquid assets, such as government bonds. During banking and/or sovereign distress, powerful supervisors might force banks to provision for losses, and lend more prudently than they would otherwise do, potentially throttling credit growth. Alternatively, supervisory power might be used to induce banks to lend more during an economic slowdown especially in countries where the government has more political influence on the decisions of supervisors.

Next, stringent capital requirements reduce risk-shifting incentives on one hand but also induce banks to hold more sovereign debt, because these assets fetch zero risk weights (Korte and Steen, forthcoming). Stringent capital requirements may also lead to faster and less costly crisis

resolution if they force banks to hold more capital, because then banks need less fiscal support from the government and can return to providing credit faster following a banking/sovereign crisis. However, stringent capital requirements might also increase procyclicality of lending, by requiring banks to maintain high capitalisation when capital is scarce.

Finally, activity restrictions may matter because they affect banks' possibilities to diversify their income stream and asset portfolio, and because they affect bank competition. On the one hand regulators might restrict relatively risky activities (such as real estate activities), potentially inducing banks to substitute less risky government bonds for more risky assets to achieve their desired risk exposure. On the other hand, activity restrictions may be used by the government to induce banks to hold more government debt (moral suasion). Activity restrictions may also alleviate a possible crowding out effect of government bonds during a banking/sovereign debt crisis if these restrictions lead to relatively little crowding out of loans to the productive sector of the economy (e.g. SMEs). Data for our regulatory and supervisory variables are from the 2001, 2003, 2007 and 2011 version of the Bank Regulation and Supervision Survey carried out by the World Bank (Barth et al., 2001). Each wave takes a snapshot of the quality of bank regulation and supervision around the world. Supervisory power, Capital stringency and Activity restrictions are indices constructed from answers given by central banks and regulators to questions in the surveys. All three variables are standardised to fall between zero and one, and have sample means of 0.670, 0.567 and 0.633, respectively. The values between survey collection years are carried forward with the latest available values.

The full set of hypothesis is summarised in table 2.1 while the detailed description together with the sources is reported in table 2.2.

[Insert Tables 2.1 and 2.2]

2.3.2. Measures of sovereign debt exposure

Most of our hypotheses are related to banks' domestic sovereign debt exposure and as such, we would ideally test them on bank level domestic sovereign debt exposure data. Unfortunately,

such granular data is not available for an international sample of banks that contains developing countries as well. Even in Europe, the publicly available data on sovereign bondholdings with the detailed breakdown of issuing country is limited to a sample of significant credit institutions collected by European Banking Authority in a series of recent stress tests[10]. Within the European setting the study of country characteristics is however more complicated, as European countries tend to have a comparable development level of political institutions, they share monetary policy, have relatively integrated and homogeneous banking system with a common Single Supervisory Mechanism. Due to limited variation in our independent country characteristicsof choice, European sample would not allow us for the identification of coefficients of interest. Instead, we use two proxies for domestic sovereign debt exposure.

The first, Bond holdings, is bank's total holdings of any government debt securities relative to its total assets following Gennaioli et al. (2018) using data from Bankscope, this data cannot differentiate between domestic and foreign sovereign issuance. Gennaioli et al. (2018) use the EBA stress test data in Europe to test and show that these cumulative bond holdings are highly correlated with banks' domestic sovereign debt holdings, as banks tend to hold predominantly domestic debt. Given that we do not have access to a more detailed data, we refer the reader to the robustness tests presented in Gennaioli et al. (2018) paper.

The data is cleaned by removing all observations with total assets below $100.000 and prior to 1990, because Bankscope's coverage is poor for earlier years. Observations that are subsidiaries of consolidated parent banks or those that have multiple reports within a calendar year are deleted to avoid double counting (Thibaut and Mathias, 2015). The sample includes bank holdings and holding companies, commercial banks, cooperative banks, savings banks, real estate and mortgage banks, investment banks and other non-banking credit institutions. The final sample consists of 168 373 bank-year observations coming from 22 712 individual financial institutions located in 186 countries and spans the years 1990-2015.

In country-year level regressions we aggregate the bank level Bond holdings variable to a country-level by taking an average, weighted by banks' total assets. This yields 3217 country-year bond holding observations from 186 countries spanning 1990 to 2015. Figure 2.2 shows

[10]This data is limited to a more recent sample and has a short time dimension

the evolution of the weighted average of Bond holdings over time separately for advanced and emerging economies.

[Insert Figure 2.2]

Since the beginning of the global financial crisis, banks in advanced countries increased their bond holdings, as also documented by Asonuma et al. (2015); Battistini et al. (2013); Ongena et al. (2016), among several other papers. The figure also shows that, except for a short period at the end of the 1990s, banks in emerging economies continuously held significantly more government debt. This is consistent with these countries' governments forcing banks to hold more government debt to reduce the financing cost of their debt, as well as banks voluntarily loading on domestic sovereign debt to benefit from risk shifting.

Given the lack of decomposition of our main variable of interest into domestic and foreign sovereign bondholdings, in the robustness checks we also employ an alternative measure of domestic sovereign debt exposure. Following Acharya and Steffen (2015) we estimate the sensitivity of bank stock returns to the returns on domestic government bonds. The more domestic sovereign bonds a bank holds the higher the sensitivity is expected to be. To calculate this variable we estimate the following regression:

$$R^B_{ijty} = \alpha_{iy} + \beta_{iy} R^S_{jty} + \gamma_i R^M_{jty} + \sum_k \delta_{kity} MACRO_{kjty} + \varepsilon_{ity}, \tag{2.1}$$

where R^B_{ijty} is the return on the stock of bank i located in country j on day t in year y, R^S_{jty} is the return on 10 year benchmark government bond in country j, R^M_{jty} is the orthogonalised equity market return in country j[11], and $MACRO_{kjty}$ is a collection of macro variables. The included macro controls are the daily change in implied volatility ($\Delta VSTOXX$), the yield curve is defined as the difference between the yield on 10-year benchmark government bonds and 3-month interbank rate, the level of the 3-month interbank offer rate, the quarterly change

[11]We orthogonalised market returns to bond returns to account for the tight co-movement of these variables.

in real GDP, the quarterly change in inflation (ΔCPI), yearly change in the nominal effective exchange rate, and the Fama-French SMB and HML[12].

The estimated β_{iy} coefficients proxy for banks' domestic sovereign debt exposures[13]. As with the bond holdings variable, in the country-level regressions we aggregate the bank-year exposure proxies weighted by banks' total assets and multiply by 100. The average factor loadings, beta, has a sample mean of -0.689 and ranges between -217 and 194. Furthermore, the correlation between the factor loadings and sovereign bond holdings is positive at 0.132, and statistically significant. The coverage of the beta estimates is however limited due to extensive data requirements.

2.3.3. Crisis variables

We use data collected by Laeven and Valencia (2012) who identify 147 systemic banking crises globally in the period 1970-2011 for which they estimate associated output loss and fiscal costs. Output loss is calculated as the cumulative difference between actual GDP path and the forecasted trend over the 3 year period from the start of banking crisis. Fiscal costs are calculated by adding up all gross fiscal outlays related to the restructuring of the financial sector, including bank recapitalisation in a period of banking crisis but excluding government asset purchases or direct liquidity assistance, therefore they represent a lower boundary of the actual fiscal outlays. Both are expressed as a fraction of GDP. On average governments spent 12.4% of GDP on direct intervention in the financial sector during banking crisis and the cumulative GDP loss over three years is around 30%.

2.3.4. Macro controls

In the portfolio regressions we include additional macro control variables, all of them taken from the IFS database. Output gap volatility proxies for macroeconomic uncertainty. A higher level of economic uncertainty may induce banks to hold more sovereign debt to reduce their overall

[12]For further details of the methodology see Acharya and Steffen (2015).

[13]In addition to proxying domestic sovereign debt exposure, the factor loadings also include the value of implicit and explicit bailout guarantees by the government. The interpretation of this proxy is thus broader than domestic sovereign debt exposures.

risk exposure. At the same time, countries with more economic uncertainty tend to have weaker political institutions. Next, we include GDP per capita as a control for economic and financial development. In more developed countries banks may have better investment opportunities and hold less government bonds. Next, GDP growth is an additional control for the possibility that banks in fast growing countries invest less in government bonds to benefit from economic booms. Finally, we also include consumer price inflation growth (ΔCPI) as a crude proxy for price level uncertainty. In countries where there is a higher level of uncertainty about the price level banks might be more reluctant to hold long term, fixed rate government securities. In bank-level loan growth regressions country-year fixed effects control for time-varying country characteristics.

2.3.5. Loan growth and other bank level variables

In the final part of this paper we turn to a more granular bank-level analysis and study loan growth during periods of economic downturns. The dependent variable in these regressions is annual loan growth. Additionally, we control for time-varying bank characteristics, including the ratio of interests on loans to average gross loans, the fraction of non-performing loans to total loans (NPL), return on average assets (ROAA), change in total assets, change in deposits and short-term funding and Tier 1 capital ratio. All bank-level control variables are lagged by one year to reduce endogeneity concerns. All bank balance sheet data is obtained from Bankscope.

In these regressions we relate loan growth to bank-level sovereign bond holdings and its triple interactions with country characteristics (X_t) described above, as well as a recession or banking crisis dummy ($Crisis_t$), as shown in equation 2.2. Recession is a dummy variable that equals one if in a given country and year GDP declined for two or more consecutive quarters and zero otherwise. Default is also a dummy variable, taking the value of one if there was a sovereign default event in a country in a given year according to Standard & Poor's definition. The regression controls also for lagged bank level controls ($Z_{i,t-1}$) and country-level fixed effects (δ_{jt}). Table 2.3 shows that about 28% percent of our observations occurred in recession years.

$$\Delta Loan_{it} = \alpha_i + \beta_1 BH_{i,t-1} + \beta_2 BH_{i,t-1} \times Crisis_t + \beta_3 BH_{i,t-1} \times Crisis_t \times X_t + \\ + \beta_4 BH_{i,t-1} \times X_t + \gamma Z_{i,t-1} + \delta j, t + \varepsilon_{it} \tag{2.2}$$

2.4. Results

In this section we present results of three sets of regressions. We first relate country level measures of banks' sovereign debt exposure to various country characteristics to find determinants of bank's sovereign portfolio choice. Next, we present the results of regressions of measures of crisis severity on interactions between country characteristics and sovereign debt exposure to check how the chosen sovereign portfolio affects the cost of banking crisis resolution. Finally, we present bank-level results of regressions of loan growth on interactions between sovereign debt exposure, economic slowdown or sovereign default and country characteristics.

2.4.1. Determinants of sovereign bond portfolio choice

Table 2.4 presents the results of regressing sovereign bond holdings (country-level) on various country characteristics one by one, including a set of control variables for macroeconomic fluctuations and economic uncertainty, as well as year fixed effects. Given that majority of our institutional characteristics display high persistency across the time dimension, we cannot add country-level fixed effects as those would not allow for identification of the coefficients of interest[14]. Instead we try to control for most important country-level characteristics that could be correlated with both bank's sovereign bondholding choice and the country institutional characteristic, therefore contributing to omitted variable bias. Those variables include: GDP per capita to control for relative wealth/development level, GDP growth and output gap measure to control the local business cycle, measure of inflation to capture potential effect of devaluing nominal debt amount. In addition the time fixed effects capture global factors that could affect average bondholdings, such as global uncertainty or oil prices that may drive bank's demand

[14]Please note that country-year fixed effects are included in the credit supply regressions as the higher data granularity allows for such specification.

for relatively safer assets.

In the baseline model we include our measure of the quality of political institutions, World Governance Index (WGI). This variable obtains a negative coefficient, which is significant at 1 percent. This is consistent with our hypothesis that banks hold more sovereign debt in countries where the quality of political institutions is lower, even after controlling for differences in the relative wealth level.

Next, we add country characteristics proxying the monetary policy, banking structure, and regulatory environments one by one. We continue to control for various structural characteristics of countries that are not policy variables, such as GDP per capita, GDP growth, output gap, CPI, including the quality of governance (WGI). In regression (2) Central Bank Independence obtains a significantly negative coefficient, while the World Governance Index is estimated to have a negative, insignificant coefficient. These results suggest that governments might apply their power to force banks into buying domestic sovereign debt through central banks, or through other institutions, whose political independence might be correlated with central bank independence, such as government debt management agencies, consistent with hypothesis.

Next, Capital controls obtains a positive coefficient, significant at 1 percent. This is consistent with out hypotheses that banks in countries with capital controls are less able to diversify their investments and hold more sovereign debt, either because of a lack of available alternative high quality securities or to lower the average risk weight of their portfolios. Finally, the last variable capturing the monetary policy framework of a country, Exchange Rate Flexibility, obtains a negative, insignificant coefficient.

Next, Foreign-owned banks and Government-owned banks obtain positive and significant coefficients, while Deposit Insurance Coverage has a negative, insignificant coefficient. This evidence is consistent with governments influencing banks in which they have ownership to buy domestic sovereign debt, while foreign ownership might have a positive coefficient if domestic banks hold a larger share of their assets in government bonds when there is a stronger foreign bank presence, as these banks are less easily swayed by the government and may enjoy fewer

benefits from risk shifting relative to domestic banks.

Finally, Supervisory Power and Activity Restrictions obtain positive, statistically significant coefficients, while Capital Stringency has an insignificant coefficient. This evidence is consistent with moral suasion, as governments may use supervisors, as well as activity restrictions to force banks to hold more domestic sovereign debt. The insignificant coefficient on capital stringency may be caused by the balancing of the trade-off between two effects: (i) reduction in the risk-shifting incentives and (ii) rebalancing portfolio toward the zero risk weights.

[Insert Table 2.4]

These results suggest that after controlling for economic and political uncertainty, the country's monetary policy framework, the ownership structure of its banking sector and the quality of bank regulation and supervision are relevant for the country's banking sector's sovereign debt exposure.

Next, we investigate whether the results hold for developing and advanced countries alike. Since emerging countries are less financially developed and experience more economic and political instability it is conceivable that certain policies may have heterogeneous effects on banks' incentives to hold sovereign debt. In Table 2.5 we re-estimate the regressions of Table 2.4 on the sample of advanced countries. WGI continues to yield negative and significant coefficients, this time even when we control for Central Bank Independence in regression 2. In the same regression Central Bank Independence continues to have a negative coefficient, albeit an insignificant one. Capital controls, Foreign owned banks, and Supervisory power have positive and significant coefficients for the sample of advanced countries, as for the full sample. While Deposit insurance coverage is estimated to be insignificant on the full sample, when estimated on the sample of advanced countries it receives a positive and significant coefficient, consistent with our hypothesis that more generous guarantees are positively correlated with bond holdings because of risk shifting incentives, but only in advanced countries for which deposit guarantee scheme is a credible insurance against bank insolvency.

[Insert Tables 2.5 and 2.6]

Finally, the only variable with significant coefficients obtained using both the full sample and the sample of advanced countries, but with different signs, is Government-owned banks. For the full sample we find a positive coefficient (regression 6 in Table 2.4), while in regression 6 in Table 2.5 we find a negative coefficient. This might be because in advanced countries, governments might be using their influence on banks they own to pursue other goals, such as providing financing to the private sector as opposed to the public sector.

Next, regressions analogous to regressions in Table 2.4 but for the sample of emerging countries are presented in Table 2.6. Interestingly, in regression (1) WGI obtains a positive coefficient, which is significant at 5 percent. Since emerging countries overall have a lower level of the World Governance Index, a possible explanation is that at already low levels of the World Governance Index a marginal decrease in the quality of governance diminishes the government's ability to force banks to buy more domestic sovereign debt. This result is robust to adding other country characteristics as control variables, as in all other regressions in Table 2.6 WGI obtains positive coefficients, which are significant in four out of nine regressions. Among the other country characteristics, Capital controls, Government owned banks and Supervisory power have significant coefficients, and these are positive, confirming the results obtained for the full sample (regressions (4), (6) and (8) in Table 2.4).

Overall, Tables 2.4 to 2.6 suggest that capital controls and Supervisory power are robust determinants of banks' sovereign debt holdings across the range of advanced and emerging countries, while political institutions (WGI) have a more heterogeneous effect.

To close this section, we assess the robustness of the results to using an alternative measure of banks' domestic sovereign debt exposure - beta factor loading (see section 2.3.2). We estimate regressions analogous to those in Table 2.4 but replace sovereign bond holdings by Beta and present the results in Table 2.7. World Governance Index obtains a negative and insignificant coefficient in regression (1), which does not include other country characteristics other than the control variables. In all regressions except for regression (2), WGI has robustly negative coefficients, which are significant in regressions (5), (6) and (7), consistent with regression

results in Table 2.4.

[Insert Table 2.7]

In regression (2) we add Central Bank Independence, which obtains a negative and significant coefficient. This confirms the result in Table 2.4, that more central bank independence is negatively correlated with a banking sector's sovereign debt holdings and suggests that this result is driven by domestic debt holdings. In regression (2) WGI obtains a positive coefficient, suggesting that conditional on central bank independence, the quality of governance is positively correlated with the interrelatedness of banks and government. In regression 3 the included country characteristic is Exchange Rate Flexibility, which obtains a positive and significant coefficient. This might be explained by banks or the government anticipating that in a bank/sovereign debt crisis such exposures in a fixed exchange rate regime might inhibit resolution of the crisis, and find it optimal not to hold a large domestic government debt portfolio under a fixed exchange rate regime.

In regressions (4) to (10) the other included country characteristics obtain coefficients that are not estimated with sufficient statistical precision. Nonetheless, Capital controls and Supervisory power obtain positive coefficients, which further corroborates the results in Tables 2.4 to 2.6, suggesting a positive relationship between Capital controls and Supervisory power, and banks' (domestic) sovereign debt exposure.

2.4.2. Crisis resolution

In this section we present regressions of output and fiscal costs of banking crises on the sovereign debt holdings of a country's banking sector and its interactions with country characteristics. If the feedback between the solvency of the banking sector and the government is strong, then we would expect banking crises to be costlier when banks are more exposed to the domestic government. In addition, we expect that these costs vary with institutional characteristics of the country, as discussed in section 2.3.1.

In regressions presented in Table 2.8 the dependent variable is Output loss. In regression (1) of Panel A we include country level bond holdings, BH (country), lagged by one year to reduce endogeneity concerns. This variable obtains a negative, insignificant coefficient, contrary to our expectations. In regressions (2) to (11) we include country characteristics one by one, also lagged by one year, and their interactions with Bond holdings. None of the estimated coefficients are significant.

In Panel B of Table 2.8 we replace BH (country) by Beta and estimate analogous regressions to those in Panel A. In the baseline regression (column 1) Beta obtains a positive coefficient that is significant at the 10 percent level. Thus a one standard deviation increase in our measure of bank-sovereign interrelatedness, Beta, is associated with a 12.9 percent GDP loss ($= 33.112 * 0.392$), which is about 43% of the mean GDP loss associated with banking crises (using that the mean GDP loss is 30.143 as shown in Table 2.3).

In regressions (2) to (11) we repeat the exercise of adding country characteristics and interactions of thereof with Beta to the baseline regression one by one, but we do not obtain significant coefficient estimates. Overall, Table 2.8 provides some evidence of the interrelatedness between banks and governments being positively associated with higher output losses following banking crises, but this relationship does not vary with country characteristics. It is also possible that our sample size, limited by data availability, is not sufficient to estimate the coefficients with sufficient precision.

Next, in Table 2.9 we present regressions of the fiscal cost associated with banking crises. In Panel A we include BH (country) which obtains a positive and insignificant coefficient. Similarly to the previous tables we proceed by adding lagged country characteristics and their interactions with BH (country-level). In regression (5) Capital controls are included and this variable and Bond holdings (country) obtain both positive coefficients, significant at 5 percent, while their interaction has a negative coefficient that is also significant. This provides some evidence that capital controls mitigate the fiscal cost of resolving banking crises, potentially because they help avoid capital flight.

[Insert Tables 2.8 and 2.9]

Next, Government ownership variable in regression (7) obtains a negative, significant coefficient, while its interaction with country level bond holdings is positive and marginally significant. This suggests that a more significant government ownership coupled with a large sovereign bond exposure is associated with a large fiscal cost of resolving banking crisis. This is perhaps because the government might involve private investors in sharing losses when a smaller share of the banking sector is owned by the government.

In Panel B of Table 2.9 we re-estimate the regressions of Panel A of Table 2.9, but we use Beta as a measure of domestic sovereign debt exposure. These regressions yield insignificant coefficient estimates.

Overall, Table 2.9 provides limited evidence of domestic sovereign debt exposure being related to more costly banking crises, and some mitigating (exacerbating) role of capital controls (government ownership).

2.5. Loan growth results

In this section we take a further step to assess the potential effect of banks' sovereign debt exposure on the real economy. To that end, we run regressions of bank-level loan growth on the interaction between a bank's sovereign debt holdings lagged by one year and a dummy variable indicating either a macroeconomic slowdown or sovereign default. Consecutively, we include triple interactions with country characteristics to test whether the identified relationship varies with country characteristics.

We control for time-varying bank-level characteristics, and add country-year fixed effects. The latter control for all time-varying characteristics, such as the abundance of growth opportunities. In addition, country-year fixed effects also control for credit demand at the country level as in, among others, Cerutti and Claessens (2017), Gennaioli et al. (2018) and Giannetti and Laeven (2012).

2.5.1. Loan growth during recessions

Our baseline specification is regression (1) in Table 2.10. BH (bank) receives an insignificant coefficient. Still in regression (1), the interaction of BH (bank) and Recession is negative at -2.622 and significant at the 10 percent level. Thus, a reduction in lending is relatively large in recession years especially for those banks that held a large amount sovereign debt on their balance sheet the year before, consistent with the results presented in Gennaioli et al. (2018).

Next, we add triple interactions of BH (banking), Recession and country characteristics one by one, and saturate the model by including interactions of BH (bank) and the included country characteristic. We concentrate on regressions that yield significant coefficients for interactions involving the Recession dummy, as our focus is on the effect of bond holdings on lending during times of economic turmoil. In regression (7), including interactions with Government owned banks, the interaction between Recession and BH (bank) is negative and significant, confirming the baseline estimate, while the triple interaction is insignificant. In regression (9) Recession $\times$ BH (bank) has a negative coefficient, while the triple interaction including Supervisory power has a positive coefficient, both significant at 1 percent. Thus, relatively powerful supervisors dampen the negative relationship between bond holdings on loan growth: when Supervisory power equals 0.8357 ($= 65.569/78.459$) the estimated loan growth during a recession year does not vary with bond holdings, while below this value a strong supervisor cannot fully offset the negative effect excessive sovereign bondholdings have on the credit supply.

This result is consistent with the following narrative. During recessions sovereign default risk increases, which in turn, is transmitted to the banking sector[15]. The resulting increase in bank default risk is especially high for those banks that are highly exposed to government debt. Relatively high default risk is then reflected in higher funding costs for these banks, which discourages lending disproportionately (see e.g. Peek and Rosengren, 1997). If the increase in the likelihood of a bank's failure is coupled with agency problems, such as classic risk shifting (Jensen and Meckling, 1976), then bank funding costs might increase even further. In this case, strong supervisors might mitigate the negative effect of domestic bond holdings by curbing

[15]Several papers show that bank and sovereign CDS spreads move strongly together (Ejsing and Lemke, 2011; Gerlach et al., 2010; Sgherri and Zoli, 2009).

banks' risk taking. In this scenario bank funding costs would increase by less than under weak supervision, and thus a smaller decline in lending is expected, consistent with estimated coefficient.

In regressions (10) and (11) the double interaction of Recession × BH (bank) obtains positive and significant coefficients, while the triple interactions involving Capital stringency and Activity restrictions have negative and significant coefficients.

These results might reflect that when banks are subject to stringent capital requirements they have to maintain high capital ratios, even when capital is costly, such as during recessions. Losses on their sovereign debt portfolios might then force banks to reduce lending, and especially those banks that are most exposed to sovereign debt. In addition, activity restrictions might reinforce the negative relationship between bond holdings and loan growth during recessions, because when banks' activities are more restricted, their loan portfolio might make up a bigger share of their assets.

Overall, Table 2.10 suggests that the regulatory and supervisory environments, in which banks exposed to sovereign debt operate, influence their lending behaviour during recessions, while we find no evidence of other country characteristics to have such an effect.

[Insert Table 2.10]

2.5.2. Loan growth during during sovereign default

Banks that hold large domestic sovereign debt portfolios might be affected especially after a domestic sovereign debt default. In Table 2.11 we present regressions analogous to regressions in Table 2.10, but we replace Recession dummy with Default, a dummy variable indicating that a sovereign has defaulted in the same year. Unfortunately, we cannot estimate the regression involving interactions with Central Bank Independence, because of a lack of sufficient variation in Central Bank Independence for countries that have experienced a sovereign default during the sample period.

In the baseline specification (regression 1) BH (bank) and its interaction with Default obtain positive and negative coefficients, respectively, suggesting that in years when sovereign default occurred banks lend less if they had a large government debt exposure. Although these estimates are insignificant, they are consistent with our priors and the result that in recession years banks with larger sovereign debt portfolios experience slower loan growth or even credit crunch (see regression 1 of Table 2.10). These results are further corroborated in regressions 3, 6 and 7, when we include interactions with Exchange rate flexibility, Government owned bank, and Deposit insurance coverage, respectively. In these regressions Default * BH (bank) obtains negative, significant coefficients. The triple interactions obtain insignificant estimates in all regressions. Interestingly, all interactions involving Supervisory power, Capital stringency and Activity restrictions (in regressions 8 to 10) have the same signs as the corresponding regressions (9 to 11) in Table 2.10.

[Insert Table 2.11]

2.6. Conclusion

In this paper we have studied banks' sovereign debt exposures using a large sample of banks across the globe. Our results highlight the role of country characteristic heterogeneity in banks' choice of sovereign debt portfolio and how it affects the real economy. In particular, we have studied four groups of country characteristics: the quality of political institutions, monetary policy framework, ownership structure of the banking sector, and the quality of bank regulation and supervision.

We find that each of these characteristics is correlated with banks' bond holdings choice in the sample, including both advanced and emerging countries. Splitting the sample by the level of income reveals differences between these wealth groups. The quality of political institutions is negatively correlated with bond holdings in advanced countries (as well as in the full sample),

while in emerging countries this correlation is positive. This is consistent with the narrative that good institutions and checks on the government might limit governments' ability to influence bank portfolio decisions in developed countries, while among countries where the quality of governance is poor a marginal improvement in governance increases the government's ability to persuade banks to buying domestic government debt. These findings are robust to controlling for several other potential determinants of a banking sector's demand for government debt.

Next, supervisory power is positively correlated with a banking sector's holdings of government debt, possibly because the government's influence is channelled through the actions of supervisors. Interestingly, capital stringency is not correlated with sectoral bond holdings, suggesting that supervisory power matters for banks' demand for government bonds not because of their roles in enforcing capital requirements.

The other robust determinant of a banking sector's bond holdings across developing and advanced countries is capital controls. More restrictions on the inflow and outflow of capital into a country are positively correlated with its banking sector's government debt exposure, possibly because these constraints limit banks' ability to diversify internationally and choose to hold relatively safe assets. While capital controls may increase banks' sovereign debt exposure, they seem to limit the damage these exposures create, as the GDP loss and fiscal cost of banking crises are negatively correlated with an interaction between bond holdings and capital controls, however our empirical evidence is not statistically significant due to limited sample size.

Finally, our last set of regressions relate a bank's loan growth to its holdings of government bonds and its interactions with recession or sovereign default and country characteristics. After controlling for demand for loans at the country level, we find that a bank that is more exposed to sovereign debt extends fewer loans in years when the economy enters a recession or the government defaults. Furthermore, this relationship depends on the regulatory environment. More powerful supervisors dampen the crowding-out effect, while capital stringency and activity restrictions reinforce it.

These results inform about the potency of the analysed policies to expose banks to sovereign debt, and to mitigate the effects of these exposures. For policymakers this offers guidance

about the policies that might effectively be used to reduce the likelihood of dangerous feedback loops between banks and governments; as well as about policies that might be used to limit the negative effects of the feedback loop once it is in force. For researchers, these results are useful, because they inform about which potential channels are worth pursuing to identify more rigorously. In particular, the role of supervisors seems to be an area where further research might fruitfully pin down the mechanisms through which banks' portfolio decisions and/or lending behaviour is affected during crises.

2.7. Tables and Figures

Table 2.1: Summary of hypothesis.

	Determinants of BH	Cost of crisis	Credit supply
WGI	-	+/-	
CBI		+/-	
Fixed Exchange rate	+/-	+	-
Capital Controls	+	-	
Foreign ownership	-	-	+
Government ownership	+	+	+
Deposit Insurance	+	+	
Supervisory power	+/-	-	-
Capital regulation	-	-	-
Activity restriction	+	-	+

Table 2.2: Data description and sources

Variable	Description	Data Source
Country-level variables		
BH (country)	Average total government debt securities to total assets in a country and year weighted by banks' total assets.	Bankscope
Beta	Average factor loading from regressions of daily domestic bank stock returns on daily 10-year benchmark government bond returns in a country and year weighted by banks' total assets.	Bloomberg, International Financial Statistics
World Governance Index	World Governance Index is an average of 6 world governance indicators: Voice and Accountability; Political Stability and Absence of Violence; Government Effectiveness; Regulatory Quality; Rule of Law; Control of Corruption. Standardised between 0 and 1, higher values indicate better governance	International Financial Statistics
Central Bank Independence	Central Bank Transparency and Independence Index, higher values indicate more independence and transparency	Dincer and Eichengreen (2014)
Capital Controls Index	Overall inflows and outflows capital restrictions index. Higher values indicate more controls.	Fernández et al. (2016)
Deposit Insurance Coverage	Maximum deposit insurance coverage as % of GDP per capita, windsorised at 1% and 99% level and divided by standard deviation	Demirgüç-Kunt et al. (2014)
Foreign owned banks	The extent to which the banking system's assets are foreign owned, percentage	Barth et al. (2001)
Government owned banks	The extent to which the banking system's assets are government owned, percentage	Barth et al. (2001)
Exchage Rate Flexibility	Dummy variable indicating that the borrower's country has a flexible exchange rate regime. It takes the value of one if a country's exchange rate regime falls in one of the following categories: pre-announced crawling band that is wider than or equal to +/-2%; de facto crawling band that is narrower than or equal to +/-5%; moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time); managed floating; and freely floating	Ilzetzki et al. (2017)
Supervisory Power	Index indicating whether the supervisory authorities have the authority to take specific actions to prevent and correct problems, higher values indicate more official supervisory power, standardised	Barth et al. (2001)

Data description and sources (continued)

Variable	Description	Data Source
Capital Stringency	Index indicating whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined, higher values indicate more capital requirement, standardised by the standard deviation of the raw index	Barth et al. (2001)
Activity Restriction	A measure of a bank's ability to engage in the businesses of underwriting, insurance, and real estate, and of the regulatory effectiveness of banks to own shares in non-financial firms standardised by the standard deviation of the raw index, higher values indicating more restrictions.	Barth et al. (2001)
Output gap volatility	Absolute value of the percentage deviation of real GDP from its long-term trend component, yearly average over four quarters	International Financial Statistics
GDP per capita	Gross Domestic Product per capita in constant prices international (PPP), in thousands of USD	International Financial Statistics
GDP growth	Annual real GDP growth	International Financial Statistics
CPI	Consumer Price Index	International Financial Statistics
Output loss	Cumulative sum of the differences between actual and trend real GDP over the 3-year period from the start of banking crisis	Laeven and Valencia (2012)
Fiscal cost	Component of gross fiscal outlays related to the restructuring of the financial sector including bank recapitalisation but excluding asset purchases and direct liquidity assistance from the treasury	Laeven and Valencia (2012) 2012
Bank-level variables		
BH (bank)	Total government securities to total assets, lagged by one year.	Bankscope
Loan growth	Annual change of gross loans over total assets in previous year	Bankscope
Recession	Dummy variable equal to one if real GDP has fallen for two or more consecutive quarters in a given year and country and zero otherwise.	International Financial Statistics
Default	Dummy variable equal to one if there was a sovereign default event in a country in a given year according to Standard & Poor's definition.	Gennaioli et al. (2018)

Data description and sources (continued)

Variable	Description	Data Source
Interests on Loans	Interest Income on Loans/Average Gross Loans, lagged by one year.	Bankscope
NPL	Non-Performing Loans/Gross Loans, lagged by one year.	Bankscope
ROAA	Return on Average Assets, lagged by one year.	Bankscope
Asset growth	Yearly change in total assets, lagged by one year.	Bankscope
Deposit growth	Yearly change in deposits and short-term funding, lagged by one year.	Bankscope
Tier 1	Tier 1 Ratio, lagged by one year.	Bankscope

Table 2.3: Descriptive statistics

See Table 2.2 for variable definitions.

Variable	N	Mean	Std. Dev.	Min	Max
Country-level variables					
BH (country)	3217	11.141	9.680	0	75.683
Beta	650	-.689	33.112	-217.792	194.321
WGI	2833	.502	.184	.002	.897
Central Bank Independence	821	.522	.238	.1	.83
Exchange Rate Flexibility	12498	.655	.475	0	1
Capital Controls	1900	.369	.340	0	1
Foreign bank ownership	2450	.390	.329	0	1
Government ownership	1997	.162	.222	0	.96
Deposit Insurance	1247	.025	.071	.001	1.013
Supervisory Power	2762	.670	.157	.242	1
Capital Stringency	2633	.567	.237	0	1
Activity Restriction	2660	.633	.177	.25	1
Output Loss	129	30.143	33.607	0	143.4
Fiscal Costs	87	12.351	13.258	0	56.8
Output gap volatility	2110	1.812468	2.656812	.021861	57.68859
GDP per capita	4524	15.03739	18.37006	.2466705	136.1355
GDP growth	2021	3.272199	3.467089	-30.52507	26.3679
CPI	5207	64.98557	38.46331	0	730.04
Bank-level variables					
BH (bank)	168373	.104	.686	-.000	195.3
Loan growth	318031	.620	27.724	-798.014	915.863
Recession	350361	.283	.450	0	1
Interests on Loans	182390	8.983	20.192	-21.52	972.5
NPL	252179	3.293	7.502	-4.36	953.85
ROAA	359441	.853	4.990	-540.48	676.15
Asset growth	326086	8.151	26.775	-881.625	954.316
Deposits growth	321034	8.315	36.199	-1132.806	1285.021
Tier 1	212873	19.240	32.614	-747.38	984.6

Table 2.4: Determinants of banks' sovereign debt holdings

The dependent variable in all regressions is BH (country), the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. The independent variables in Regression 1 are World Governance Index, Output gap volatility, GDP per capita, GDP growth and CPI. In addition to these variables, regressions 2 to 10 include one country characteristic at a time, denoted by X. X is thus one of the following variables in each regression: Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. All regressions include year fixed effects. White's standard errors robust to heteroskedasticity are reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		X								
	Baseline	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
X		-3.808***	-0.073	4.263***	1.620*	2.571*	-2.011	5.551***	0.348	5.483***
		(1.431)	(0.672)	(1.163)	(0.898)	(1.537)	(2.224)	(1.716)	(1.184)	(1.823)
World Governance Index	-10.987***	-2.341	-10.996***	-8.215**	-18.551***	-15.300***	-12.145***	-15.233***	-16.831***	-15.455***
	(2.763)	(5.211)	(2.758)	(3.682)	(2.789)	(2.697)	(3.182)	(2.744)	(2.786)	(2.830)
Output gap volatility	-0.263	-0.258	-0.265	-0.204	-0.539**	0.163	-0.456	-0.496**	-0.453*	-0.433*
	(0.262)	(0.279)	(0.262)	(0.331)	(0.251)	(0.278)	(0.345)	(0.230)	(0.237)	(0.239)
GDP per capita	-0.068***	-0.156***	-0.068***	-0.105***	-0.018	-0.034*	-0.093***	-0.028	-0.025	-0.017
	(0.022)	(0.047)	(0.022)	(0.038)	(0.019)	(0.019)	(0.027)	(0.020)	(0.020)	(0.018)
GDP growth	-0.122	-0.058	-0.122	-0.264**	-0.264**	-0.202*	-0.140	-0.217**	-0.210*	-0.206*
	(0.103)	(0.132)	(0.103)	(0.130)	(0.114)	(0.117)	(0.130)	(0.107)	(0.107)	(0.105)
CPI	-0.058*	-0.231***	-0.058*	-0.018	-0.145***	-0.070	-0.068	-0.130***	-0.134***	-0.132***
	(0.033)	(0.049)	(0.034)	(0.037)	(0.041)	(0.048)	(0.057)	(0.040)	(0.040)	(0.040)
N	995	496	995	794	837	766	623	881	879	879
R^2	0.143	0.287	0.143	0.199	0.197	0.169	0.204	0.197	0.188	0.198
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.5: Determinants of banks' sovereign debt holdings in advanced countries

The dependent variable in all regressions is BH (country), the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. The sample includes advanced countries only (high income countries based on World Bank country classification). The independent variables in Regression 1 are World Governance Index, Output gap volatility, GDP per capita, GDP growth and CPI. In addition to these variables, regressions 2 to 10 include one country characteristic at a time, denoted by X. X is thus one of the following variables in each regression: Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. All regressions include year fixed effects. White's standard errors robust to heteroskedasticity are reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Determinants								
	Baseline	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
Determinant		-1.500	0.315	3.141*	1.884**	-6.530***	17.394***	5.025***	-1.457	2.267
		(1.405)	(0.625)	(1.786)	(0.885)	(1.645)	(3.288)	(1.645)	(1.239)	(1.641)
World Governance Index	-21.949***	-18.619***	-21.924***	-18.444***	-26.916***	-31.228***	-21.905***	-24.982***	-26.655***	-25.245***
	(2.900)	(4.419)	(2.889)	(3.354)	(2.719)	(3.120)	(4.096)	(2.721)	(2.828)	(3.055)
Output gap volatility	-0.473	-0.523	-0.463	-0.625**	-0.328	-0.072	-0.680**	-0.246	-0.175	-0.130
	(0.293)	(0.369)	(0.294)	(0.311)	(0.335)	(0.320)	(0.301)	(0.289)	(0.294)	(0.294)
GDP per capita	-0.009	-0.062	-0.009	-0.031	0.022*	0.026**	-0.014	0.014	0.020	0.015
	(0.016)	(0.038)	(0.016)	(0.024)	(0.013)	(0.013)	(0.023)	(0.013)	(0.015)	(0.014)
GDP growth	0.087	0.227	0.084	0.008	-0.023	0.086	0.137	0.024	0.055	0.058
	(0.100)	(0.139)	(0.101)	(0.122)	(0.115)	(0.117)	(0.118)	(0.105)	(0.103)	(0.102)
CPI	-0.069	0.022	-0.071	-0.042	-0.003	0.071	0.093	0.005	0.004	0.007
	(0.049)	(0.069)	(0.050)	(0.055)	(0.059)	(0.062)	(0.067)	(0.054)	(0.054)	(0.055)
N	575	306	575	464	472	449	402	513	512	512
R^2	0.172	0.175	0.172	0.169	0.206	0.205	0.169	0.199	0.187	0.187
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.6: Determinants of banks' sovereign debt holdings in emerging countries

The dependent variable in all regressions is BH (country), the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. The sample includes emerging countries only (low and middle income countries based on World Bank country classification). The independent variables in Regression 1 are World Governance Index, Output gap volatility, GDP per capita, GDP growth and CPI. In addition to these variables, regressions 2 to 10 include one country characteristic at a time, denoted by X. X is thus one of the following variables in each regression: Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. All regressions include year fixed effects. White's standard errors robust to heteroskedasticity are reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Determinants								
	Baseline	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
Determinant		-1.083	-1.210	5.491***	-2.700	8.031***	-3.580	5.792*	1.809	4.252
		(3.300)	(1.483)	(1.535)	(2.168)	(2.087)	(3.054)	(3.131)	(2.233)	(3.203)
World Governance Index	13.820**	13.601	13.793**	15.288**	10.104	15.984**	40.306***	8.826	6.576	5.187
	(6.339)	(9.903)	(6.310)	(7.523)	(7.820)	(7.141)	(8.877)	(6.664)	(6.924)	(6.676)
Output gap volatility	-0.478	0.051	-0.521	0.034	-0.812**	0.082	-0.364	-0.860***	-0.797**	-0.801**
	(0.367)	(0.438)	(0.370)	(0.471)	(0.328)	(0.372)	(0.651)	(0.317)	(0.327)	(0.319)
GDP per capita	-0.546***	-0.915***	-0.552***	-0.704***	-0.490***	-0.580***	-0.750***	-0.483***	-0.461***	-0.433***
	(0.096)	(0.131)	(0.098)	(0.103)	(0.100)	(0.104)	(0.102)	(0.098)	(0.101)	(0.100)
GDP growth	-0.650***	-0.461*	-0.667***	-0.770***	-0.847***	-0.796***	-0.636**	-0.728***	-0.707***	-0.732***
	(0.214)	(0.255)	(0.213)	(0.258)	(0.258)	(0.279)	(0.299)	(0.242)	(0.244)	(0.241)
CPI	-0.059	-0.403***	-0.056	-0.006	-0.128**	0.041	-0.028	-0.132**	-0.130**	-0.134**
	(0.051)	(0.063)	(0.052)	(0.056)	(0.060)	(0.073)	(0.084)	(0.061)	(0.061)	(0.062)
N	420	190	420	330	365	317	221	368	367	367
R^2	0.107	0.335	0.109	0.179	0.133	0.155	0.200	0.129	0.124	0.127
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.7: Determinants of banks' sovereign debt holdings - alternative exposure measure

The dependent variable in all regressions is Beta, the average factor loadings from regressions of daily domestic bank stock returns on daily 10-year benchmark government bond returns in a given country and year weighted by banks' total assets. The independent variables in Regression 1 are World Governance Index, Output gap volatility, GDP per capita, GDP growth and CPI. In addition to these variables, regressions 2 to 10 include one country characteristic at a time, denoted by X. X is thus one of the following variables in each regression: Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. All regressions include year fixed effects. White's standard errors robust to heteroskedasticity are reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Determinants								
	Baseline	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
Determinant		-16.851**	6.292*	5.864	3.755	11.403	-10.379	7.957	-3.647	-0.877
		(7.671)	(3.250)	(8.381)	(6.520)	(11.034)	(12.015)	(9.800)	(6.232)	(9.360)
World Governance Index	-28.516	40.932*	-24.694	-19.093	-32.759*	-35.205*	-41.185**	-25.925	-29.075	-28.061
	(17.951)	(21.748)	(17.627)	(18.406)	(18.163)	(18.628)	(19.925)	(19.373)	(18.358)	(18.072)
Output gap volatility	1.168	2.948	1.571	1.580	0.051	-0.144	2.747	1.062	0.852	1.084
	(1.770)	(2.225)	(1.784)	(1.773)	(1.691)	(1.749)	(2.550)	(1.751)	(1.750)	(1.768)
GDP per capita)	-0.139	-0.318	-0.181	-0.088	-0.146	-0.170	-0.146	-0.154	-0.133	-0.156
	(0.178)	(0.242)	(0.176)	(0.183)	(0.175)	(0.198)	(0.201)	(0.184)	(0.185)	(0.177)
GDP growth	0.164	0.850	0.197	0.345	0.100	-0.468	-0.446	0.098	0.088	0.158
	(0.610)	(0.880)	(0.609)	(0.731)	(0.622)	(0.653)	(0.729)	(0.614)	(0.614)	(0.612)
CPI	-0.015	-0.541*	-0.011	-0.031	-0.125	-0.222	0.035	0.024	-0.034	0.012
	(0.188)	(0.288)	(0.187)	(0.210)	(0.197)	(0.198)	(0.255)	(0.202)	(0.195)	(0.195)
N	496	299	496	441	450	427	372	492	490	491
R^2	0.063	0.086	0.068	0.072	0.079	0.090	0.071	0.064	0.062	0.062
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.8: Output cost of banking crises

Panel A: The dependent variable in all regressions is Output loss, calculated as the cumulative sum of the differences between actual and trend real GDP over the 3-year period from the start of banking crisis. BH (country) is the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with BH (country). X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. BH (country) and all country characteristics are lagged by one year. All regressions include year fixed effects. Bootstrapped standard errors reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		X									
	Baseline	World Governance Index	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
BH (country, lagged)	-0.492	-0.001	2.148	-2.302	0.535	1.525	-2.465	-0.662	2.212	-3.620	6.179
	(0.589)	(3.197)	(83.648)	(2.206)	(2.483)	(2.113)	(1.975)	(3.459)	(10.590)	(6.395)	(14.810)
X (lagged)		0.364	43.611	-4.936	-8.811	153.820	-117.996	0.036	2.117	-7.756	1.982
		(12.608)	(832.003)	(5.963)	(25.986)	(149.570)	(180.036)	(0.133)	(5.134)	(11.879)	(10.109)
BH (country) × X (lagged)		0.297	-3.160	0.527	-0.834	-17.004	17.506	-0.005	-0.215	1.020	-0.712
		(2.512)	(102.041)	(0.604)	(7.240)	(20.776)	(37.189)	(0.030)	(0.962)	(1.936)	(1.742)
Constant	33.035***	35.055*	6.743	48.070**	37.584***	9.885	42.871***	33.254**	11.105	62.760	13.242
	(6.359)	(17.910)	(681.945)	(21.123)	(12.544)	(16.327)	(13.905)	(14.369)	(55.050)	(43.646)	(85.681)
N	56	31	18	55	36	24	22	23	26	25	26
R^2	0.021	0.003	0.033	0.041	0.024	0.360	0.110	0.018	0.010	0.048	0.022

Panel B: The dependent variable in all regressions is Output loss, calculated as the cumulative sum of the differences between actual and trend real GDP over the 3-year period from the start of banking crisis. Beta is the average factor loadings from regressions of daily domestic bank stock returns on daily 10-year benchmark government bond returns in a given country and year weighted by banks' total assets. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with Beta. X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. Beta and all country characteristics are lagged by one year. All regressions include year fixed effects. Bootstrapped standard errors reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		X									
	Baseline	World Governance Index	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
Beta (lagged)	0.392*	0.206	1.265	-0.121	0.441	0.275	-0.070	0.639	-1.363	0.538	1.698
	(0.220)	(0.888)	(116.258)	(0.431)	(0.443)	(0.538)	(0.209)	(0.560)	(1.534)	(0.890)	(1.863)
X (lagged)		-11.112	19.036	-0.964	-92.867	43.876	9.597	0.031	-0.906	-1.136	3.856
		(12.778)	(1612.474)	(3.518)	(104.237)	(54.789)	(1378.804)	(0.096)	(2.259)	(2.507)	(3.249)
Beta ×		0.123	-1.014	0.276	-0.715	-1.788	0.979	-0.003	0.158	-0.056	-0.237
X (lagged)		(0.628)	(143.504)	(0.236)	(5.904)	(3.367)	(31.798)	(0.005)	(0.143)	(0.182)	(0.276)
Constant	30.852***	45.399***	15.098	30.159***	40.401***	20.313**	26.779***	25.163**	35.107	34.734***	5.351
	(4.167)	(14.324)	(1305.565)	(9.215)	(8.006)	(8.683)	(3.688)	(10.895)	(24.223)	(13.000)	(21.936)
N	17	17	14	16	16	14	14	15	15	15	15
R^2	0.538	0.586	0.718	0.599	0.661	0.190	0.091	0.649	0.698	0.591	0.703

Table 2.9: Fiscal cost of banking crises

Panel A: The dependent variable in all regressions is Fiscal cost, calculated as the component of gross fiscal outlays related to the restructuring of the financial sector including bank recapitalizations but excluding asset purchases and direct liquidity assistance from the treasury. BH (country) is the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with BH (country). X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. BH (country) and all country characteristics are lagged by one year. All regressions include year fixed effects. Bootstrapped standard errors reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		X									
	Baseline	World Governance Index	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
BH (country, lagged)	0.130	-0.328	-0.0913	0.0156	1.713**	0.686	-1.494	-0.246	-2.195	4.826*	2.646
	(0.241)	(1.753)	(20.82)	(1.145)	(0.725)	(1.468)	(1.520)	(3.934)	(9.880)	(2.781)	(7.170)
X (lagged)		-1.303	-11.60	0.405	23.67**	-21.80	-139.2**	-0.0544	-2.007	5.352	0.168
		(8.275)	(124.5)	(2.727)	(10.12)	(54.46)	(68.28)	(0.197)	(4.438)	(4.991)	(5.106)
BH (country) × X (lagged)		-0.270	3.780	0.0369	-3.462***	2.084	29.41*	0.00366	0.284	-1.172	-0.199
		(1.490)	(26.33)	(0.335)	(1.175)	(7.228)	(15.63)	(0.0332)	(0.888)	(0.873)	(1.031)
Constant	11.56***	15.74	3.342	10.88	2.871	6.250	14.15	14.16	25.84	-13.51	1.778
	(2.819)	(10.40)	(98.88)	(7.684)	(4.741)	(9.834)	(9.216)	(23.32)	(48.85)	(16.13)	(33.48)
N	51	31	18	49	38	24	22	23	26	25	26
R^2	0.005	0.024	0.394	0.010	0.134	0.166	0.327	0.087	0.115	0.296	0.101

Panel B: The dependent variable in all regressions is Fiscal cost, calculated as the component of gross fiscal outlays related to the restructuring of the financial sector including bank recapitalizations but excluding asset purchases and direct liquidity assistance from the treasury. Beta is the average factor loadings from regressions of daily domestic bank stock returns on daily 10-year benchmark government bond returns in a given country and year weighted by banks' total assets. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with Beta. X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. See Table 2.2 for variable definitions. Beta and all country characteristics are lagged by one year. All regressions include year fixed effects. Bootstrapped standard errors reported in the parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		X									
	Baseline	World Governance Index	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
Beta (lagged)	0.149	-0.709	-1.394	0.056	0.201	-0.177	-0.040	0.282	-0.512	0.303	0.639
	(0.150)	(0.603)	(154.042)	(0.271)	(0.339)	(0.352)	(0.121)	(0.324)	(0.833)	(0.394)	(1.438)
X (lagged)		0.987	-12.310	-2.769	-50.024	-10.749	-0.228	-0.018	-0.721	-1.394	-1.530
		(6.810)	(2129.981)	(2.179)	(77.109)	(26.881)	(66.997)	(0.047)	(1.159)	(1.220)	(1.273)
Beta ×		0.559	1.916	0.058	-0.762	0.682	-0.275	-0.002	0.060	-0.060	-0.090
X (lagged)		(0.400)	(190.151)	(0.139)	(5.253)	(2.166)	(1.958)	(0.003)	(0.085)	(0.087)	(0.199)
Constant	7.300***	6.293	17.244	13.045**	12.156**	5.839	4.391***	8.942*	12.641	12.116**	17.056**
	(2.171)	(9.144)	(1724.136)	(6.456)	(5.294)	(4.240)	(1.589)	(4.930)	(12.142)	(5.786)	(7.408)
N	17	17	14	16	16	14	14	15	15	15	15
R^2	0.331	0.621	0.357	0.448	0.496	0.105	0.097	0.523	0.441	0.524	0.592

Table 2.10: Sovereign debt exposure and loan growth during recessions

The dependent variable in all regressions is Loan growth, the annual change in a bank's loans-to-assets ratio. BH (country) is the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. Recession is a dummy variable indicating two or more quarters of negative GDP growth in a country in a year. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with BH (country). X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. All regressions include Interest on Loans, Non-performing loans (NPL), Return on average assets (ROAA), Asset growth, Deposit growth and Tier 1. See Table 2.2 for variable definitions. All independent variables, except Recession, are lagged by one year. All regressions include bank country-time fixed effects. Standard errors clustered at the bank level are in parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		X									
	Baseline	World Governance Index	Central Bank Independence	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
$BH_{i,t-1}$	3.375	109.646***	50.154***	34.963***	-4.733	-3.502	2.788	7.770*	107.516***	-27.539***	-56.433***
	(2.872)	(16.460)	(15.213)	(7.683)	(3.830)	(3.395)	(2.396)	(4.211)	(18.956)	(5.166)	(12.477)
$X \times BH_{i,t-1}$		-142.724***	-18.715	-31.897***	49.710***	75.724***	82.646***	-11.242	-120.107***	42.436***	89.120***
		(22.566)	(26.832)	(7.851)	(17.790)	(19.888)	(21.434)	(8.355)	(22.038)	(5.145)	(16.889)
Recession $\times BH_{i,t-1}$	-2.622*	0.552	-2.698	-7.199	-0.513	-3.387	-2.971**	-3.837	-65.569***	28.782***	49.482**
	(1.408)	(25.596)	(14.295)	(10.598)	(3.872)	(2.913)	(1.343)	(4.474)	(18.413)	(8.255)	(23.577)
$X \times BH_{i,t-1}$		-7.908	-1.584	3.909	1.639	1.482	-22.224	1.653	78.459***	-35.149***	-72.323**
$\times$ Recession		(34.753)	(21.930)	(10.689)	(25.161)	(28.855)	(27.755)	(12.502)	(22.197)	(11.282)	(34.641)
Interest on $Loan_{t-1}$	-0.019	-0.023	-0.075	-0.019	-0.026	-0.029	-0.028	-0.049	-0.026	-0.026	-0.026

	(0.100)	(0.097)	(0.077)	(0.100)	(0.097)	(0.093)	(0.094)	(0.080)	(0.095)	(0.095)	(0.096)
NPL_{t-1}	-0.065	-0.074	0.267**	-0.071	-0.043	-0.056	-0.071	-0.068	-0.068	-0.056	-0.056
	(0.045)	(0.047)	(0.121)	(0.045)	(0.052)	(0.047)	(0.048)	(0.049)	(0.047)	(0.046)	(0.046)
$ROAA_{t-1}$	-0.295***	-0.270**	-0.112	-0.292***	-0.341***	-0.252**	-0.275**	-0.332***	-0.245**	-0.244**	-0.260**
	(0.111)	(0.111)	(0.253)	(0.111)	(0.122)	(0.110)	(0.113)	(0.110)	(0.110)	(0.110)	(0.110)
Asset $growth_{t-1}$	0.090***	0.089***	0.141***	0.090***	0.097***	0.088***	0.085***	0.078***	0.090***	0.089***	0.088***
	(0.016)	(0.017)	(0.028)	(0.016)	(0.017)	(0.017)	(0.018)	(0.019)	(0.017)	(0.017)	(0.017)
Deposit $growth_{t-1}$	0.003	0.004	-0.016	0.003	0.001	0.004	0.009	0.011	0.004	0.004	0.005
	(0.015)	(0.016)	(0.022)	(0.015)	(0.015)	(0.016)	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
Tier 1_{t-1}	0.297***	0.288***	0.565***	0.294***	0.288***	0.301***	0.308***	0.311***	0.294***	0.299***	0.301***
	(0.065)	(0.066)	(0.131)	(0.065)	(0.075)	(0.067)	(0.072)	(0.074)	(0.066)	(0.066)	(0.066)
N	64590	63068	24399	64590	55977	63279	61707	59280	63722	63602	63652
N.Banks	12608	12438	9710	12608	12331	12452	12214	11682	12508	12497	12502
N.Countries	108	105	55	108	83	99	98	81	102	100	101
R^2	0.328	0.327	0.494	0.329	0.342	0.323	0.324	0.310	0.327	0.324	0.323
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.11: Sovereign debt exposure and loan growth following sovereign default

The dependent variable in all regressions is Loan growth, the annual change in a bank's loans-to-assets ratio. BH (country) is the average government debt security holdings of banks in a country in a given year relative to total assets, weighted by total assets. Default is a dummy variable indicating a sovereign default in a country in a given year. Regressions 2 to 11 include one country characteristic at a time, denoted by X, and its interaction with BH (country). X is thus one of the following variables in each regression: World Governance Index, Central Bank Independence, Exchange Rate Flexibility, Capital Controls, Foreign owned banks, Government owned banks, Deposit Insurance Coverage, Supervisory Power, Capital Stringency and Activity Restriction. All regressions include Interest on Loans, Non-performing loans (NPL), Return on average assets (ROAA), Asset growth, Deposit growth and Tier 1. See Table 2.2 for variable definitions. All independent variables, except Recession, are lagged by one year. All regressions include bank country-time fixed effects. Standard errors clustered at the bank level are in parentheses. *, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		X								
	Baseline	World Governance Index	Exchange Rate Flexibility	Capital Controls	Foreign owned banks	Government owned banks	Deposit Insurance Coverage	Supervisory Power	Capital Stringency	Activity Restriction
BH (bank, lagged)	3.287	105.115***	32.610***	-4.792	-3.465	2.681	6.266*	72.421***	-19.823***	-40.950***
	(2.777)	(16.979)	(7.503)	(3.701)	(3.206)	(2.293)	(3.667)	(12.727)	(4.148)	(10.564)
X × BH (bank, lagged)		-136.867***	-29.648***	50.020***	74.021***	76.547***	-7.921	-79.885***	32.103***	66.109***
		(23.236)	(7.638)	(17.339)	(17.864)	(21.911)	(7.110)	(14.932)	(3.884)	(14.624)
Default × BH (bank, lagged)	-24.731	-122.783	-48.889***	46.455	11.691	-41.540***	-48.550**	-63.345	116.465	68.319
	(17.742)	(287.375)	(14.483)	(54.962)	(50.658)	(14.478)	(22.842)	(174.787)	(98.078)	(97.047)
X × BH (bank lagged) × Default		183.699	61.225	-124.336	-53.599	281.325	97.600	55.745	-177.142	-119.903
		(577.921)	(46.009)	(83.312)	(58.445)	(231.955)	(126.630)	(261.887)	(114.826)	(110.327)
Interest on Loans (lagged)	-0.018	-0.023	-0.018	-0.025	-0.029	-0.028	-0.049	-0.024	-0.027	-0.026
	(0.100)	(0.097)	(0.100)	(0.097)	(0.093)	(0.093)	(0.080)	(0.095)	(0.095)	(0.095)

NPL (lagged)	-0.067	-0.075	-0.073	-0.043	-0.056	-0.071	-0.068	-0.069	-0.051	-0.056
	(0.045)	(0.047)	(0.045)	(0.052)	(0.047)	(0.048)	(0.049)	(0.047)	(0.046)	(0.046)
ROAA (lagged)	-0.312***	-0.298***	-0.310***	-0.341***	-0.266**	-0.287**	-0.345***	-0.249**	-0.246**	-0.263**
	(0.111)	(0.111)	(0.111)	(0.122)	(0.110)	(0.113)	(0.111)	(0.111)	(0.111)	(0.110)
Asset growth (lagged)	0.090***	0.090***	0.091***	0.097***	0.088***	0.086***	0.078***	0.089***	0.088***	0.087***
	(0.016)	(0.017)	(0.016)	(0.017)	(0.017)	(0.018)	(0.019)	(0.017)	(0.017)	(0.017)
Deposit growth (lagged)	0.003	0.003	0.002	0.001	0.004	0.009	0.011	0.004	0.005	0.005
	(0.015)	(0.016)	(0.014)	(0.015)	(0.016)	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
Tier 1 (lagged)	0.294***	0.285***	0.291***	0.288***	0.301***	0.308***	0.311***	0.295***	0.302***	0.302***
	(0.065)	(0.065)	(0.064)	(0.075)	(0.067)	(0.072)	(0.074)	(0.066)	(0.066)	(0.066)
N	65306	63672	65306	55985	63286	61714	59291	63729	63609	63659
N Banks	12760	12576	12760	12333	12454	12216	11684	12510	12499	12504
N Countries	117	110	117	84	100	99	82	103	101	102
R^2	0.327	0.326	0.328	0.342	0.323	0.323	0.311	0.326	0.324	0.323
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

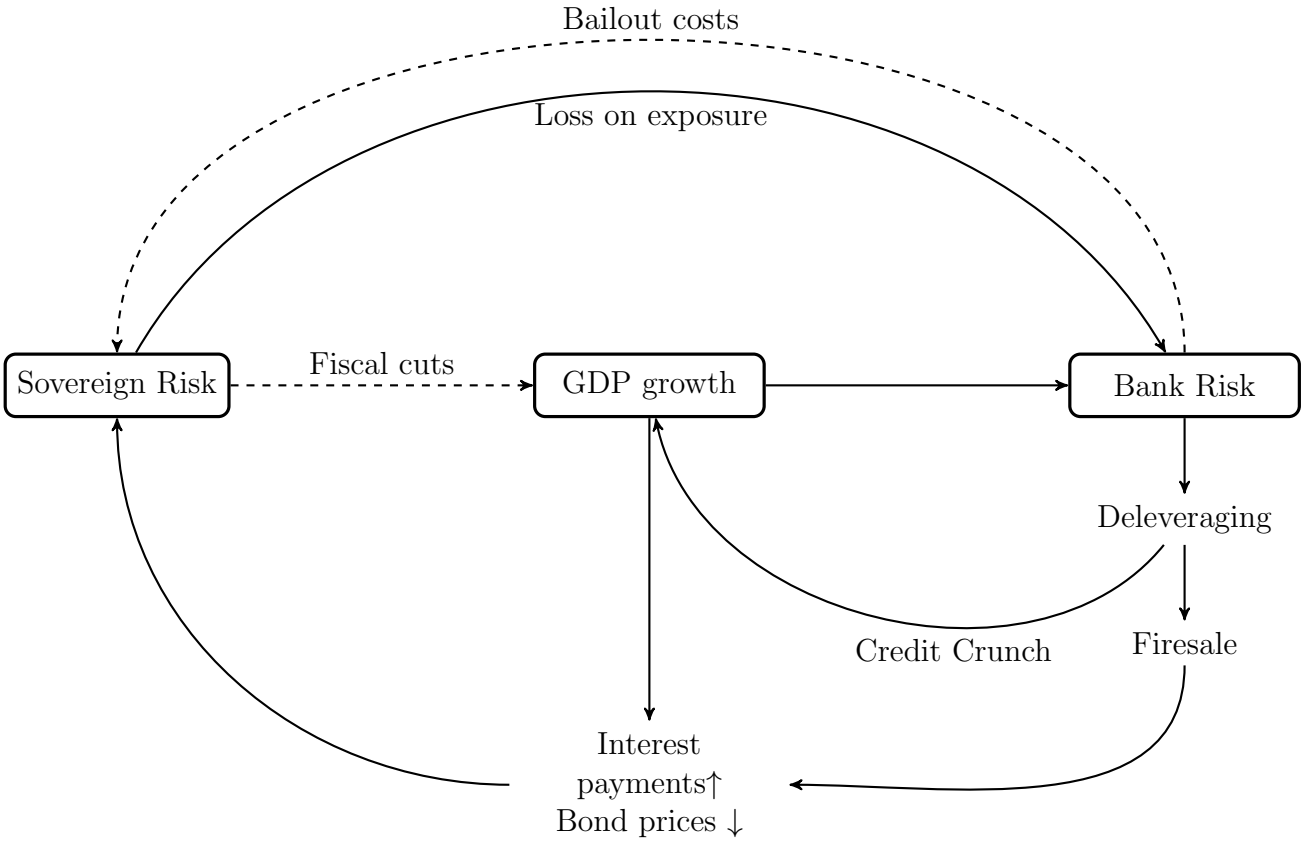
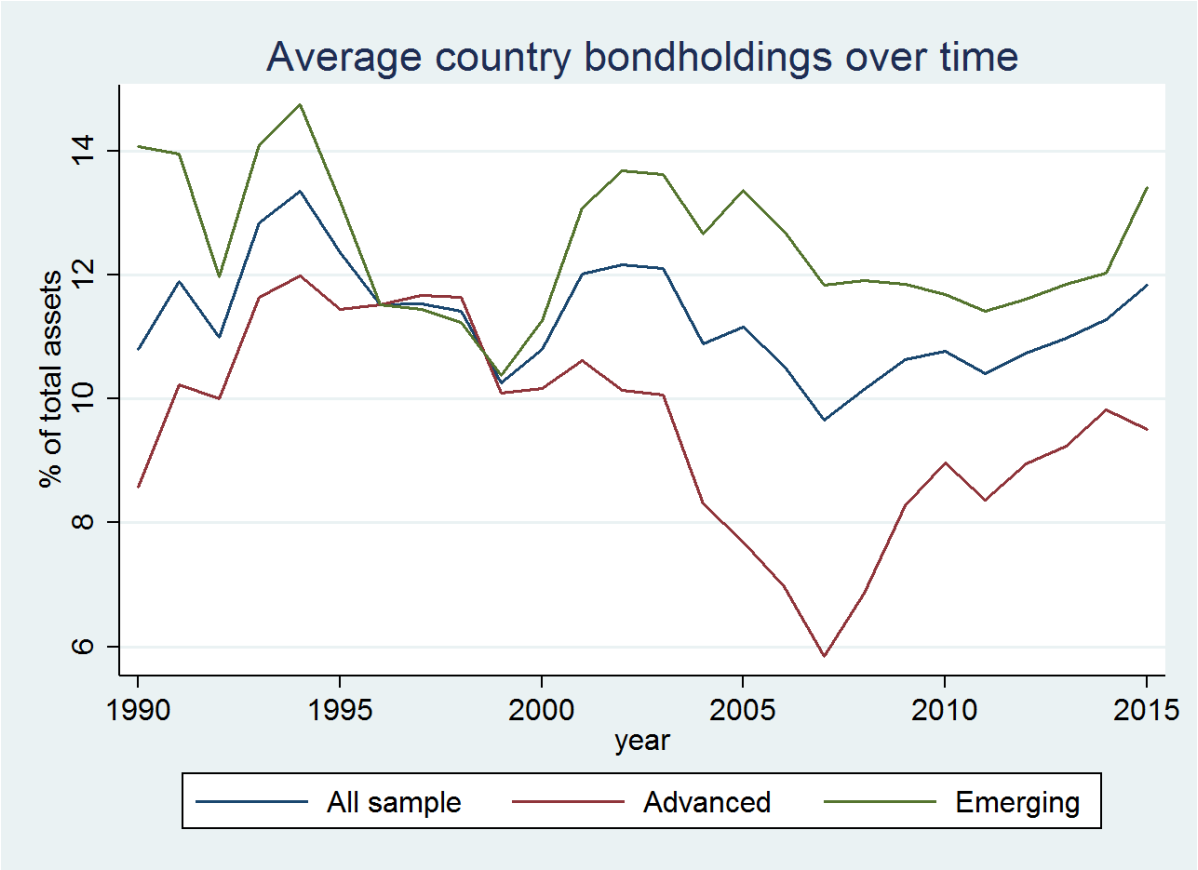


Figure 2.1: Sovereign-bank risk loop

Figure 2.2: Average country-level sovereign bondholdings BH_{jt} over time



Chapter 3

Reducing non-performing loans:

Stylised facts and economic impact

Abstract

Using newly collected data on non-performing loans (NPL) in more than 190 countries over 27 years as well as policies aimed at dealing with NPLs, this paper presents stylised facts about episodes of high NPLs and NPL reduction episodes. We find that a combination of asset management companies and public funds made available for recapitalisation is shown to be the most effective policy package in terms of resolving NPLs. A typical policy-assisted NPL reduction episode starts with a sharp drop in the stock of NPLs while in later years a greater contribution to the decline in NPL ratio comes from revived credit growth. This profile enables us to focus on specific events - sharp drops in NPL ratios - and their aftermaths, using cases of persistently high NPLs as a control group. Using matching analysis, we estimate that reductions in NPLs are associated with extra economic growth in excess of 1.5 percentage points per annum over several years.

Keywords: non-performing loans, economic growth, banking regulation

JEL Codes: F34, G21, G33, O40

3.1. Introduction

The global financial crisis brought the problem of non-performing loans (NPLs) into the forefront of the policy debate from India to Italy. In contrast with earlier experiences, NPLs continue clogging balance sheets of banks in many countries almost a decade after the 2008-09 global financial crisis. Both emerging markets and advanced economies have been affected: in Greece, close to half of loans were non-performing as of 2016, in Italy more than 15 percent.

Yet surprisingly little is known about the "anatomy" of a typical case of high non-performing loans and the trajectory of NPL reduction. This contrasts with rich literature on the typical aftermaths of a financial crisis (see, for instance, Reinhart and Rogoff 2014), a currency crisis (for instance, Hong and Tornell 2005) or fiscal consolidation episodes (see, for instance, Alesina et al. 2015).

The evidence on the effectiveness (or lack thereof) of various policies in dealing with NPLs is equally scarce. The policy debate has been largely informed by case studies, including the United States in the 1980s (the savings and loans crisis) as well as the Nordic countries, Japan, Mexico, Korea and South-East Asia in the 1990s (see, for instance, Klingebiel 2000; Calomiris et al. 2004; Macey 1999; Krueger and Tornell 1999; Woo 2000; Fung et al. 2004; Hoshi and Kashyap 2010). Baudino and Yun (2017) provide a useful recent summary of lessons learned from various case studies. The debate in Europe has also been strongly influenced by competition policy considerations and the perceived need to minimise state aid provided to the banks. While insightful, case studies do not reveal how and whether various policies worked in an average case where they were attempted.

The evidence on the macroeconomic effects of NPLs has been previously reported but is primarily qualitative. A loan several months, or years, overdue is a burden for both the lender and the borrower. For a debtor, a non-performing loan traps valuable collateral and the unresolved debt makes it more difficult to obtain new funding and make investment (see, for instance, Bernanke et al. 1999). On the bank side, NPLs tie up capital, contract credit supply, distort allocation of credit and worsen market confidence (for instance, Kwan and Eisenbeis 1996; Cucinelli 2015; Jorda et al. 2013; Peek and Rosengren 2000, 2005; Caballero et al. 2008).

Estimates of the overall macro-level impact of high NPLs, on the other hand, are few and predominantly derived from vector auto-regression (VAR) complicating causal interpretation of the findings (Nkusu 2011; Espinoza and Prasad 2014; Klein 2013).

This paper contributes to the literature by closing these three gaps. It distils key stylised facts about instances of high NPL levels since 1990, in a large global sample, as well as about policies deployed to reduce NPLs. It looks at how such policies related to the trajectories of NPLs, providing insights into relative effectiveness of various policies. Finally, we use an event study approach to estimate the impact of reducing NPLs on economic growth. The impact analysis is complicated by the fact that NPLs themselves are often a reflection of an economic downturn, while fast economic growth can lead to a swifter drop in the NPL ratio. Our paper tackles the issue of causality by focusing on the cases of sharp reductions in NPLs. It uses matching technique to compare the aftermaths of such sharp reductions with plausible counterfactuals based on episodes where high NPLs persisted. This approach also enables us to focus specifically on NPL reductions as opposed to combining positive and negative changes in NPL ratios as is customary in the VAR analysis.

The paper also contributes to the literature on the economic impact of debt relief. An event study by Reinhart and Trebesch (2016) finds that episodes of sovereign debt relief are associated with extra annual growth dividend of up to 5 percentage points. NPL reductions are conceptually similar as they stem from restructuring or writing off a large number of smaller (and typically private-sector) liabilities. We show that NPL reductions can also have significant real effects of economically meaningful magnitude.

All three parts of the analysis draw on a novel database of NPL ratios, episodes of high NPLs and policies used in the context of high NPLs. The dataset on NPLs splices aggregated bank-level data from Bankscope with the country-level NPL data from World Development Indicators (WDI). The policy database draws on various existing databases, as well as narrative evidence collected from various policy reports.

The construction of NPL episodes draws on the methodology used in the literature on the impact of fiscal consolidation (for instance, Beetsma et al. 2015; Guajardo et al. 2014; Alesina

et al. 2015). These studies employ narrative evidence to identify cases of fiscal consolidation, distinguish between expenditure-based and tax-based episodes and analyse the differential impact of fiscal consolidations on consumer confidence, output and other macroeconomic indicators.

The data reveal that NPLs are not just a by-product of (well-studied) crisis episodes; the cases of high NPLs can be linked to a systemic banking, currency or sovereign debt crisis only in around 40 percent of NPL cases. NPL levels seen in the mid-2010s are not exceptional by historical standards, but in the past cases of high NPLs tended to be of more "acute" nature while they have recently become more "chronic". An average NPL reduction episode starts only once NPL ratio exceeds 21 percent (median value). A successful NPL reduction episode typically builds on a policy action that leads to a significant drop in the stock of NPLs, while in later years a greater contribution to the decline in NPL ratio comes from revived credit growth. Reductions kick-started predominantly by a credit boom are rare (less than 10 percent of the total) and occur mainly in countries with low debt-to-GDP ratios (the median value of 15 percentage points).

In an event study analysis, comparing the countries with sudden NPL reductions and those with persistenly high NPLs, we find that a combination of asset management companies and public funds made available for recapitalisation is shown to be the most effective in terms of resolving NPLs. However, the effectiveness depends also on the financing choice of the public intervention. Using matching analysis, we estimate that reductions in NPLs are associated with extra economic growth in excess of 1.5 percentage points per annum over several years. This growth differential is reflected in faster investment growth and to some extend growth of consumer spending and a decline in unemployment rate.

The rest of the paper is organised as follows. Section 3.2 reviews the literature on the complex relationship between non-performing loans and the real economy, and briefly outlines various types of policies used to reduce NPLs. Section 3.2 presents the data on NPL ratios and NPL policies and discusses stylised facts about a typical case of high NPLs and a typical episode of NPL reduction around the world. Section 3.4 discusses the link between financial

sector policies and NPL reductions while Section 3.5 explores how this link is affected by banks' sovereign bond holdings. Section 3.6 focuses on instances of sharp reductions in NPL ratios and uses matching analysis to estimate the economic impact of these reductions, employing instances of high and persistent NPLs to construct plausible counterfactuals. It also discusses the overall results and illustrates various findings with a case study. Finally, Section 3.7 concludes and discusses policy implications.

3.2. Literature review

Drawing on the existing literature, this section outlines the interlinkages between non-performing loans and economic performance. On the one hand, macroeconomic environment and bank-specific factors affect loan performance. On the other hand, high concentration of non-performing loans has a negative impact on the economy, slowing down the creation of new credit and worsening market expectations. This section examines both of these channels in turn and reviews measures that can be deployed to facilitate a reduction in the stock of non-performing loans.

3.2.1. Determinants of non-performing loans

Factors driving NPLs fall into two broad groups: macroeconomic conditions (such as inflation, interest rate and real GDP growth) and bank-specific factors (capital ratios, quality of risk management). A wealth of papers document both.

GDP growth stands out as a key driver of NPLs. In a dynamic panel setting, Beck et al. (2013) show that while the interest rate and share prices influence the NPL ratio, the growth rate of GDP has the greatest explanatory power. In a similar vein, Espinoza and Prasad (2014) document how lower economic growth and higher interest rates trigger an increase in non-performing loans for banks in the Gulf States. Using panel autoregressive distributed lag model, Mohaddes et al. (2017) argue that a sustained growth above 1.2 percent per annum in an advanced economy like Italy could half NPL ratio over a period of around 5 years.

Other studies have found significant relationships between asset quality and macroeconomic

environment in countries such as Greece (Louzis et al., 2012), Spain (Salas and Saurina, 2002), Italy (Quagliariello, 2009) and Mexico (Blavy and Souto, 2009). Nkusu (2011) arrives at similar conclusions in a panel of 26 advanced economies. (Ghosh, 2015) examines more detailed state-level NPL determinants such as house price inflation, banking sector competition or public indebtedness in the sample of the US banks. Klein (2013) extends these results for Central, Eastern and South-Eastern Europe, pointing out that bank-specific factors, such as leverage or ROA, play a crucial role alongside the wider macroeconomic conditions.

3.2.2. Consequences of non-performing loans

A high ratio of non-performing loans to total loans impacts banks' lending in several ways. A bank plagued with a high stock of NPLs is likely to prioritise internal consolidation and improving assets quality (deleveraging) over the provision of new credit. A high NPL ratio requires greater loan loss provisions, depleting capital resources available for new lending and denting bank's profitability. It is also found to be a significant predictor of bank failures (González-Hermosillo et al. 1997; Lu and Whidbee 2013; Barr et al. 1994). Where banks avoid failure, NPLs impact negatively on a bank's cost structure and efficiency (Maggi and Guida, 2011) and their willingness to lend (Cucinelli, 2015). As the NPL ratio increases, banks become more risk-averse in their lending (Leon and Tracey, 2011; Hou and Dickinson, 2007)[16].

Bank lending, in turn, is crucial for the health of the economy. It tends to underpin both working capital and business expansion thus leading to real GDP growth at major turning points of the business cycle (for example, Jorda et al. 2013). Lending standards are often relaxed during economic booms and tightened in recessions, amplifying the impact of an economic downturn on credit volumes and quality (Rajan, 1994; Ruckes, 2004). A credit crunch serves as a transmission mechanism from greater creditor risk-aversion to weaker demand, which in turn can lead to business failures and a further increase in non-performing loans, making banks even more reluctant to lend. Such vicious credit risk spirals were observed, for instance, after the 1995 crisis in Mexico (Krueger and Tornell, 1999) and after the 1997 crisis in Indonesia

[16]Some studies question the causal nature of the link between NPLs and lending. Accornero et al. (2017) argue that in Italy NPLs and lack of credit growth have both been manifestations of poor business conditions.

(Agung et al., 2001). Delays in the recognition of loan losses can further exacerbate the pro-cyclicality of lending (Beatty and Liao, 2011).

An overhang of non-performing loans can also result in a misallocation of resources in an economy with strong bank-business interlinkages. When banks channel most of new credit to the troubled sectors and companies ("zombie lending"), they help to prevent second-round business failures, at the expense of diverting funds away from the more productive parts of the economy. This way, the lending disruption on the back of high NPLs compromises the country's long-run growth prospects through the reduction of total factor productivity (see Peek and Rosengren 2005; Caballero et al. 2008). Large capital injections in banks are required to break this vicious circle (Giannetti and Simonov, 2013). Furthermore, large NPL ratios can negatively impact sovereign bond's ratings (Boumparis et al., 2017) thus further exacerbating the cost of falling into the negative feedback loop (see Chapter 2 for further discussion).

In sum, to estimate the causal relationship from NPLs to economic performance cross-country studies must circumvent the problem of simultaneous causation. The most common approach builds on vector autoregressive (VAR) models where identification of the impact of NPLs relies on assumptions about the ordering of the variables within the VAR system. Although studies use different samples and dependent variables, they typically find a negative and significant impact of rising NPL ratios on GDP growth and employment. Such effects tend to persist for several years after the initial NPL shock (Nkusu, 2011; Espinoza and Prasad, 2014) and can also be observed when it comes to employment, at least in the Emerging Europe in the aftermath of the 2008-09 financial crisis (Klein, 2013). Kaminsky and Reinhart (1999) further find that a large increase in the NPL ratio serves as a reliable predictor of financial crises.

3.2.3. Dealing with non-performing loans

When it comes to resolving NPLs, identifying the problem is the first step. Banks need to transparently and credibly assess and report the quality of their assets in order to build up provisions against expected losses. A credible guidance to markets can help to restore market confidence damaged by rising NPLs. For instance, the primary reason behind introduction

of IFRS accounting standards in Greece in the aftermath of the sovereign debt crisis was to improve the market trust in accounting practices.

Relying on banks' voluntary efforts to resolve NPLs may not be sufficient, even when NPLs are recognised on balance sheet. The regulator may guide banks as to the optimal use of their capital buffers and determine target loan loss provisions. Banks may need to develop special capacity to deal with NPLs - another area where the regulator may step in.

Creating a good legal framework for corporate restructuring and timely disposal of NPLs is crucial, in particular when judicial capacity to deal with NPLs case-by-case is lacking (see Laeven and Laryea 2009). Centralised out-of-court debt workout programme were actively used by governments in Korea, Thailand, Indonesia and Malaysia in the 1990s (Woo, 2000); Serbia adopted a consensual restructuring framework for debt of small enterprises in 2012.

We further consider five types of financial sector policies targeting reduction in NPL ratio: the establishment of an asset management companies, provision of bailouts to the financial sector (public funds for bank recapitalisation), changes to macroprudential regulation, changes to loan classification rules and changes to provisioning stringency.

The first type of policies encourages development of a secondary market for NPLs. One option is to create a "bad bank" or asset management companies (AMCs) that enable commercial banks to transfer NPLs from their balance sheets to a specialised entity at a fair (market) value. The AMCs can in turn securitise the impaired loans and resell them in a secondary market, use their expertise to partially recover bad loans or initiate foreclosure with the view to monetise collateral attached to bad loans.

This route was followed for example in Sweden and Mexico in the 1990s (Macey, 1999; Krueger and Tornell, 1999). Similarly, public or private asset management companies, created in the aftermath of the Asian financial crisis, assembled assets valued at up to 20 percent of GDP and achieved a significant degree of value recovery (Woo, 2000; Fung et al., 2004). More recently, in 2016, the Italian government reached a deal with the EU allowing it to attach a government guarantee to a subset of the €350m of NPLs to stimulate the establishment of private AMCs and sales of NPLs on the secondary market. The Italian approach was also

implemented in 2019 in Greece where tranches of securitised NPLs will be guaranteed by the government. Such guarantees help to bridge the difference between the reservation value of NPLs to the originating banks and the price potential buyers would be willing to pay, a gap that often remains large in cases where weak contract enforcement creates strong asymmetry of information (Garrido et al., 2016).

Majority of AMCs globally are publicly funded. Alternatively, banks may establish internal AMCs by ring-fencing on- or off-balance sheet funds for a special internal workout department. Internal AMCs have the same objective as public AMC: to recover maximum value from a portfolio of impaired assets. In a few cases, governments directly used deposit insurance funds to acquire non-performing assets. This option is, however, less popular as it may compromise the ability of deposit insurers to perform their core function.

Alternatively, public funds can be used to recapitalise ailing banks directly. The bailouts give banks an opportunity to fully provision their non-performing exposures, write them off, or sale at discounted prices to a third party. Policy packages often combine establishment of AMCs with the use of public bailout.

The third block of policies are macroprudential measures that target behaviour of financial institution through limits on leverage, maximum interbank exposures, concentration ratios, capital surcharges on systemically important financial institutions, reserve requirements or similar parameters. Macroprudential measures can also target borrowers by imposing limits on loan-to-value or debt-to-income ratios.

Changes in the stringency of loan classification and provisioning rules may also have an impact on NPL resolution. Forcing banks to recognise and fully provision NPLs generally strengthens incentives to resolve or write-off non-performing assets. At the same time, a change towards stricter loan classification may actually result in an increase in reported NPL ratios, at least in the short-term.

This list of policies is not exhaustive but it accounts for a major bulk of actions historically taken to reduce NPL ratios. Examples of other measures include changes in tax treatments of NPLs that remove disincentives to write non-performing loans off for banks and borrowers or

judicial reforms.

3.3. An anatomy of NPL reductions

3.3.1. Constructing data on NPL ratios

In this section we present key stylised facts about episodes of high non-performing loans and NPL reductions. A non-performing loan is a loan where the full repayment of the principal and interest is no longer expected. Typically, the principal or interest would be at least 90 days in arrears, although the precise definition of an NPL loan varies across jurisdictions. This complicates international comparisons. In the absence of a universally applied definition of NPL, however, there is little a researcher can do to remedy the situation.

As this paper primarily focuses on changes in non-performing loans within each country, different definitions should not bias the results as long as country-specific approaches to classifying NPLs do not undergo major changes. The dataset inevitably lacks episodes where regulatory forbearance results in NPLs being severely under-reported. In countries practising "directed lending", this would often be the case. In that sense, the stylised facts about NPL reduction episodes and any estimates of economic impact of lower NPLs should be viewed as conditional on the authorities willing to recognise the NPL problem in the first place.

Our source of data on country level non-performing loans is the World Development Indicators (WDI) database of the World Bank and complemented with bank-level information available in Bankscope, aggregated to the country level, through the splicing procedure. The initial WDI country-level dataset is an unbalanced panel covering 134 countries over the period 1997-2016. The data are then cross-checked against a bank-level database, Bankscope, and extended with additional observations. Bankscope reports the NPL ratio for banks in 190 countries since 1980, with a more reliable coverage for the period 1990-2015.

The combined dataset is constructed using a splicing procedure based on de la Fuente Moreno (2014). The new spliced ($\widehat{NPL^S}$) time series for each country is estimated by extending

the WDI series backward when Bankscope measure is available. We preserve the last WDI observation and use growth rate of Bankscope NPL[17] to retropolate the spliced NPL. We then use the ρ coefficient to adjust for differences in levels inferred from the cross-country WDI database and from Bankscope. The new spliced NPL measure is equal to:

$$\widehat{NPL_t^S} = NPL_t^{WDI} + \widehat{d_t^m} \qquad \text{for } 1990 \leq \text{t} \leq \text{T} \tag{3.1}$$

Where T is the linking year, when first country-level WDI data are available while Bankscope data are also available for preceding years. The mixed splicing distance measure is given by equation 3.2 with a convergence coefficient $\rho = 0.3$.

$$\widehat{d_t^m} = d_T \rho^{\frac{T-t}{t}} \tag{3.2}$$

The average distance between the two time series at the linking point is defined by equation 3.3 and only final observations with NPL within the 0 to 100 percent range are preserved.

$$d_T = ln\Big(\frac{NPL_T^{WDI}}{NPL_T^{BS}}\Big) \tag{3.3}$$

In addition to extending time coverage for 134 countries that report at least one year of WDI data, we use the average difference between WDI and Bankscope to update the NPL data for 60 countries with observations available in Bankscope only. First, we calculate the average distance between WDI and Bankscope data at all linking points $\bar{d_T}$. Second, we update the Bankscope measure as follows:

$$\widehat{NPL_t^S} = NPL_t^{BS} + \bar{d_T} \tag{3.4}$$

The resulting dataset comprises 3,537 country-year observations in 194 countries between 1990 and 2016. Figure 3.1 illustrates the results of splicing procedure for Argentina, with WDI and Bankscope series exhibiting similar trends. Figure 3.2 summarises the procedure for the average NPL ratio across the entire sample. To the best of our knowledge, the splicing

[17]Bankscope data is reported on bank-year basis and aggregated to country-year level.

procedure is not used widely in the field of finance or economics and this paper is one of the first one to apply it to macroeconomic data. The additional step using the average distance at linking point $\bar{d_T}$ described in equation 3.4 is also a novel contribution to the literature. This approach may seem adhoc, however, all of empirical results reported in this paper are robust to the use of WDI data only. The obvious advantage of this novel splicing procedure is the extension of the dataset and verification from two independent data sources, that exhibit high correlation (68%***).

[Insert Figures 3.1 and 3.2]

3.3.2. Historical perspective

The (unweighted) average NPL ratio across all countries jumped in the 1990s and peaked at almost 12 percent in 1999, in the immediate aftermath of the Asian and Russian crises (Figure 3.2). It then started declining swiftly and was further pushed down by the credit boom in the run-up to the global financial crisis. It bottomed out at around 5 percent in 2007. The pattern is similar for the median.

In the aftermath of the global financial crisis the average quality of bank assets deteriorated less quickly than in the 1990s, with a jump of 2 percentage points between 2007 and 2009. However, rather than declining afterwards, the average NPL ratio has resumed an upward drift, exceeding 8 percent by 2014. As a percentage of GDP, average NPLs plateaued at around the peak levels reached briefly in 1998-99.

In other words, the magnitude of today's NPL problem is not unprecedented. Yet if in the past NPL episodes appeared to be of "acute" nature, the more recent episodes tend to be "chronic", slowly but steadily building up as economic growth and credit expansion slow down. Furthermore, only 40 to 48 percent of instances of high NPL episodes (exceeding NPL ratio of 7 percentage points) can be linked to a banking, currency or sovereign debt crisis that occurred between 1990 and 2012 based on the data reported by Laeven and Valencia (2012). The opposite is also true: 38 percent of banking crises were followed by high NPLs while the

majority were not. This highlights the value of analysing the episodes of high NPLs in historical perspective as these are more than just by-products of the (relatively well-studied) crises.

All in all, cases of elevated NPLs have been common: 165 out of 190 countries in the dataset experienced NPL ratios in excess of 7 percent at some point (the baseline analysis uses a 7 percent threshold for high NPL ratios, a ratio that is around 2.5 percentage points above today's median; alternative thresholds are used as robustness checks).

3.3.3. Data on policies addressing high NPLs

The database also puts together information on various policies aimed at resolving NPLs and adopted across countries. Data on asset management companies is taken from the Building Better Bad Banks project by Hallerberg and Gandrud (2015). A dummy variable is equal to one if an AMC was operating in the past 3 years. Where the data on AMC closure is not available, an AMC is assumed to have an average life span in the sample - 8 years. The database contains information on 139 cases of AMCs (109 public, 20 internal, 8 backed by deposit insurance and 2 unclassified) across 62 countries during the period 1990-2016.

The data on financial sector bailouts is taken from Bova et al. (2016) and covers public bailouts during systemic banking crises as well as stand-alone interventions. The database includes 95 recorded cases of financial sector recapitalisations across 66 countries. For 83 of those episodes, the data includes estimated fiscal costs of recapitalisation, averaging 9.7 percent of GDP.

Cerutti et al. (2015) are our source of data for changes in macroprudential policies. We use the positive changes in the values of the macroprudential policy index (MPI) as an indication of regulation being tightened (in other words, the dummy variable is coded one when MPI increased and zero otherwise). The database covers 119 countries from 2000 to 2013, with 135 cases of macroprudential tightening in 76 countries. In contrast, the instances of macroprudential loosening are limited to Bulgaria in 2008 and Serbia in 2013, and therefore are not studied in more detail.

The stringency of loan classification is proxied by the total number of days of delinquency after which a loan is classified as sub-standard, doubtful or lost (combining the three categories),

building on Barth et al. (2001, 2013). The data comes from surveys of 127 central banks conducted in 1999, 2003, 2007 and 2011 (with the values in between survey years carried forward). The average loan classification measure is 18 months, ranging from 4 months to over 3 years across countries.

The provisioning stringency (taken from the same source) is proxied by the sum of the minimum required provisions as loans become substandard, doubtful and loss (this sum averages 120 percent).

The data points constructed from the above sources were cross-checked against, and complemented with, narrative evidence regarding policy response, if any, in instances when NPL ratios were high. The narrative evidence was collected by looking at published case studies, newspaper articles, reports of governments and international organisations.

3.3.4. Episodes of high NPLs and NPL reductions

In our analysis of NPL reductions we look at sustained drops in NPLs that over a number of years amounted to a reduction of 7 percentage points or more. For each such occurrence we record the length of the period of reduction, from the first year in which the NPL ratio is smaller than in the preceding year to the last year in which the ratio does not exceed the value in the preceding year. Occasionally, the NPL ratio increases briefly before falling again. Such occurrences are not considered to break an NPL reduction period as long as they are limited to a single year and involve a relatively small increase in NPL ratio (of less than 1.6 percentage points). Countries that suffer from recurrent NPL problems may have multiple NPL reduction periods (assumed to be independent draws from the same data-generating process). We identify 104 episodes when NPL ratios above 7 percent persisted for four years or more and 178 episodes of NPL reduction. A typical episode of high and persistent NPLs lasts for 6 years, with NPL ratio rising by 1.5 percentage points a year, although some episodes stretched to up to 17 years and remained ongoing as of 2016 (see Table 3.2 for definition and Tables 3.11 and 3.12 for the list of NPL episodes).

[Insert Figure 3.3]

Some sort of policy action was taken in almost all instances of identified high NPLs and policy packages typically combined multiple types of measures discussed above. Of these, state support of the banking system has been the most widespread (Figure 3.3). In fact, introduction of AMCs was accompanied by the use of public funds in 36 percent of cases as public recapitalisation can facilitate creation of secondary market for NPLs as well as tightening of provisioning or classification rules. And while much of the policy debate centres on the establishment of market for distressed debt, with reference to the experiences of the Nordic countries in the early 1990s and South-East Asia in the late 1990s, recapitalisation packages have been more often accompanied by straight debt write-offs (implemented in around 60 percent of such episodes) than by creation of AMCs or bad banks. In Europe, developed secondary NPL markets are largely limited to Ireland and Spain, with attempts to set one up in Greece (see European Central Bank 2017b). Despite regulators actively encouraging banks to dispose of their toxic assets on the secondary market, there is no empirical evidence that such action would improve capitalisation[18] and risk-profile in the long term.

[Insert Figure 3.4]

If policy measures were successful and a significant reduction in NPLs was achieved, the NPL ratio broadly followed an average profile shown in Figure 3.4. At first, a country's NPL ratio rises fast as growth of performing credit slows down and eventually turns negative. Once the ratio peaks (at a median value of 21 percent), the NPL ratio drops equally fast. During the first two years this drop is strongly driven by the reduction in the stock of non-performing assets (the numerator of the ratio). As credit growth resumes, from years 3 onwards the declines in NPL ratio become primarily driven by the growing denominator of the ratio. A typical NPL reduction episode lasts for five years and NPL ratio eventually declines to a median level of 4.4 percent - comparable to 3.5 percent average ratio in countries that do not experience high NPLs (see Table 3.3).

[18]NPLs are usually sold at significant discounts (average 80%) and despite providing a reduction in risk-weighted assets, such sale also reduces the retained earnings due to the recognition of losses on the transaction.

The following formula can be used to compute the relative contributions of the decline in NPL stock and credit growth to the overall magnitude of a reduction in NPL ratio:

$$\text{Performing Loan share} = \frac{\text{Overall Loan Growth}}{\text{Overall NPL Growth} - \text{Overall Loan Growth}} \tag{3.5}$$

The calculation is equivalent to comparing the hypothetical reduction in NPL ratio that would have been achieved holding initial stock of NPLs constant with the one that would have been achieved holding the stock of total credit constant. The median contribution of credit growth at the start of an NPL reduction episode turns out to be 20.4 percent. In other words, a drop in NPLs is considerably more likely to be followed by a revival in credit growth than the other way round.

In some instances, NPL reductions were kick-started predominantly by credit growth (for example, in Bangladesh in the 2000s). However, such occurrences are rare: credit growth contributed more than 70 percent to the initial drop in NPL ratio in less than 10 percent of cases. Furthermore, these instances are concentrated in countries with shallow financial sectors, with a median credit-to-GDP ratio of 15 percent compared with 45 percent in countries where high NPLs persist. In sum, a strong upturn in credit growth is a theoretically possible but empirically improbable solution to most of today's instances of high NPLs.

3.3.5. Episodes of sharp drops in NPL ratio and the estimation strategy

The analysis of the economic impact of policy-assisted NPL reductions exploits the fact that a typical episode starts with a sharp drop in NPL ratio, typically accounted for by a drop in the stock of NPLs, followed by a phase of more gradual reduction. Focusing specifically on the episodes that contain a "steep" initial phase can help to reduce potential reverse causality concerns in estimation of the impact of a drop in NPL ratio on subsequent rather than concurrent economic performance.

Overall, in 143 cases (close to 80 percent of the total number) a drop of at least 5 percentage points in the NPL ratio occurs within a single year at the start of an NPL reduction episode. In 75 of these cases at least a 10 percentage point reduction occurs within a single year. And

in further 38 episodes a 10 percentage point drop happens within two years. Only in six cases the steep drop occurs towards the middle or the end of an episode rather than at the start. The baseline analysis focuses on the episodes that feature a 5 percentage point drop in a single year at the start of an episode or a ten percentage point drop over two years (the events of interest in our study). The strategy is to compare these "sharp drop" episodes with otherwise similar cases where high NPL ratios persisted.

The analysis proceeds in two steps. First, we look at the link between various policies and the NPL trajectory, including the likelihood of observing a sharp drop in NPL ratio. This exercise complements a separate study by Plekhanov and Skrzypinska (2019) who identify statistically and economically significant relationship between financial sector policies and NPL reductions by looking at the impact of policy measures in a given jurisdiction on NPLs of subsidiary banks operating in other jurisdictions compared with NPLs of other banks in host countries (see Chapter 4). Second, we look at the impact of a sharp drop in NPLs on economic outcomes by comparing evolution of economic indicators after a sharp drop in NPLs with economic outcomes during episodes of high and persistent NPLs that are similar in terms of their initial characteristics using propensity score matching.

[Insert Figure 3.5]

The rationale for the two-step approach (schematically presented in Figure 3.5) is the likely absence of the direct impact of NPL resolution policies on growth, investment or other outcome variables. Financial sector policies can target NPL levels. Reductions in NPLs may, in turn, affect economic outcomes by removing the burden of non-performing assets from the balance sheets or banks and corporates, hence improving access to credit, and boosting business confidence.

3.4. Policy effectiveness

3.4.1. Effect of various policies on NPLs

We start by looking at the link between various policies and NPL reductions. We are specifically interested in how policies are related to the events used later to identify the impact of NPL reductions on economic outcomes. In particular, we look at (i) the likelihood of a sharp drop in NPLs within three years of a policy being put in place and (ii) the magnitude of the subsequent NPL reduction, conditional on a sharp drop occurring. For this reasons, we estimate the following two-part model:

$$Pr(\text{Sharp Reduction}_{ct} = 1) = \Phi\big(\beta_0 + POL_{ct}\gamma_0 + X_{ct}\lambda_0 + \varepsilon_{ct}\big) \tag{3.6}$$

$$\big[\text{Magnitude}_{ct}|\text{Sharp Reduction}_{ct} = 1\big] = \beta_1 + POL_{ct}\gamma_1 + X_{ct}\lambda_1 + \epsilon_{ct} \tag{3.7}$$

The first stage links the likelihood of a sharp drop in NPL ratio in country c and time period t to a vector of policy dummy variables (POL) in a probit regression[19]. These variables take a value of one if a corresponding policy was in operation at any point during the preceding three years. The set of control variables X includes the initial value of the NPL ratio and macroeconomic variables such as the logarithm of GDP per capita at purchasing power parity (PPP), growth of GDP per capita, consumer price inflation and an index capturing the strength of insolvency resolution frameworks. The sample is restricted to instances of NPL ratio above 7 percent in order to exclude cases where NPL drop was not feasible.

The second stage links the magnitude of a sharp drop in NPLs (Magnitude_{ct}) conditional on a sharp drop taking place ($\text{Sharp Reduction}_{ct} = 1$) to the set of policy variables and controls defined above. The model is estimated as a two-part model following the framework of Belotti et al. (2015). This framework assumes a gamma distribution of the size of the overall magnitude of reduction in NPLs conditional on achieving a sharp reduction[20] and an identity link function

[19]Where the function $\Phi(.)$ represents the cummulative standard normal distribution

[20]This assumption matches the best our empirical distribution of NPL reduction magnitude, which

for simplicity. The choice of the two-part model approach is dictated by the fact that we do observe all changes in NPLs (unlike, for instance, in the Heckman selection framework) but we are specifically interested in the link between policies and events defined as sharp reductions in NPL ratio. The results are reported in Tables 3.4 and 3.5 for the first stage probit and second stage GLM, respectively.

[Insert Tables 3.4 and 3.5]

The use of asset management companies is associated with a statistically and economically significant increase in the likelihood of achieving a sharp drop in NPLs, as represented by positive and statistically significant coefficients on the AMC Policy dummy in Table 3.4. The magnitude of NPL reductions in the presence of AMCs are, on average, around 3 percentage points larger than could be otherwise expected, as indicated by positive and significant coefficients in Table 3.5.

The provision of financial sector bailouts, on the other hand, has no significant impact on the magnitude of the NPL reduction and, if anything, there is an indication that it may somewhat reduce the likelihood of a sharp drop in NPL ratio. This is perhaps not a surprising result, as financial sector recapitalisations rarely state explicitly how the injected new capital is expected to be used and thus may provide little incentives for banks to write-off toxic assets. Moreover, such recapitalisations may encourage banks to take on more risk in the future, as they implicitly guarantee future obligations.

Macroprudential tightening is designed to work as a countercyclical tool to prevent build-up of NPLs in the future(see, for instance, Bruno et al. 2017). Therefore, it has insignificant detectable impact in a medium term in a situation when NPL ratios are already high. If anything, it may be associated with lower reductions in NPLs (negative coefficients in the table 3.5) as macroprudential tightening may limit options for refinancing and restructuring of existing exposures.

has a positive skewness parameter.

Higher initial NPL ratios at the beginning of the episode are associated with larger NPL reductions provided one is achieved. However, on average, the higher the initial level of NPL ratio, the lower the probability of achieving a "sharp" reduction in a short period of time. This result illustrates the importance of addressing the NPL crisis early and implementing preventative measures. It also explains the more "chronic" nature of recent NPL crises (see Section 3.3.2). Should the NPL ratio continue going up, one can expect to further slow down the economic activity, which in turn perpetuates the negative feedback loop and increases the aggregate NPL ratio. In a situation of continued weak economic growth, the reduction of NPLs is particularly difficult to achieve, especially if a government has reached its maximum fiscal capacity.

Both Italy and Greece has experienced this particular vicious cycle in the recent years. The real per capita GDP has fallen by 5 percent and 22 percent respectively for Italy and Greece in the past decade, while the public debt reached record levels of 130 and 180 percent of GDP[21]. Given the continued weak economic prospects, lack of fiscal space and the fact that their NPL ratios remain at dangerously high levels[22], it is difficult to expect any rapid improvements.

NPL reductions are more likely to occur in lower-income economies that experience higher economic growth. Countries with better insolvency resolution framework and more efficient judicial systems are less likely to be in a situation of high NPLs (see Cerulli et al. 2017). Indeed, NPLs average 5.7 percent in the quartile of countries with the strongest frameworks versus 8.7 percent in the bottom quartile of countries. At the same time, once NPLs rise, countries with better insolvency resolution frameworks are less likely to experience large reductions in NPLs - perhaps because a strategy of holding on to problematic exposures and seeking resolution looks more attractive. Although not reported, we have also conducted a robustness check where the two part model is replaced with a static OLS. For this purpose we take all episodes of sharp NPL reductions, gradual reductions and persistency and calculate the change in NPL ratio throughout the episode duration, thus achieving a continuous estimate of the NPL change, ranging from -69 to +37 percentage points, this allows us to avoid the truncation on the zero

[21]Source: Eurostat

[22]NPL ratio was reported 14% for Italy and 45% for Greece in 2017 according to WDI data

threshold that necessitates the two stage approach. The results are robust to such change.

3.4.2. Policies as a package

While estimates point towards relative effectiveness of AMCs and ineffectiveness of bailouts, in many cases these policies were combined as a package (Figure 3.3). Indeed, even efficient and developed secondary market for NPLs may necessitate relatively low prices associated with transfer of non-performing assets, leaving banks with potentially large capital shortfalls. Higher transfer prices, on the other hand, may require larger injections of capital into AMCs, thus putting more burden on taxpayers.

To check for any complementarities between the use of AMCs and public funds for recapitalisation, the exercise is repeated distinguishing between three types of interventions: AMC only, provision of bailouts in the absence of AMCs or a combination of AMCs and public funds made available for recapitalisation. The first two columns in Table 3.6 report estimates for the likelihood of a sharp drop in NPLs, comparable to first stage of the two-part model. The dependent variable in the columns (2-4) is now the reduction in NPL ratio over the course of an episode, irrespective of whether a sharp reduction event occurred in a static OLS specification[23].

We find that public bailouts have no significant impact on probability of sharp reduction NPLs, in line with earlier estimates, while AMCs are associated with a higher likelihood of a sharp drop in NPLs and a greater magnitude of a reduction in NPLs. However, the effect of AMCs on both the likelihood and the magnitude of NPL reduction is estimated to be around 2.5 times greater if AMCs are used in conjunction with public funds being available for recapitalisation. We do not find any significant effects of changes in loan classification and provision stringency (results are available upon request).

[Insert Table 3.6]

[23]The results are robust to the approach using two-part model as explained in the previous section

3.5. The effect of bank's sovereign bondholdings

In section 3.4 we show that the use of AMCs and the bank recapitalisations can increase the likelihood of a sharp reduction in NPLs as well as the overall magnitude of the reduction in the stock of NPLs at a country-level. It is worth pointing out however, that those policies carry usually a substantial upfront fiscal cost; in the case of financial sector bailout averaging close to 10 per cent of GDP in our sample (Bova et al., 2016). Since both public AMCs and bailouts require public-fund support from the government the policy intervention itself can deteriorate fiscal balance and increase sovereign risk thus triggering the negative feedback loop between sovereigns and banks.

When government raises funding for such schemes via bond issuance, a large proportion of it may come from the banks themselves. In India, for instance, the 2017 policy package, aimed at addressing high NPLs, explicitly stated to load the banks with newly-issued domestic sovereign bond holdings and using the proceeds to increase banks' capital reserves. To make the situation even more complex, the preponderance of banks, that were subject to the government bailout, where already majority state-owned and had large domestic exposures to domestic sovereign debt. In these schemes, money effectively does not change hands but banks' regulatory capital ratios improve.

Similar argument can be extended to the deployment of publicly-funded AMCs. In order to provide a relief to the banking sector, such AMCs must offer a sufficiently high transfer price for the NPLs that are sold by the ailing banks. This, in turn, implies a large fiscal cost to the budget to provide necessary funding to the AMC. The data on transfer pricing is rarely released to the public and we have not been able to find realistic and comparable estimates of average AMC cost to the public finances for a larger sample of countries. Despite this data limitation, it can be argued that in order for the AMC scheme to make a positive impact on the financial sector health, it may require large fiscal outlays.

For example, Slovenia struggled with a sudden increase in the NPL ratio in the aftermath of the Global Financial Crisis and in response the government established a *Bank Assets Management Company* (BAMC) in 2013. BAMC has purchased approximately 60% of the total

Slovenian corporate NPLs in the first year of its operation. The gross carrying amount off the transferred impaired loans constituted 16% of Slovenian GDP in 2013[24]. Simultaneously, the bank's average sovereign bond holdings increased from 10% of total assets to 17% between 2012 and 2013, thus providing anecdotal evidence of the circular funding hypothesis.

The empirical evidence on the relevance of "circular" funding of bank bailouts or AMCs for NPL resolution is scarce. The prior literature on the problematic nature of the sovereign-bank nexus has grown substantially in the past decade. However, systematic evidence on whether the sovereign-bank nexus also reduces the effectiveness of financial sector policies, and in particular policies aimed at resolving overhang of NPLs, has not been discussed in the literature to the best of my knowledge. More generally, a high share of domestic sovereign bond holdings in bank's total assets has been linked to the crowding out of private lending, increases in systemic risk and negative real effects in terms of lower investment and slower job creation (see, for instance, Broner et al. 2013; Chari et al. 2018; Bocola 2016; Asonuma et al. 2015; Acharya and Steffen 2015; Gennaioli et al. 2014; Reinhart and Rogoff 2008). Chapter 2 of this thesis provides more background on the sovereign-bank nexus topic, while this section provides an empirical assessment of the effectiveness of policy packages aimed at resolving NPLs - taking into account the "funding-circularity" argument. In order to empirically test this hypothesis, we include the average size of sovereign bond portfolio held by banks in each country, as a measure of the sovereign-bank interconnectedness, in our estimation and interact it with the policy dummies.

$$Pr(\text{Sharp Reduction}_{ct} = 1) = \Phi\big[\beta_0 + POL_{ct}\gamma_0 + B\bar{H}_{ct}\phi_0 + B\bar{H}_{ct} \times POL_{ct}\theta_0 + X_{ct}\lambda_0 + \varepsilon_{ct}\big] \quad (3.8)$$

[24]Slovenia also engaged in bank recapitalisations prior to establishing BAMC (For the description of BAMC intervention see https://www.oenb.at/dam/jcr:a9498bc7-aeab-44b3-a314-640884cb8ad6/Balogh-Session-3.pdf

$$\Delta\text{NPL ratio over the episode}_{ct} = \beta_1 + POL_{ct}\gamma_1 + B\bar{H}_{ct}\phi_1 + B\bar{H}_{ct} \times POL_{ct}\theta_1 + \gamma_1 + X_{ct}\lambda_1 + \epsilon_{ct} \tag{3.9}$$

The equations 3.8 and 3.9 correspond to the equation 3.6 and the static OLS version of equation 3.7 with two major changes: (i) the regression is extended to include the country-level aggregate size of bank's sovereign bond exposure as share of total assets, $B\bar{H}_{ct}$ together with its interactions and (ii) the second stage equation includes the changes of the average NPL ratio over both the sharp reduction periods as well as the persistency periods in the static OLS approach[25].

The bank's sovereign bond holdings are aggregated to the country-level by taking an average across all banks in each country-year and weighting by banks' total assets. Even though the sovereign bondholdings here cannot differentiate between the domestic vs foreign government bonds, Gennaioli et al. (2014, 2018) show that it is a good proxy for the size of bank's home bias, as for most countries majority of sovereign bonds held are domestic bonds. The average size of sovereign bondholdings in our sample is 11% and has a standard deviation of 9.6%, the measure is higher for emerging countries (12.4% vs 9.6% for advanced). Results of the regressions are reported in Table 3.7. The core coefficients remain robust to the addition of sovereign bondholdings and their interaction with policy dummies.

[Insert Table 3.7]

Sovereign bondholdings are overall positively correlated with the probability of sharp reduction in NPL, possibly because banks with large NPL burden intentionally shift risk to increase the exposure to sovereign or due to a lack of alternative investment options.

In the baseline estimation bailouts implemented on their own (not in conjunction with the establishment of asset management companies) have no statistically significant impact on the likelihood or the magnitude of a drop in NPLs (see Table 3.6). However, the estimated impact

[25]The results are robust to the Two Part Model approach explained in section 3.4.

of bailouts on NPL resolution becomes significantly negative when banks have large exposures to the sovereign debt portfolio. It appears that in this case banks, and markets, interpret such a scheme as a license to *do more of the same*, as there is little evidence of structural change or genuine fresh funds injected into the banks. One can also argue, that in the presence of the substantial sovereign-bank nexus, governments cannot credibly commit sufficient funds for financial recapitalisations or that such bailouts create a negative sovereign risk shock that triggers the diabolic loop. It is worth noting that the high exposure to sovereign debt reduces only the probability of the sharp reduction episode following the financial sector recapitalisation (columns 1-3), it does not however affect the overall magnitude of the NPL reduction (columns 5-6).

On the other hand, if bailouts are accompanied by the establishment of asset management companies, the interaction term with sovereign bond holdings is small and not statistically significant. This preserves the positive impact of a policy package combining bailouts and AMCs, even in the presence of significant circular financing of government by banks. In this case, the presence of structural element of the reform package – associated with establishment of a market for non-performing loans – lends the credibility to the initiative. This result can be explained by the fact that the part-circular nature of funding underpinning the policy package becomes secondary as the intervention itself reallocates the bad loans away from the banks towards the more efficient users of the assets.

3.6. The economic impact of NPL reductions

3.6.1. Methodology

With the relationship between financial sector policies and reductions in NPL ratios in mind, this section, in turn, investigates the link between falling NPL ratios and economic outcomes. Our methodology aims to deal with both the reverse causality running from higher economic growth to lower NPL ratios and non-random nature of episodes of NPL reductions, linked to

non-random nature of adoption of NPL policies.

To provide a better insight into the direction of the causal relationship, we focus on the aftermaths of sharp drops in NPLs (the treatment group, Sharp Reduction$_{it=1}$). To alleviate concerns about countries' selection into the group of NPL reduction episodes, we use matching to produce plausible counterfactuals. In particular, the control group are episodes of high and persistent NPLs (Sharp Reduction$_{it=0}$). The matching takes into account a set of variables X available for each episode i, including GDP growth and inflation during the year of the sharp drop (year zero) as rising prices may help to inflate the burden of non-performing debt away. In various specifications we also match on GDP per capita at PPP, GDP growth during the preceding year, the public debt-to-GDP ratio (that may affect availability of fiscal space to implement policy packages), private sector credit-to-GDP ratio (capturing the level of financial development and bank dependency), the initial NPL ratio, investment-to-GDP ratio and unemployment rate. We focus on five economic outcomes (Y): growth of GDP per capita, investment growth, growth of exports, consumption growth, and unemployment rate. We are interested in estimating the average treatment effect on the treated (ATT), the expected difference between the observed outcomes in the treatment group Y_{1i} and the counterfactual economic outcomes that would have occurred in the treatment group in the absence of treatment Y_{0i}:

$$ATT = E[Y_{1it} - Y_{0it}|\text{Sharp Reduction}_{it} = 1] \tag{3.10}$$

To calculate the ATT, we draw on kernel propensity score matching with a common support requirement (Rosenbaum and Rubin, 1983) by estimating differences conditional on a set of observed covariates X:

$$\begin{aligned} E[Y_{1it} - Y_{0it}|\text{ Sharp Reduction}_{it} = 1] = E\Big[&E(Y_{1it}|X_{it}, \text{Sharp Reduction}_{it} = 1) \\ &-E(Y_{0i}|X_{it}, \text{Sharp Reduction}_{it} = 0)|\text{ Sharp Reduction}_{it} = 1\Big] \end{aligned} \tag{3.11}$$

For each episode from a treatment group, the algorithm selects a set of episodes from the control group which together resemble as closely as possible the treated episodes, based

on the estimated propensity that belongs to the treatment episode, conditional on the set of economic characteristics X. The weights attached to control observations are inversely related to the distance in terms of the estimated propensity scores. Under the assumption that the conditioning variables capture all the relevant differences between the treatment and control groups, this procedure creates a valid estimate of the correlation between the reduction in NPL ratios and economic outcomes (ATT).

3.6.2. Results of the matching analysis

Sharp reductions in NPL ratio are associated with extra GDP growth of more than 1.5 percentage points per annum over several years as compared with the cases of high and persistent NPLs (see Table 3.8). The growth effect kicks in around 2 years after the start of the episode and peaks around year 4; the average treatment effect on the treated is statistically significant for five years following the beginning of sharp reduction episode. These growth differentials accumulate over time when it comes to the level of GDP per capita (see Figure 3.6). The trajectories of output for the treated and controls are similar up and including the year when a sharp drop in NPLs occurs, despite the fact that we do not match specifically on GDP growth prior to episode start, with a stark divergence in paths from year two onwards, exceeding 13 percentage points by year 5. The additional 1.5 percent annual GDP growth is economically meaningful and at least in our estimation window does not show any signs of further reversal, leading up to the conclusion that reduction of NPLs has a persistent economic effect rather than transitionary.

[Insert Table 3.8]

Stronger growth appears to be underpinned by rebounding investment. The estimated differences in investment growth between the treatment and control group are large with estimates ranging between 3 and 8 percent additional investment growth per annum and statistically significant in most years and specifications. Figure 3.7 shows the cumulative effect of the investment growth differentials, which despite being estimated with less precision than

the GDP growth differentials, shows a cumulative difference in Investment index of approximately 45 percentage points. The impact on exports is more volatile and appears to be weaker than on investment or consumption, possibly due to exporters' ability to access credit against international receivables and their lower sensitivity to domestic credit conditions.

The results of propensity score matching need to be interpreted with caution. Despite our best efforts to reduce concerns of reverse causality and the selection bias, given our data restrictions, we cannot confidently claim that all of our results reflect causal effects. However, the results of our analysis point to the fact that carefully chosen policy action can help to lower NPL ratios, which in turn stimulates economic performance.

[Insert Figures 3.6 and 3.7]

3.6.3. Example: The case of the Philippines

The case of the Philippines provides a useful illustration of various estimated relationships. Following the Asian crisis of 1997, the Philippines experienced several years of high and persistent NPLs: the NPL ratio jumped to 12.4 percent in 1998 and climbed further peaking at 27.7 percent in 2001.

A policy package, aimed at cleaning up bank balance sheets, included introduction of AMCs supported by availability of bailout funds and other policy measures. In particular, the Special Asset Management Companies Law of 2002 provided the legal basis for establishment of privately-funded AMCs, introduced tax deductions and other incentives for setting up such special purpose vehicles. At the same time, the regulation put a threshold of 5 percent for bank's ownership of any AMCs that purchases assets from its balance sheet (Fung et al., 2004), thus increasing the likelihood of a genuine market for non-performing assets being created. In addition, the Privatisation and Management Office was established in 2001 to deal with government's banking assets. Financial sector recapitalisation funds provided by the government are estimated to have totalled 13.2 percent of GDP (Laeven and Valencia, 2012).

The introduction of the policy package was followed by a sharp drop in NPL ratio (which fell to 14.6 percent at end-2002). NPL eventually declined to 5.6 percent in 2007, representing an overall NPL reduction of 22 percentage points over a six-year episode. Economic growth picked up from an average of 2.5 percent in 1998-2001 to 3.6 percent in 2002 (the year of the initial sharp drop in NPL ratio) to the average of 5.7 percent over the subsequent five-year period (2003-07).

More recent examples of policy packages that delivered a swift reduction in the NPL ratio at a country level include Spanish and Slovenian examples. Both countries following the 2009 global financial crisis, experienced a sharp increase in NPL ratio. Subsequently the authorities established the AMCs (SAREB and BAMC, respectively) and supported selected banks with direct recapitalisation. In response to the policy actions NPLs dropped sharply from the peak of 14% and 18% in 2014 to the below 5% level in 2019. The GDP growth has followed the previously described pattern, with a substantial contraction around the time of the peak NPL episode and policy implementation and a recovery in the years following.

3.6.4. Discussion

If the links between policy packages and NPL reductions are strong and reductions in NPL ratios yield large growth dividends, why have measures to reduce NPLs not been deployed on a larger scale? In part, this may be because policies that are found to have been effective in dealing with NPLs - such as a combination of AMCs and use of bailout funds - are costly. On average, the fiscal cost of a bank bailout is estimated to have cost around 10 percent of GDP. Some of these funds may be eventually recovered, for instance in the form of return on public shareholding in banks or profits generated by public AMCs, others may be written off.

Even so, from a social perspective the net present value (NPV) of future gains in GDP appears to clearly justify the initial fiscal cost. If future output is discounted at 8 percent, an assumption based on the cost of funding for an emerging market with a modest credit rating, the infinite-horizon NPV of additional output is estimated at more than 40 percent of today's GDP (this calculation conservatively assumes that only 20 percent of the difference in output between an NPL reduction scenario and a high-NPL scenario persists after year 6). Stricter

assumptions may yield lower estimates but the NPV of associated extra tax revenue is most likely exceeding the initial fiscal outlay in most calculations.

At the same time, the balance of cost and benefit may be less straightforward over a horizon of up to 4 years - the length of a typical electoral cycle. The NPV of extra output generated over this period is between 4 and 9 percent of today's GDP, depending on how fast NPL ratio responds to the policy package. This highlights why policies aimed at reducing NPLs - similarly to long-term infrastructure projects - may not always be politically attractive even if their life-cycle socio-economic benefits are convincingly documented.

In addition, there is a stochastic element to this calculation: NPL policies raise the likelihood of a sharp drop in NPLs but their success is not guaranteed and depends on the design and implementation of the policy package. Centralised solutions to the overhang of NPLs involving well-capitalised state-backed bad banks or asset management companies require strong administrative capacity and appropriate legal regimes. In some cases the authorities' administrative strength, rather than fiscal, may be a binding constraint.

3.6.5. Robustness checks

We run a series of robustness checks to validate the reported results. The first set of checks of the propensity score matching analysis excludes episodes of NPL reduction where credit growth made a sizeable contribution at the start of an episode. Credit growth contribution exceeded 80 percent only in 6 cases and in further 9 cases it ranged between 70 and 80 percent (the corresponding specifications are presented in columns (1) and (2) of Table 3.9). The results also hold for stricter requirements with respect to contribution made by the initial drop in the stock of NPLs.

The second set of checks use various permutations of variables on which episodes are matched, as well as their lagged values. These include the NPL ratio, investment-to-GDP ratio, private credit-to-GDP ratio and the unemployment rate as well as the Worldwide Governance Indicators as a proxy for the quality of institutions (political stability, rule of law, regulatory quality), selected questions from the World Bank's Bank Regulation and Supervision Survey that look at the asset quality and provisioning rules, and the World Bank Doing

Business indicators of the depth of the credit market, ease of insolvency proceedings and the strength of legal rights (extended sets of results are available upon request).

We also test the robustness with respect to the magnitude of NPL ratio reduction used to identify various episodes. The baseline analysis uses a 7 percent cutoff for episodes of high and persistent NPLs and a 7 percentage point drop for episodes of NPL reductions. The results are qualitatively similar if higher cut-offs are used, for instance 15 percent (see Column 5, Table 3.9).

[Insert Table 3.9]

A stricter definition can also be applied to the sharp drops in NPLs at the start of the episodes used as the treatment group. A 7 percentage point drop in the first year (or a 10 percentage point drop over two years) leaves up to 90 treated episodes satisfying the common support requirement. The estimated growth differentials are, if anything slightly higher than those reported in Table 3.8 (see Table 3.10).

[Insert Table 3.10]

The large part of our analysis relies on the newly constructed spliced NPL ratio. We conduct robustness checks replacing the spliced NPLs with ratios reported by WDI and find qualitatively similar results although weaker statistical significance due to the reduced sample. We also explored number of alternative specifications for the estimation of policy effects including: inclusion of gradual reduction episodes to treatment group, inclusion of sharp NPL reduction episodes that experienced the biggest NPL reduction following a few years of medium NPL declines, changing the length of policy window from 3 years to 2 years and 1 year.

3.7. Conclusion

The paper constructed a novel panel dataset of NPL ratios since 1990 covering more than 190 countries as well as a novel dataset of financial sector policies targeting NPL reductions. Having identified episodes of high NPLs and NPL reductions episodes, the analysis covered the "anatomy" of a typical episode of high NPLs, the effectiveness of policies aimed at reducing NPLs, and the impact of sharp drops in NPL ratios on economic growth and other economic outcomes.

The analysis shows that episodes of high NPLs are more than just by-products of (relatively well-studied) crises: only 40 to 48 percent of cases of high NPLs episode can be linked to a banking, currency or sovereign debt crisis. NPL levels seen in the 2010s are not exceptional by historical standards, but if in the past instances of high NPLs were of "acute" nature, today's malaise seems to be more "chronic", with NPLs building up slowly and persisting. Episodes of high NPLs typically last for 6 years while NPL reductions tend to start after NPL ratio surpasses 21 percent.

In the overwhelming majority, countries tend to eventually adopt policy packages aimed at resolving NPLs. What appears to work best is a combination of availability of public funds (bailouts) and establishment of specialised asset management companies (a market-based solution). This package is 2 to 3 times more likely to achieve a fast and large reduction in NPLs than introduction of AMCs as a stand-alone measure, while financial sector bailouts in the absence of AMCs have no statistically or economically significant impact on NPLs, at least within a three-year window. The effectiveness of adopted policies depends also on the banking sector exposure to domestic sovereign debt. High sovereign bond holdings are in fact detrimental to the effect of bailout packages on NPLs when bailout packages are implemented in isolation. We attribute this effect to the circular funding argument.

A typical NPL reduction episode starts with a sharp drop in NPL ratio driven primarily by falling stock of NPLs. Occasionally credit expansions results in a rapid fall in NPL ratio - but such cases are rare and are predominantly found in shallow financial sectors (with a median credit-to-GDP ratio of 15 percentage points).

Once a steep drop in NPLs occurs, economic growth improves by more than 1.5 percentage points a year over several years. This is reflected by a rebound in investment and consumption growth and lower unemployment rate. The estimated effect is of similar order of magnitude compared with the growth impact of sovereign debt restructurings estimated by Reinhart and Trebesch (2016).

From a medium-to-long-term perspective, returns to policies aimed at reducing NPLs are high. Yet high upfront fiscal costs combined with the delayed onset of benefits may make the proposition insufficiently attractive to politicians with short electoral horizons. In other cases, administrative capacity required to implement a coordinated policy package and to develop a secondary market for NPLs may be a binding constraint.

Overall, the findings can be viewed as both good and bad news for the economies burdened with non-performing loans. The good news is that policy packages can be effective in terms of reducing the NPLs and lower NPL burden is, in turn, associated with significant economic benefits in the medium term. Past episodes of high NPLs provide valuable insights into package of measures that can help banks and corporations clean their balance sheets. The not-so-good news come from the anatomy of the past NPL episodes. A successful NPL resolution may be particularly challenging when the malaise is more chronic than acute, debt levels are high, the use of public funds for recapitalisation is restricted and political horizons are short.

3.8. Tables and Figures

Table 3.1: Data description and sources

Variable	Description	Data Source
Sharp NPL drop episode	Sequence of negative changes in NPL ratio that start at minimum ratio of 7pp. The total reduction must exceed 7pp or more and at least one year with reduction bigger than 5pp of NPL must be recorded at the beginning or in the middle of the episode. We allow for one year in between the subsequent NPL reductions for one-off NPL increase no bigger than 1.6pp.	own calculations
Gradual drop episode	Sequence of negative changes in NPL ratio that start at minimum ratio of 7pp and the total reduction is 7pp or bigger but no single year has min 5pp NPL reduction. We allow for one year in between the NPL reductions when NPL increases by max 1.6pp.	own calculations
Persistent NPL episode	When NPL is at a level of 7pp or higher and there is no sequence of NPL drops that would reduce the NPL by more than 7pp. NPL during persistence episodes can be increasing, constant or slowly decreasing.	own calculations
Sharp drop dummy	Dummy variable equals one when sharp drop episode happens and zero otherwise	own calculations
NPL change over episode	The total difference in NPL from the beginning to the end of sharp drop or persistency episode. It is below -7 for sharp drop episodes and above -7 for persistent episodes	own calculations
Magnitude of sharp reduction	The total difference in NPL from the beginning to the end of sharp drop episode. It is by definition bigger than -7.	own calculations
NPL	The ratio of non-performing loans to gross loans. The data combines WDI and Bankscope NPL measures according to mixed splicing procedure. More details in section 3.3.1.	WDI and Banksope
AMC	Dummy variable equals one when in a given year an Asset Management Company was in operation in country. It refers to publicly backed AMC, internal bad bank and when deposit insurance fund disposes of distressed assets	Hallerberg and Gandrud (2015)
Bailout	Dummy variable equals one when in a given year a government has realised an implicit or explicit contingent liability to financial sector during a banking crisis.	Bova et al. (2016)
AMC only	Dummy variable equals one when in any given year Asset Management Company was operating but there have been no financial sector bailouts and zero otherwise.	

Data description and sources (continued)

Variable	Description	Data Source
Bailout only	Dummy variable equals one when in any given year government has bailed-out a financial institution but no Asset Management Company was operating and zero otherwise.	
AMC and Bailout	Dummy variable equals one when in any given year Asset Management Company was operating and there has been financial sector bailout, zero otherwise.	
Macroprudential tightening	Dummy variable equals one when in any given year the borrower-targeting or financial institution-targeting macroprudential regulation has tightened and zero otherwise. This can include decrease in Loan-to-value ratio, leverage of banks, interbank exposures, etc.	Cerutti et al. (2015)
GDP pc	Gross domestic product per capita in PPP	IFS
GDP pc growth	Percentage increase in gross domestic product per capita in PPP	IFS
Inflation	Percentage increase in CPI	IFS
Advanced dummy	Dummy variable equals one when country is classified as High-Income economy	World Bank
Insolvency resolution	Distance to frontier index is derived from questionnaire responses by local insolvency practitioners and verified through a study of laws and regulations as well as public information on insolvency systems. Higher values represent better insolvency resolution framework	World Bank - Ease of Doing Business
Sovereign Bonds	Average total government debt securities held by bank to total assets in a country and year weighted by banks' total assets.	Bankscope

Figure 3.1: Splicing - Comparison of the NPL time series - Argentina

The chart presents non-performing loans ratio time series based on time series data for Argentina. The green line shows the WDI data, the red line shows the average Bankscope data aggregated to country-year level and the blue line represents the additional data obtained through splicing procedure (see section 3.3.1 for description).

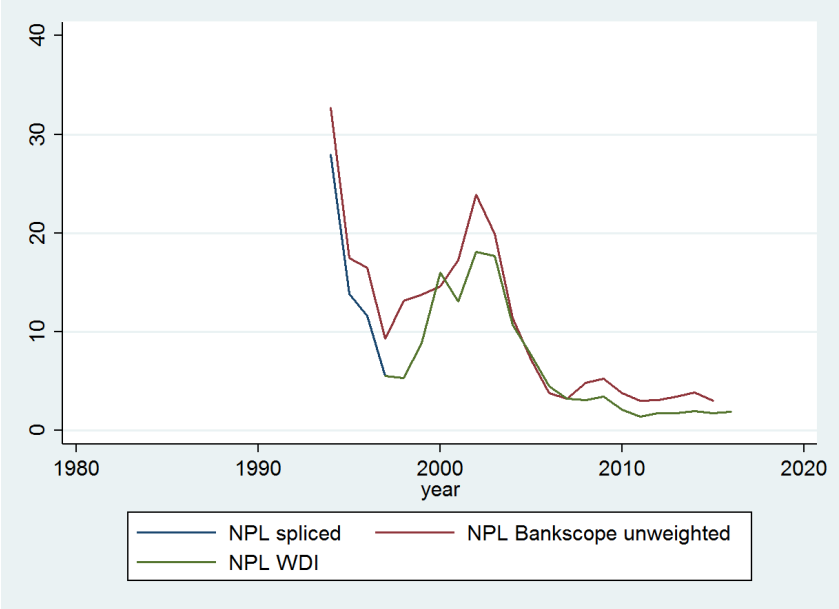


Figure 3.2: Splicing - Comparison of the NPL time series - full sample

The chart presents non-performing loans ratio time series based on cross-country data for averaged for all countries in our sample (equally weighted). The blue line shows the WDI data, the green one shows the average Bankscope data aggregated to country-year level and the red line represents the spliced NPL (see section 3.3.1 for detailed description of the procedure).

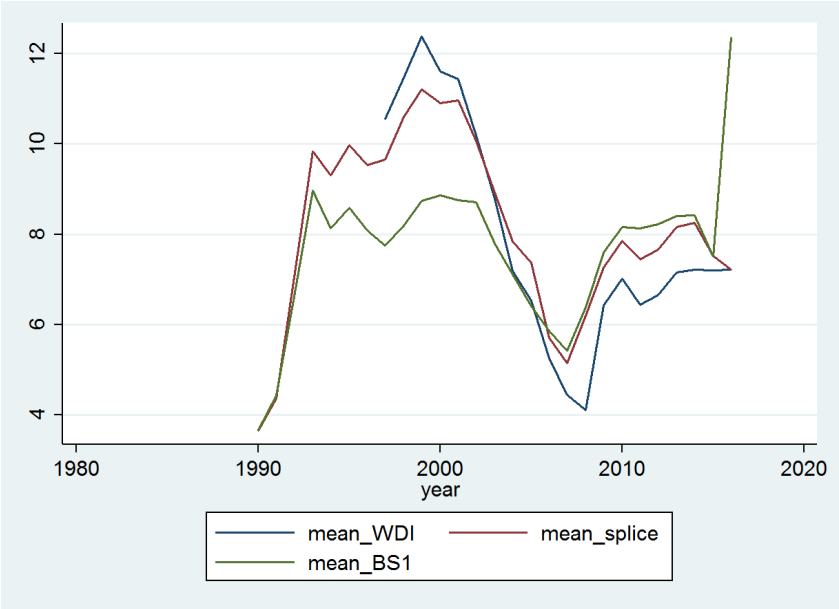


Figure 3.3: Overlap in different types policy measures taken to address high NPLs

The chart represents the fraction of high NPL episodes and episodes of NPL reduction that coincide in time with the use of particular policy type. Only 3.2% of NPL crises have not been addressed by one of those three policy options.

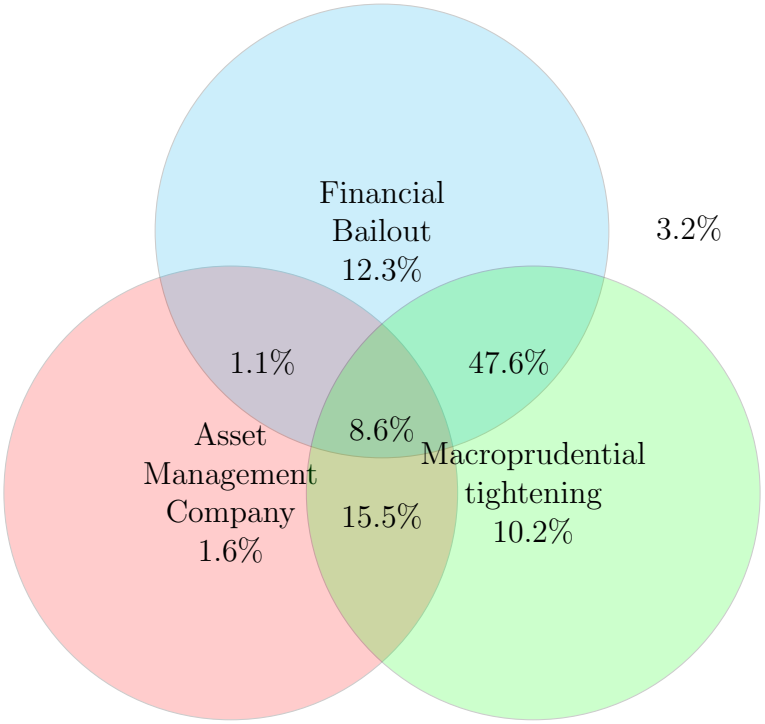


Figure 3.4: An average pattern of sharp NPL reduction episode.

The figure illustrates an average time series of selected indicators over the course of a sharp NPL reduction episode which starts in year 0. The green line represents the evolution of NPL ratio (right hand side axis) while the bars capture the growth in stock of non-performing loans (blue) and credit growth (red).

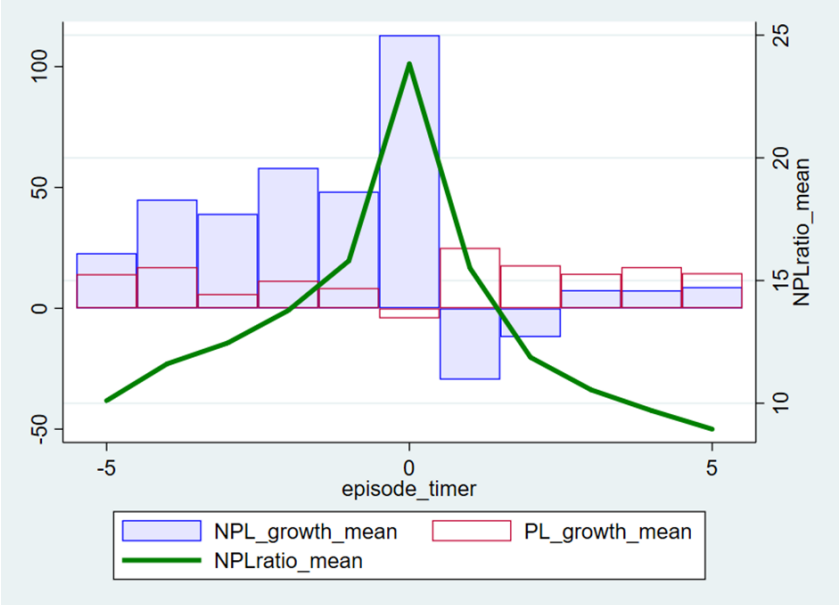


Figure 3.5: Two-stage approach illustration

The chart summarises the analytical framework adopted in this chapter.

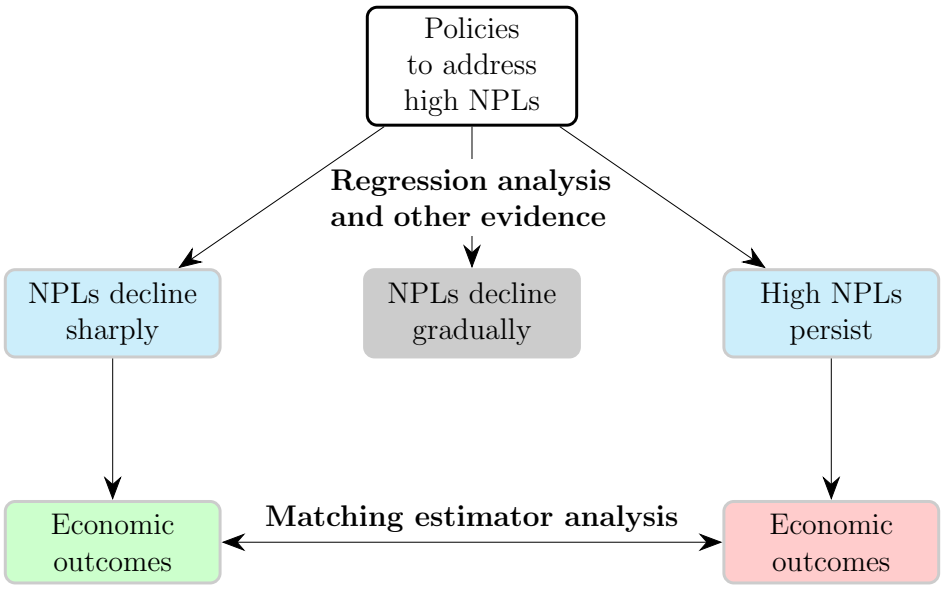


Figure 3.6: Output trajectories with and without NPL reduction

Based on the matching estimator where the treated group are cases of high NPLs where a sharp reduction in NPL ratio occurs in year 0; the control group are cases where high NPLs persist. Propensity score kernel matching with common support, where the matching variables are economic growth in year 0, the level of NPLs and a number of other variables. The resulting growth rates are turned into an index where value of 100 is assigned at year 0.

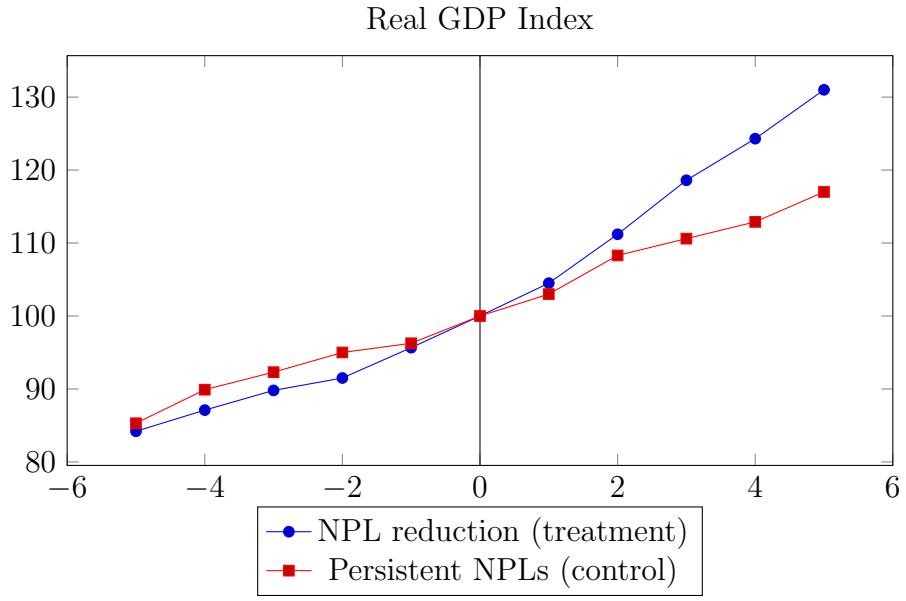


Figure 3.7: Output trajectories with and without NPL reduction

Based on the matching estimator where the treated group are cases of high NPLs where a sharp reduction in NPL ratio occurs in year 0; the control group are cases where high NPLs persist. Propensity score kernel matching with common support, where the matching variables are economic growth in year 0, the level of NPLs and a number of other variables. The resulting growth rates are turned into an index where value of 100 is assigned at year 0.

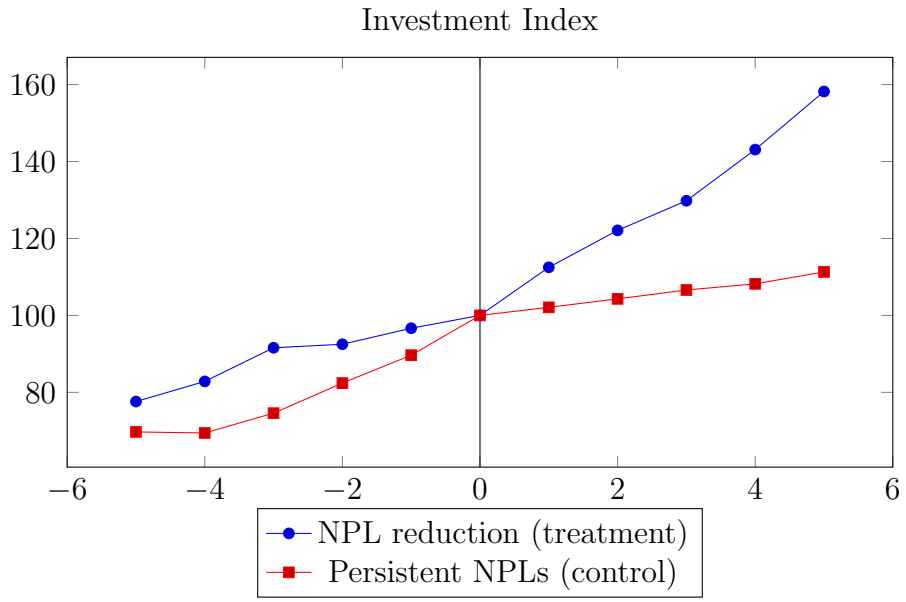


Table 3.2: High NPL episodes characteristics

NPL reduction episodes have a minimum reduction in non-performing loans ratio of 7 percentage points; episodes of high and persistent NPLs have a duration of minimum 4 years, no decrease in NPLs that would be classified as *sharp* and a minimum initial NPL ratio of 7 percent.

	Mean	St. dev.	Median	Min	Max
High and persistent NPLs					
Duration (years)	5.9	2.0	5.5	4.0	17.0
Initial NPL ratio	11.4	5.3	9.5	7.0	42.4
Change in NPL ratio	8.1	8.5	6.8	-6.7	37.0
NPL ratio at the end	19.5	9.9	18.0	7.0	59.8
NPL reduction episodes					
Duration (years)	5.8	3.3	5.0	2.0	15.0
Initial NPL ratio	24.0	13.8	21.2	8.0	95.3
Change in NPL ratio	-17.4	10.9	-14.2	-69.4	-7.1
NPL ratio at the end	6.7	7.5	4.4	0.1	66.4

Table 3.3: Means for selected variables by episode type

Means are reported in percent across all years in an episode, unless indicated otherwise. NPL reduction episodes have a minimum reduction in non-performing loans ratio of 7 percentage points; episodes of high and persistent NPLs have a duration of minimum 4 years, no decrease in NPLs that would be classified as *sharp* and a minimum initial NPL ratio of 7 percent.

	NPL reductions			Persistent NPL	Low NPL
	All	Sharp	Gradual		
Number of episodes	178	149	29	104	144
NPL ratio (start)	23.92	25.90	13.77	11.37	3.50
NPL ratio (end)	6.64	7.22	3.68	19.45	3.56
GDP pc (start)	13,137	11,591	20,816	15,433	19,980
GDP growth (start)	3.02	3.36	1.31	3.11	4.24
Public debt, %GDP (start)	64.19	66.96	53.54	54.20	48.72
Inflation, % (start)	7.19	7.40	6.21	4.72	4.86
Private sector credit, % (start)	31.09	26.79	51.29	45.44	55.30
Annual GDP growth	5.51	5.85	4.46	2.90	3.66
Annual investment growth	9.49	10.40	6.73	4.75	5.12
Annual consumption growth	5.07	5.50	3.78	2.79	3.99
Annual export growth	7.89	8.59	6.12	5.64	4.70
Unemployment rate (start)	9.76	9.97	8.72	9.61	8.80
Unemployment rate (end)	8.75	9.06	7.22	10.23	8.12

Table 3.4: Effectiveness of NPL targeting policies - first stage probit

The dependent variable in all regressions is the dummy variable equal to one when a country has experienced a sharp reduction in NPLs and zero otherwise. The independent variables in regression 3.6 are level of spliced NPL ratio, dummy for AMC, Bailout and Macroprudential tightening, GDP per capita (PPP), GDP pc (PPP) growth, CPI growth, dummy variable indicating advanced countries and insolvency resolution index. See table 3.1 for more detailed definitions. Column 0 reports OLS results as baseline, columns 1-4 report probit results - first part of Two Part Model. The regression includes only country-years that have NPL ratio above 7pp and have either experienced a persistency or sharp drop episode. Column 4 includes country FE. Standard errors are reported in the brackets.
*, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(0)	(1)	(2)	(3)	(4)
			Sharp reduction dummy		
NPL	-0.213***	-0.0531***	-0.0488***	-0.0809***	-0.0684***
	(0.0358)	(0.00465)	(0.00495)	(0.00876)	(0.00668)
Policy AMC	5.272***	0.429***	0.449***	0.669***	0.538**
	(0.908)	(0.0923)	(0.0996)	(0.16)	(0.241)
Policy Bailout	-1.367	-0.278**	-0.242	-0.212	-0.376*
	(1.352)	(0.139)	(0.152)	(0.246)	(0.214)
Macroprudential tightening	-0.822	0.101	0.0738	-0.341	0.131
	(1.858)	(0.185)	(0.201)	(0.26)	(0.245)
GDP pc	-0.0176	0.000229	0.00324	0.0142**	0.0303
	(0.0307)	(0.00196)	(0.00332)	(0.00651)	(0.0238)
GDP pc growth	41.69***	6.546***	9.005***	9.433***	8.078***
	(6.496)	(0.803)	(1.062)	(1.498)	(1.406)
Inflation	-0.0372		0.0292	3.824***	-0.0111
	(0.858)		(0.103)	(1.114)	(0.133)
Advanced dummy	-3.731***		-0.221*	-0.277	-2.011
	(1.148)		(0.124)	(0.236)	(1.644)
Insolvency Resolution				-0.00698*	
				(0.00364)	
Constant	10.69***	0.178**	0.077	0.254	
	(0.743)	(0.0806)	(0.0905)	(0.181)	
Observations	1248	1472	1248	645	1002
Model	OLS		Probit		
Country FE					Yes
Pseudo R2		0.148	0.151	0.241	0.318

Table 3.5: Effectiveness of NPL targeting policies - second stage GLM conditional on sharp reduction

The dependent variable in all regressions is the difference in NPL from the beginning until the end of sharp reduction; the variable is censored at NPL equal to 7pp the minimum required reduction over the period to qualify as sharp reduction. The independent variables in regression 3.7 are level of spliced NPL ratio, dummy for AMC, Bailout and Macroprudential tightening, GDP per capita (PPP), GDP pc (PPP) growth, CPI growth, dummy variable indicating advanced countries and insolvency resolution index. See table 3.1 for more detailed definitions. Columns 1-4 report Generalised Linear Model results - second part of Two Part Model. GLM assumes a gamma distribution of dependent variable and identity link function. The regression includes only country-years that have NPL ratio above 7pp and have experienced a sharp drop episode. Column 4 includes country FE. Standard errors are reported in the brackets.
*, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)
	Magnitude of sharp reduction (%)			
NPL	0.266***	0.207***	0.149	-0.0977***
	(0.0582)	(0.0618)	(0.105)	(0.0354)
Policy AMC	3.460***	2.805***	1.66	0.578
	(1.109)	(1.067)	(1.5)	(0.78)
Policy Bailout	1.853	3.59	4.012	-1.217
	(2.128)	(2.295)	(3.104)	(0.931)
Macroprudential tightening	-2.719	-4.810***	-2.956	0.587
	(1.868)	(1.792)	(2.346)	(0.724)
GDP pc	-0.0716***	-0.0153	-0.0593	-0.120*
	(0.0113)	(0.0206)	(0.0455)	(0.0714)
GDP pc growth	12.16	23.56*	53.46***	-8.346**
	(7.954)	(12.67)	(17.32)	(3.838)
Inflation		6.255	15.63	-2.612
		(7.173)	(14.35)	(2.149)
Advanced dummy		-6.117***	1.903	-1.419
		(1.223)	(2.584)	(6.093)
Insolvency Resolution			-0.173***	
			(0.0344)	
Constant	17.93***	19.16***	22.35***	
	(0.824)	(1.218)	(2.139)	
Country FE				Yes
N GLM	597	503	277	503

Table 3.6: Effectiveness of NPL targeting policies - probit and OLS

The dependent variable in columns 1-2 is a dummy variable equal to one when a country has experienced a sharp reduction in NPLs and zero otherwise - when the country had persistently high NPL ratio. The dependent variable in columns 3-4 is equal to the total change in NPL over the duration of the sharp drop or persistency episode; it is naturally below -7pp for sharp drop episodes and above -7pp for persistency episodes. The independent variables are level of NPL, dummy for AMC without Bailout, Bailout without AMC, combination of AMC and Bailout, GDP per capita (PPP), GDP pc (PPP) growth, CPI growth and a variable indicating advanced countries. See table 3.1 for more detailed definitions. Columns 1-2 report probit results and columns 3-4 report OLS results. The regressions include only episodes that have initial NPL ratio above 7% and have either experienced a sharp reduction or persistency - one observation per episode. Standard errors are reported in the brackets.
*, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)
	Sharp Reduction dummy		NPL change over episode	
NPL spliced	-0.0163**	-0.0158**	0.574***	0.574***
	(0.00664)	(0.00617)	(0.0598)	(0.0536)
Policy AMC only	0.326*	0.329*	-4.418**	-4.473**
	(0.195)	(0.189)	(2.13)	(1.985)
Policy Bailout only	0.19	0.162	1.097	0.518
	(0.357)	(0.298)	(3.494)	(2.91)
Policy AMC and Bailout	0.838***	0.820***	-7.804***	-8.410***
	(0.241)	(0.229)	(2.653)	(2.463)
GDP pc	-0.00334	0.00275	0.0935	0.0533
	(0.00691)	(0.00538)	(0.0751)	(0.0557)
GDP pc growth	4.639***	4.500***	-17.71*	-20.03**
	(1.521)	(1.263)	(10.23)	(9.015)
Inflation	-0.144		0.303	
	(0.169)		(1.009)	
Advanced dummy	-0.443*	-0.428**	2.507	2.572
	(0.23)	(0.205)	(2.408)	(2.057)
Constant	-0.463***	-0.582***	-8.580***	-7.674***
	(0.143)	(0.125)	(1.43)	(1.208)
Observations	428	522	428	522
Pseudo R2	0.073	0.063		
Adjusted R2			0.195	0.203
Model	Probit	Probit	OLS	OLS

Table 3.7: Sovereign-bank nexus distortion of NPL targeting policies

The dependent variable in columns 1-3 is a dummy variable equal to one when a country has experienced a sharp reduction in NPLs and zero otherwise - when the country had persistently high NPL level. The dependent variable in columns 4-6 is equal to the total change in NPL over the duration of sharp drop or persistency episode; it is naturally below -7pp for sharp drop episodes and above -7pp for persistency episodes.
The independent variables are level of NPL, dummy for AMC without Bailout, Bailout without AMC, combination of AMC and Bailout, average sovereign bondholdings held by banks (% of total assets, weighted by total assets), interactions of sovereign bondholdings with policy types and macro-controls: GDP per capita (PPP), GDP pc (PPP) growth and dummy variable indicating advanced countries. See table 3.1 for more detailed definitions.
Columns 1-3 report probit results and columns 4-6 report OLS results. The regressions include only country-years that have NPL ratio above 7pp and have either experienced a persistency or sharp drop episode - multiple observations per episode. Columns 3 and 6 control for country-year fixed effects. Standard errors are reported in the brackets.
*, ** and *** represent significance of the result at 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Sharp reduction dummy			NPL change over episode		
NPL	-0.0555***	-0.0595***	-0.0658***	0.722***	0.770***	0.760***
	(0.00469)	(0.0055)	(0.00834)	(0.0462)	(0.0528)	(0.0562)
AMC only	0.464***	0.562***	0.189	-6.799***	-9.304***	-6.634**
	(0.107)	(0.204)	(0.406)	(1.352)	(2.459)	(2.927)
Bailout only	0.0228	0.436	0.37	-0.356	-2.799	-5.141*
	(0.165)	(0.293)	(0.445)	(2.006)	(3.127)	(3.109)
AMC and Bailout	0.599***	0.557**	0.991**	-8.593***	-7.245***	-9.395***
	(0.135)	(0.23)	(0.501)	(1.698)	(2.75)	(3.102)
S. bondholdings		1.013**	3.209***		-8.136	-8.18
		(0.506)	(1.243)		(5.899)	(7.966)
S. bondholdings ×		-0.613	2.3		10.52	-3.167
AMC only		(1.371)	(2.468)		(16.61)	(17.66)
S. bondholdings ×		-5.419*	-5.778*		20.12	20.61
Bailout only		(2.948)	(3.392)		(27.64)	(25.43)
S. bondholdings ×		0.404	0.794		-20.82	-11.74
AMC and Bailout		(1.501)	(2.754)		(17.17)	(18.48)
GDP pc	0.00503**	0.00722***	0.0134	0.0223	-0.0124	0.0634
	(0.00253)	(0.00278)	(0.0172)	(0.0305)	(0.0309)	(0.109)
GDP pc growth	6.500***	8.094***	5.529***	-50.56***	-50.88***	-28.44***
	(0.804)	(1.037)	(1.651)	(7.374)	(8.106)	(7.654)
Advanced dummy	-0.362***	-0.439***	-1.015	4.153***	5.693***	-7.273
	(0.111)	(0.121)	(1.646)	(1.357)	(1.388)	(10.94)
Constant	0.193**	0.0938		-10.03***	-9.278***	
	(0.0826)	(0.113)		(0.941)	(1.247)	
Observations	1472	1115	790	1472	1115	1115
Pseudo/Adjusted R^2	0.155	0.187	0.384	0.199	0.233	0.511
Model	Probit	Probit	Probit	OLS	OLS	OLS
Country-year FE			Yes			Yes

Table 3.8: Results of propensity score matching estimating the impact of sharp NPL reduction on economic outcomes

The table reports the estimated Average Treatment Effect on the Treated from propensity score matching exercise for five consecutive years since the beginning of the episode. Treatment is defined as an episode of a sharp NPL reduction, of at least 5 percentage points in the year $t = 0$. Controls are defined as cases of high and persistent NPL episodes, where NPLs remain above the 7 percent threshold for a minimum of 4 years. The matching procedure is using propensity score from kernel matching with common support. Treatments and controls are matched on GDP growth, GDP per capita level, the initial level of NPLs, public debt ratio to GDP and inflation in the year $t = 0$. Standard errors are reported in the brackets. * p<0.10 ** p<0.05 *** p<0.01

	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$
GDP growth	1.549**	2.253***	2.330***	2.582***	1.926***
	(0.663)	(0.632)	(0.564)	(0.558)	(0.536)
Investment growth	5.893**	7.239**	8.388***	3.291	5.087**
	(2.914)	(3.561)	(2.309)	(3.011)	(2.433)
Consumption growth	3.423**	2.583***	2.876***	3.857***	3.216***
	(1.358)	(0.933)	(0.981)	(0.998)	(1.120)
Export growth	0.0225	1.983	4.352**	0.707	1.616
	(2.152)	(1.863)	(1.907)	(1.90)	(2.154)
Unemployment rate	-2.741**	-2.663**	-2.464**	-2.141**	-2.067**
	(1.106)	(1.109)	(1.080)	(1.063)	(1.042)
Controls	99	102	108	114	119
Treated	117	116	110	108	107

Table 3.9: Robustness test - Results of propensity score matching estimating the impact of sharp NPL reduction on economic outcomes using stricter definition of NPL reduction

The table reports the estimated Average Treatment Effect on the Treated from propensity score matching exercise for five consecutive years since the beginning of the episode. Treatment is defined as an episode of a sharp NPL reduction, of at least 7 percentage points in the year $t = 0$ or 10 percentage points over two years. Controls are defined as cases of high and persistent NPL episodes, where NPLs remain above the 7 percent threshold for a minimum of 4 years. The matching procedure is using propensity score from kernel matching with common support. Treatments and controls are matched on GDP growth, GDP per capita level, the initial level of NPLs, public debt ratio to GDP and inflation in the year $t = 0$. Standard errors are reported in the brackets. * p<0.10 ** p<0.05 *** p<0.01

	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$
GDP growth	1.367**	2.508***	2.495***	3.211***	2.380***
	(0.681)	(0.653)	(0.698)	(0.593)	(0.591)
Investment growth	8.691**	8.944**	7.298***	4.817	7.311***
	(3.584)	(4.338)	(2.694)	(3.422)	(2.641)
Consumption growth	2.689**	2.614**	2.504**	4.183***	3.370***
	(1.055)	(1.076)	(1.052)	(1.089)	(1.142)
Export growth	0.084	3.729*	3.528	1.322	3.050
	(2.389)	(2.143)	(2.294)	(2.185)	(2.074)
Unemployment rate	-3.057**	-3.014**	-2.946**	-2.468**	-2.129**
	(1.144)	(1.157)	(1.138)	(1.115)	(1.082)
Controls	99	102	108	114	119
Treated	90	89	84	83	82

Table 3.10: Robustness test - Results of propensity score matching estimating the impact of sharp NPL reduction on economic outcomes, alternative specifications

The table reports the estimated Average Treatment Effect on the Treated from propensity score matching exercise for years 2-4 since the beginning of the episode. Treatment is defined as an episode of a sharp NPL reduction, of at least 5 percentage points in the year $t = 0$. Controls are defined as cases of high and persistent NPL episodes, where NPLs remain above the 7 percent threshold for a minimum of 4 years. The matching procedure is using propensity score from kernel matching with common support. Treatments and controls are matched on GDP growth, GDP per capita level, the initial level of NPLs, public debt ratio to GDP and inflation in the year $t = 0$. Column (1) excludes the episodes of sharp NPL reduction that where credit growth contributed in more than 80% to the sharp decrease of NPL ratio. Column (2) excludes the episodes of sharp NPL reduction that where credit growth contributed in more than 70% to the sharp decrease of NPL ratio.
Columns (3) and (4) use extended set of matching variables; matching also on the investment-to-GDP ratio, private credit-to-GDP ratio and unemployment rate. Column (3) matches on variables in the year $t = 0$, while column (4) matches on lagged variables $t = -1$. Column (5) uses a stricter definition of NPL episode using a 15 percentage points threshold in lieu of 7 percent. Standard errors are reported in the brackets. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
	Exclusing credit-driven	Excluding more credit-driven	Extended set of matching variables		Using 15% for high NPL
GDP growth	2.689***	2.364***	2.553***	2.814***	2.119***
	(0.539)	(0.471)	(0.728)	(0.536)	(0.562)
Investment growth	8.092***	7.908***	8.599***	6.532***	8.446***
	(2.521)	(2.193)	(2.892)	(1.308)	(2.788)
Consumption growth	2.596***	2.451***	1.385**	2.652***	2.457***
	(0.574)	(0.538)	(0.691)	(0.525)	(0.713)
Export growth	2.87	2.519**	3.885**	1.400	2.128
	(1.502)	(1.246)	(1.884)	(1.407)	(1.564)
Unemployment rate	-2.614**	-2.690**	1.304	-2.517*	-1.797
	(1.230)	(1.177)	(1.908)	(1.326)	(1.417)
Controls	88	95	85	88	88
Treated	76	41	69	67	91

Table 3.11: List of sharp NPL reduction episodes

List of sharp NPL reduction episodes in alphabetical order.. ISO is a 2-digit ISO code, Start and End capture the first year and last year of the sharp reduction period. Initial NPL is the NPL in the year prior to episode start (lagged, in %), NPL change over episode in %.

ISO	Country	Start	End	Initial NPL	ΔNPL	ISO	Country	Start	End	Initial NPL	ΔNPL
AE	United Arab Emirates	2002	2009	15.7	-13.4	LT	Lithuania	1998	2006	22.2	-21.6
AF	Afghanistan	2009	2010	75.66	-48.58	LT	Lithuania	2010	2016	23.99	-18.19
AF	Afghanistan	2011	2014	49.9	-45.05	LV	Latvia	1996	2007	19.71	-19.21
AI	Anguilla	2004	2008	16.18	-10.19	LV	Latvia	2011	2017	15.93	-12.09
AL	Albania	2000	2002	24.25	-21.59	LY	Libya	2012	2015	38.1	-20.44
AM	Armenia	1998	1999	23.36	-17.36	MA	Morocco	2005	2011	19.4	-14.6
AM	Armenia	2002	2006	24.4	-22.5	MD	Moldova	1999	2008	33.13	-29.43
AR	Argentina	1995	1999	27.95	-22.65	MG	Madagascar	2003	2006	28.58	-21.26
AR	Argentina	2003	2016	18.1	-16.36	MG	Madagascar	2007	2009	21.66	-17.01
AZ	Azerbaijan	2002	2009	28	-25.62	MK	Macedonia, FYR	1995	1996	94.15	-27.72
BA	Bosnia and Herzegovina	2000	2008	23.27	-20.25	MK	Macedonia, FYR	1998	1999	95.3	-62.4
BB	Barbados	1996	2006	22.56	-18.19	MK	Macedonia, FYR	2000	2009	41.3	-34.59
BD	Bangladesh	2000	2007	41.1	-28.3	ML	Mali	1994	2003	38.1	-32.82
BD	Bangladesh	2008	2011	14.5	-8.77	MN	Mongolia	2001	2004	25.01	-14.69
BF	Burkina Faso	2011	2015	13.57	-9.86	MN	Mongolia	2009	2010	17.72	-13.39
BG	Bulgaria	1998	1999	24.4	-8	MN	Mongolia	2013	2015	14.68	-9.67
BG	Bulgaria	2000	2005	26.7	-24.7	MO	Macao, China	2001	2002	16.84	-9.21
BG	Bulgaria	2016	2017	20.6	-7.43	MO	Macao, China	2003	2014	12.81	-12.71
BJ	Benin	1996	1997	28.13	-17.52	MR	Mauritania	2009	2011	30.43	-20.08
BJ	Benin	2005	2006	18.43	-8.72	MW	Malawi	2003	2004	25.23	-18.23
BM	Bermuda	2010	2011	14.73	-12.54	MW	Malawi	2014	2016	15.12	-12.43
BY	Belarus	2002	2009	14.9	-13.2	MZ	Mozambique	1999	2000	22.52	-13.58
BZ	Belize	2014	2016	38.1	-10.98	MZ	Mozambique	2002	2010	23.4	-21.56
CI	Ivory Cost	2005	2008	32.71	-23.51	NG	Nigeria	1994	1999	35.47	-16.07
CI	Ivory Cost	2009	2011	16.03	-12.65	NG	Nigeria	2003	2009	21.4	-15.15
CI	Ivory Cost	2013	2015	22.84	-9.1	NG	Nigeria	2010	2015	37.25	-34.29
CN	China	2002	2013	29.8	-28.85	NI	Nicaragua	2002	2007	11.73	-9.57
CR	Costa Rica	1997	2008	31.91	-30.71	NP	Nepal	2006	2007	11.48	-8.78
CU	Cuba	2005	2007	12.9	-11.86	OM	Oman	1996	2000	14.39	-8.39
CU	Cuba	2008	2013	13.64	-9.07	PE	Peru	2004	2009	14.8	-12.6
CV	Cape Verde	1995	1996	24.37	-7.58	PG	Papua New Guinea	1993	1995	25	-18.19
CV	Cape Verde	1999	2002	21.21	-17.24	PG	Papua New Guinea	2001	2007	23.52	-23.13
CV	Cape Verde	2008	2010	13.15	-8.97	PH	Philippines	2002	2016	27.7	-25.81
CW	Curacao	2003	2004	25.88	-8.72	PK	Pakistan	2002	2007	23.4	-16.1
CW	Curacao	2005	2007	23.52	-20.23	PL	Poland	1995	1998	23.05	-12.55
CZ	Czech Republic	1997	1999	27.73	-7.43	PL	Poland	2004	2009	21.2	-18.38
CZ	Czech Republic	2001	2008	29.3	-26.93	PS	Palestinian Territory	2009	2015	19.25	-15.41
EC	Ecuador	2001	2014	31	-27.44	PY	Paraguay	2004	2011	20.6	-19.16
EG	Egypt	2006	2016	26.5	-19.3	QA	Qatar	2002	2009	15.44	-14.24
ET	Ethiopia	2003	2005	32.87	-17.63	RO	Romania	1999	2003	71.7	-69.4
ET	Ethiopia	2006	2010	21.92	-18.8	RO	Romania	2014	2017	21.87	-10.57
GD	Grenada	2006	2008	11.37	-8.34	RS	Serbia	1996	1999	18.8	-13.28
GE	Georgia	1999	2001	13.04	-9.22	RS	Serbia	2001	2002	27.53	-12.78
GE	Georgia	2002	2007	11.6	-10.79	RU	Russia	1999	2007	17.3	-14.9
GM	Gambia	2014	2016	19.07	-12.58	RW	Rwanda	2002	2015	74.1	-68.88
GN	Guinea	2004	2007	17.63	-12.07	SE	Sweden	1994	2008	10.95	-10.87
GN	Guinea	2010	2015	23.18	-17.12	SK	Slovak Republic	1996	1997	39.43	-14.24

List of sharp NPL reduction episodes (continued)

ISO	Country	Start	End	Initial NPL	ΔNPL	ISO	Country	Start	End	Initial NPL	ΔNPL
GQ	Equatorial Guinea	2004	2007	9.82	-7.12	SK	Slovak Republic	1999	2005	31.6	-29
GQ	Equatorial Guinea	2009	2012	16.18	-11.77	SL	Sierra Leone	2001	2004	37.9	-30.5
GR	Greece	2000	2002	15.5	-9.9	SL	Sierra Leone	2007	2010	26.9	-16.31
GY	Guyana	2004	2006	35.81	-31.57	SM	San Marino	2012	2013	34.05	-13.76
HR	Croatia	1997	1998	14.76	-7.93	SN	Senegal	1994	1995	37.94	-24.92
HU	Hungary	1994	2005	17.2	-15.4	SN	Senegal	1997	1999	29	-15.03
IL	Israel	1999	2010	9.9	-8.5	SZ	Swaziland	1997	2004	31	-29
IQ	Iraq	2010	2011	36.08	-9.36	TG	Togo	1996	1998	20.27	-10.6
IQ	Iraq	2013	2015	34.95	-19.13	TG	Togo	2002	2004	31.13	-9.49
IS	Iceland	2011	2016	18.3	-16.6	TG	Togo	2005	2008	23.86	-18.42
JO	Jordan	2002	2008	19.3	-15.2	TH	Thailand	1999	2002	42.9	-31.4
KE	Kenya	2000	2002	33.7	-20.6	TJ	Tajikistan	2006	2008	58.13	-53.33
KE	Kenya	2004	2012	34.9	-30.47	TM	Turkmenistan	2010	2013	10.56	-8.28
KG	Kyrgyz Rep.	2001	2005	30.9	-22.9	TR	Turkey	2002	2008	29.3	-25.98
KG	Kyrgyz Rep.	2006	2008	15.36	-11.76	TT	Trinidad and Tobago	1994	1999	11.13	-8.07
KG	Kyrgyz Rep.	2011	2015	15.8	-11.3	TZ	Tanzania	2000	2003	25.2	-16
KH	Cambodia	2002	2003	25.55	-13.94	TZ	Tanzania	2004	2006	12.93	-7.31
KN	Sain Kitts and Nevis	2001	2004	16.95	-9.91	UA	Ukraine	2000	2003	35.8	-13.9
KR	Korea, Rep.	2001	2009	8.9	-8.33	UA	Ukraine	2007	2009	59.76	-55.87
KW	Kuwait	2001	2008	19.2	-15.4	UG	Uganda	1999	2003	20.2	-17.2
KY	Cayman Islands	2003	2004	11.94	-7.57	UY	Uruguay	2003	2009	33.9	-33.39
KY	Cayman Islands	2011	2014	15.05	-11.33	VN	Vietnam	1999	2005	15.11	-14.08
KZ	Kazakhstan	2002	2007	37.71	-35.31	XK	Kosovo	2009	2012	21.96	-13.28
KZ	Kazakhstan	2011	2017	20.93	-13.03	XK	Kosovo	2011	2014	15	-13.28
LA	Lao PDR	2010	2014	25.89	-25.18	YE	Yemen, Rep.	2007	2010	24.52	-10.62
LB	Lebanon	1994	1999	13.68	-10.08	ZM	Zambia	2001	2004	26	-20.7
LR	Liberia	2006	2009	34.46	-28.58	ZW	Zimbabwe	2001	2004	19.55	-16.89
LR	Liberia	2011	2014	38.1	-24.02	ZW	Zimbabwe	2005	2007	20.95	-20.39

Table 3.12: List of gradual NPL reduction episodes

ISO	Country	Start	End	Initial NPL	NPL Δ over episode	ISO	Country	Start	End	Initial NPL	NPL Δ over episode
BN	Brunei Darussalam	2010	2016	9.36	-8.96	MT	Malta	2002	2005	18	-11.5
BO	Bolivia	2003	2013	17.7	-16.2	MV	Maldives	2011	2017	24.83	-14.2
BR	Brazil	1999	2008	10.2	-7.22	MX	Mexico	1999	2006	11.3	-9.8
CO	Colombia	2000	2006	13.6	-10.9	MY	Malaysia	2002	2016	17.8	-16.2
DO	Dominican Republic	2004	2015	8.7	-7.16	OM	Oman	2004	2009	12.5	-10.5
DZ	Algeria	2010	2015	21.14	-11.93	SA	Saudi Arabia	2000	2006	11.4	-9.5
GB	United Kingdom	1993	1993	10.98	0	SD	Sudan	2011	2016	14	-8.9
GD	Grenada	1999	2005	12.32	-7.29	SG	Singapore	2002	2015	8	-7.24
HN	Honduras	2000	2008	11.2	-8.1	SI	Slovenia	2013	2017	15.18	-7.21
IN	India	1998	2010	15.7	-13.49	TH	Thailand	2003	2014	16.5	-14.2
JM	Jamaica	2000	2007	13.53	-10.93	TN	Tunisia	2004	2012	24.2	-12.9
KH	Cambodia	2004	2016	14.47	-12.88	VE	Venezuela, RB	1995	1998	10.63	-7.83
KW	Kuwait	2010	2017	11.5	-9.1	VE	Venezuela, RB	2003	2006	9.2	-8.1
LB	Lebanon	2005	2012	17.7	-13.94	ZM	Zambia	2011	2014	14.82	-7.87

Chapter 4

Cross-border spillovers from reducing non-performing loans

Abstract Authorities in many countries recently deployed policies to reduce non-performing loans (NPL). This paper sheds light on the effectiveness of such policies. Using data on ownership of subsidiaries of foreign banks in Emerging Europe, we first show that changes in NPLs have an impact of NPLs of banks' foreign subsidiaries. The transmission is driven by internal capital markets, consolidated supervision and, to some extent, by the exchange of knowledge within banking groups. We then use a novel dataset on policies deployed to address high levels of NPLs in a large number of countries over the period 1990-2013 and bank-level data to assess the impact of various NPL policies on bank subsidiaries operating in foreign jurisdictions. The difference-in-difference identification strategy exploits the exogenous timing of introduction of policies in foreign jurisdictions. Establishment of asset management companies (AMCs) with the view to develop a secondary market for impaired loans is found to have positive impact on foreign bank subsidiaries' NPL reduction. AMCs are estimated to be associated with a 12-20 percent yearly reduction in the stock of NPLs over several years. The social benefits of policies to reduce NPLs may be larger than previously thought - on account of positive cross-border spillovers.

Keywords: non-performing loans, cross-border spillover, asset management companies

JEL Codes: F42, G21, G28, G33, O40

4.1. Introduction

A decade after the global financial crisis of 2008-09, balance sheets of banks in many advanced economies and emerging markets remained clogged by non-performing loans (NPLs) - broadly understood as loans that are at least 90 days in arrears. Persistence of NPLs after the 2008-09 crisis has brought the issue of NPL resolution to the forefront of policy debate, with countries from Italy to India belatedly putting forward packages aiming to reduce NPL ratios. Such packages may include establishment of Asset Management Companies (AMCs) specialising in dealing with NPLs, provision of public sector funds for bank recapitalisation with the view to facilitate management and write-off of NPLs, changes to loans classification and provisioning rules and amendments to tax treatments of NPLs, among others.

Financial sector shocks and policy changes have been shown to affect banks across borders. Foreign bank affiliates respond to financial shocks in home territories of parent banks (Peek and Rosengren, 1997, 2000; Schnabl, 2012; Cerutti and Claessens, 2017) reflecting the workings of internal capital markets of banking groups (de Haas and van Lelyveld, 2010; Ongena et al., 2013a). Macroprudential measures can also significantly affect behaviour of bank affiliates abroad (Aiyar et al., 2014a,b; Ongena et al., 2013b; Berrospide et al., 2017) and monetary policy is transmitted internationally (Hills et al., 2017; Cetorelli and Goldberg, 2012).

This paper investigates whether changes in NPLs affect foreign subsidiaries of banks and evaluates cross-border effects of policies aimed at reducing NPLs. The estimates of such cross-border effects are of major interest for two reasons.

First, policy packages aimed at reducing NPLs tend to be costly, at least in the short-to-medium term. Positive cross-border spillovers of such policies imply higher welfare benefits of policy actions. In certain setting, for instance in the context of the European Union (EU), such cross-border effects can be internalised in the decision making process,

strengthening the case for a more forceful (and, perhaps, more centralised) approach to addressing high NPLs.

Second, cross-border estimates can be seen as the lower bound of the effectiveness of NPL policies in the jurisdiction where they are deployed. Coupled with information on the magnitude of transmission of changes in NPLs within banking groups these estimates also shed light on the direct impact of NPL policies. Estimating the effectiveness of NPL policies within jurisdictions with precision is difficult (see Chapter 3) and much of the evidence to date is based on case studies of various episodes (Baudino and Yun 2017, for a recent summary of lessons learned). The use of policies in response to high and rising NPLs and the timing of such policies is arguably non-random. As a result, effective policies adopted early in the crisis may look ineffective due to the severity of economic downturn, and the effect of policies adopted late may be estimated with positive bias.

In contrast, estimates of cross-border effects of NPL reductions exploit arguably exogenous variation in the deployment of policies. Identification comes from comparing the evolution of NPLs in domestic banks and in subsidiaries of foreign banks in the same year and operating in the same jurisdiction. This approach accounts for the relevant differences in macroeconomic conditions and policy environments across countries and across time.

To estimate the transmission of changes in NPLs from parent to subsidiary banks we use detailed information on bank ownership in Central and South-Eastern Europe (CESEE) based on De Haas et al. (2015). This region is particularly interesting, due to the large NPL variation over time as well as across-borders and the common presence of foreign bank subsidiaries, however the data is limited to the 1990-2010 period. To estimate the cross-border effects of policies aimed at reducing NPLs, we use a novel dataset on policy actions in a large number of countries over the period 1990-2015 and bank-level data from Bankscope database in combination with bank-level data on bank

ownership (Claessens and Van Horen, 2015)[26].

The paper contributes to two distinct strands of literature. The first, briefly touched upon above, examines cross-border transmission of various financial sector shocks through bank ownership networks. This paper extends the analysis of cross-border policy spillovers by looking specifically at the evolution of non-performing loans and a broader set of policy measures. The second strand looks at the aftermaths of banking crises and, more specifically, at approaches to dealing with the overhang of non-performing loans in the banking sector and their effectiveness. The analysis reveals that a one percent reduction in the stock of parent's bank NPLs is associated with a 0.6 of a percentage point reduction in the stock of NPLs of a subsidiary bank operating in a foreign jurisdiction when parent's NPL levels are high (above the 5 percentage points NPL ratio threshold). This transmission appears to be driven largely by the workings of internal capital markets within banking groups and consolidated supervision and, to some extent, by the transfer of knowledge in the area of NPL resolution. We find that banks with parents located in Basel jurisdiction exhibit higher co-movement in NPL stock, those whose parents are better capitalised tend to have a slower growth of NPLs and that those subsidiaries located close to their parent have stronger credit risk transmission. Our analysis however does not allow to quantify the magnitude of each channel.

As a result of this transmission, policies aimed at reducing NPLs can have detectable cross-border effects. In particular, the establishment of Asset Management Companies (AMCs) specialising in dealing with NPLs has an impact on NPL resolution in banks' foreign subsidiaries. This impact does not appear to be enhanced by public sector bailouts in the foreign jurisdiction. We estimate that the establishment of an AMC in the jurisdiction of a parent bank reduces the stock of NPLs on the balance sheets of foreign

[26]The CESEE sample allows us to map directly the links between the subsidiary-parent bank pairs, however the sample is limited to a shorter time period. The ownership data from Claessens and Van Horen (2015) allows us to extend the analysis until 2015 and to include a larger number of countires, at the expense of granularity, as this data set allows only to map the subsidiary-parent country link rather than subsidiary-parent bank ID.

subsidiary banks by an additional 12 percent per annum compared with domestic banks in the same jurisdiction. In contrast, financial sector bailouts not accompanied by the establishment of AMCs appear to have a weak impact on NPL ratios, if any. Changes in loan classification stringency, revisions to provisioning rules or macroprudential policy tightening do not appear to have significant cross-border effects on NPL ratios or credit availability.

The rest of the paper is structured as follows. Section 4.2 discusses the adverse economic effects associated with high NPLs as well as financial sector policies that can help reduce NPL ratios. Section 4.3 explores possible transmission of such policies across borders. Section 4.4 estimates the impact of changes in NPLs on NPLs of banks' foreign affiliates. Section 4.5 examines the cross-border effects of various policies aimed at reducing NPLs and infers their likely effectiveness in the domestic jurisdiction. It also revisits possible cross-border transmission channels of NPLs in the context of the results of empirical analysis. Section 4.6 concludes.

4.2. Policies to reduce NPLs and their potential cross-border effects

4.2.1. Adverse effects of non-performing loans

A high ratio of non-performing loans to total loans tends to have a negative impact on bank lending and economic activity. High NPLs require greater loan loss provisions, reducing capital resources available for lending, denting bank efficiency and profitability (Berger and DeYoung, 1997; Keeton and Morris, 1987; Salas and Saurina, 2002; Jiménez and Saurina, 2006). The NPL exposure focuses bank's internal resources on loan recovery work, including repossession of collateral and its disposal. These efforts are costly (Townsend, 1979) and come at the expense of expanding business.

Undercapitalised banks may take excessive risk in a gamble to boost profitability

(Jensen and Meckling, 1976), which may exacerbate the NPL problem further. Recent studies find a positive correlation between banks' leverage ratios or loan-to-asset ratios and NPLs (Klein, 2013; Garrido et al., 2016). High NPLs ultimately predict bank failures (González-Hermosillo et al., 1997).

High NPLs may also result in a misallocation of resources in an economy. Zombie lending - channelling new credit predominantly to troubled companies - may help to prevent second-round business failures but at the expense of starving more productive parts of the economy of credit (see Peek and Rosengren 2005; Caballero et al. 2008). Breaking this vicious cycle requires large capital injections (Giannetti and Simonov, 2013). Reducing NPLs can thus be associated with a sizeable growth dividend (see Chapter 3.6).

Dealing with non-performing loans

Recognising the adverse effects of NPLs, policymakers adopted a number of measures aimed at accelerating NPL reductions. The first step is to transparently assess the quality of bank assets and build up provisions against expected losses. Relying on banks' voluntary efforts in this area may not be sufficient and regulators may need to guide banks with respect to loan classification and provisions as well as assist banks with developing special capacity to deal with NPLs. When judicial capacity to deal with NPLs on a case-by-case basis is lacking, creating a sound legal framework for timely corporate restructuring is crucial. For instance, centralised out-of-court debt workout programmes were actively used in Korea, Thailand, Indonesia and Malaysia in the 1990s (Woo, 2000). In this paper, we consider five types of financial sector policies that can influence NPL ratios: the establishment of an asset management company, provision of bailouts to the financial sector (for instance, public funds for bank recapitalisation), changes to macroprudential regulation, changes to loan classification and changes to provisioning stringency, we discuss these in turn.

Asset management companies

The establishment of "bad banks", also referred to as asset management companies, encourages the development of a secondary market for NPLs. It enables commercial banks to transfer NPLs to a specialised entity at a fair (market) value. The AMCs can choose to securitise and resell impaired loans in a secondary market, use their expertise to partially recover bad loans or initiate foreclosure with the view to monetise collateral attached to bad loans. AMCs have additional advantages: unlike individual banks, they may internalise the effect of foreclosure on value of housing collateral in the portfolio (Favara and Giannetti, 2017), enjoy economies of scale and are not subject to bank capital regulation.

AMCs were deployed, for instance, in Sweden and Mexico in the 1990s (Macey, 1999; Krueger and Tornell, 1999). AMCs established following the Asian financial crisis assembled assets valued at up to 20 percent of GDP and achieved a significant degree of value recovery (Fung et al., 2004). In 2016, the Italian government reached a deal with the European Union (EU) to attach a government guarantee to a subset of NPLs, thus creating number of internal AMCs. Such guarantees help to bridge the difference between the reservation value of NPLs and the price potential buyers are willing to pay that arises due to asymmetric information (see Avgouleas and Goodhart (2017) for a recent discussion of issues related to the design of AMCs).

Reflecting information asymmetry[27] and high risks, majority of AMCs are funded publicly. In other cases, banks establish internal (private) AMCs, ring-fencing own funds on- or off-balance sheet for a special workout unit. Internal AMCs have the same objective - to maximise the recovery value from a portfolio of impaired assets. Occasionally, deposit insurance funds are directly used to acquire non-performing assets. Such in-

[27]Informational asymmetry arises at the bank which originated the non-performing loan has private (soft) information that is not observed by (or cannot be transferred to) the third party buyer. This is an additional level of asymmetry to the classical asymmetric information problem between the bank and the borrower.

stances are less common, however, as this approach may weaken the ability of deposit insurers to perform their core duties.

The recently emerging theoretical literature, however points that without the disposal of legacy assets the deposit guarantee scheme is at risk of bearing the costs of potential bank failures anyway. Segura and Suarez (2019) find that the requirements to dispose of toxic assets (through AMCs), in extreme cases together with bank public recapitalisations, can limit the costs to a deposit guarantee scheme and be ex-ante optimal from the perspective of policy maker. In similar vein, Lucchetta et al. (2019) show that internal AMCs, funded by "bail-inable" debt, can be welfare enhancing. Due to the theoretical predictions, in the remainder of this work we will treat all types of AMCs are equivalent.

For the empirical analysis, data on AMCs is taken from the Building Better Bad Banks project by Hallerberg and Gandrud (2015). The database contains information on 139 AMCs (109 public, 20 internal, 8 backed by deposit insurance and 2 unclassified) across 60 countries during the period 1990-2016. Where the data on AMC closure is not available, an AMC is assumed to have a life span of 8 years, the mean across the sample. Examples of public AMCs include UK Asset Resolution Ltd, the Bank Asset Management Company in Slovenia, the Asset Management Corporation of Nigeria and the Korean Asset Management Company. The use of AMC covers all years of our observations, regions and level of country development.

Public bank recapitalisation

Public funds can also be used to directly recapitalise ailing banks. Such bailouts enhance banks' ability to provision non-performing exposures, write them off or sell them at a discount. Policy packages often combine establishment of AMCs with the use of public funds for bank bailouts. In the long term, government interventions can exacerbate moral hazard: banks counting on a potential bailout may take greater risks (Lammertjan and Koetter, 2012). Our analysis is focused on the short-term effect of bailouts on bank

NPLs and abstracts from their possible negative implications over the longer term.

The data on financial sector bailouts is taken from Bova et al. (2016) and covers 95 interventions, both during systemic banking crisis and stand-alone cases, spanning 66 countries. Estimates of fiscal cost of recapitalisation (available for 83 of those episodes) average 9.4 percent of GDP. The dataset also records public bailouts and recapitalisations in the non-financial sector (for instance, with respect to public-private partnerships, subnational governments or state-owned enterprises) which we use in a placebo test.

Macroprudential policies

The third block of policies comprises macroprudential measures. These measures target behaviour of financial institutions through limits on leverage, maximum interbank exposures, risk concentration ratios, capital surcharges on systemically important financial institutions or reserve requirements. Macroprudential measures can also target borrowers by limiting loan-to-value or debt-to-income ratios. While macroprudential tightening may limit build-up of NPLs over the economic cycle their short-term impact on the stock of existing NPLs is likely to be limited. The long-term impact is also debated as tightening in one area, for instance mortgage lending, can prompt banks to take extra risks in other areas such as corporate lending or securities trading (Acharya et al., 2019).

The data on macroprudential policies come from Cerutti et al. (2015). The database covers 119 countries from 2000 to 2013 and identifies 135 cases of macroprudential tightening in 76 countries. The cases of macroprudential loosening are limited to Bulgaria in 2008 and Serbia in 2013 and are not explored further.

Changes in loan classification and provisioning stringency

Changes in the stringency of loan classification and provisioning may also have an impact on NPL resolution. Forcing banks to recognise and fully provision NPLs strengthens incentives to promptly resolve non-performing assets. At the same time, a move towards

stricter loan classification may result in an initial increase in reported NPL ratios.

Data on stringency of loan classification and provisioning is taken from Barth et al. (2013). The stringency of loan classification is proxied by the total number of days of delinquency after which a loan is classified as sub-standard, doubtful or lost (combining the three categories). The data comes from surveys of 127 central banks conducted in 1999, 2003, 2007 and 2011 (values are carried forward in other years). The indicator ranges from 4 months to over 3 years, with an average of 18 months. The provisioning stringency is proxied by the sum of the minimum required provisions as loans become substandard, doubtful and loss (this sum averages 120 percent).

This list of policies is not exhaustive. Examples of other relevant measures include changes in tax treatments of NPLs that remove disincentives in terms of writing off bad loans for banks and borrowers, judicial and legal reforms to accelerate the foreclosure process and improvements in out-of-court resolution mechanisms (see European Central Bank 2017b). At the same time, the five types of measures outlined above account for a bulk of actions historically taken to reduce NPL ratios. One or more of these measures were deployed in more than 90 percent of cases of high NPLs as identified in Chapter 3.4.2.

4.3. Cross-border transmission of NPL policies

4.3.1. Cross-border transmission of financial sector policies

Various spillover effects of financial-sector policies have been documented by earlier studies. For instance, foreign bank affiliates have been shown to respond to financial shocks in home territories of parent banks (Peek and Rosengren, 1997, 2000; Schnabl, 2012) reflecting the workings of internal capital markets of banking groups (de Haas and van Lelyveld, 2010; Ongena et al., 2013a). This response tends to be partial, affected by

frictions in internal capital markets (Cerutti and Claessens, 2017). It is higher when foreign affiliates are financed by intra-group funding rather than by local deposits (De Haas and van Lelyveld, 2014). In a case when the macroeconomic shocks are locally idiosyncratic, the foreign-owned banks can be seen as a stabilising force with respect to local shocks in a host economy, thus dampening the local business cycle, in comparison with banking sector dominated by local banks. In presence of a local negative funding shock, the foreign-owned bank can rely on capital or liquidity injection from the parent group, therefore maintaining (or even expanding) credit supply, in comparison with domestic banks. However, once the macroeconomic shocks become correlated across countries the strong presence of foreign-owned banks provides a network channel through which systemic risk is transmitted globally and can lead to amplification of the local macro cycle (see De Haas et al. 2015 for more detailed explanation).

Macroprudential measures significantly affect behaviour of bank subsidiaries abroad. Conversely, changes to macroprudential regulation and capital requirements may have little impact on lending behaviour of foreign-owned banks operating in a jurisdiction where such changes are introduced (Aiyar et al., 2014a,b; Ongena et al., 2013b; Berrospide et al., 2017). Several transmission channels may similarly give rise to cross-border transmission of policies aimed at reducing banks' NPL ratios. The main potential channels - the workings of internal capital markets, consolidated supervision, and transfer of knowledge on how to work with impaired exposures - are discussed in turn.

4.3.2. Internal capital markets

Parent banks and foreign subsidiaries are linked through internal capital markets enabling banking groups to reallocate capital with the view to maximise growth opportunities and better manage solvency risk at the holding level. In addition, liquidity can be injected in subsidiaries through short-term or long-term loans. Capital and liquidity can flow internally in both directions. When positions of parent banks are strong, they tend

to support their subsidiaries at times of adverse shocks in host economies. Conversely, when parents experience an adverse shock, lending in subsidiaries tends to be negatively affected as parents focus their banking-group resources on the home markets (the so-called *reverse support effect*, see de Haas and van Lelyveld 2010).

An adverse NPL shock experienced by a parent bank is likely to propagate to its subsidiary through the reverse substitution effect. This weakens the ability of the subsidiary to deal with NPLs through timely provisioning and write-offs. In some circumstances, the incentives of subsidiary's management to improve performance may be reduced, while adverse incentives to take on extra risk may become stronger (Berger and DeYoung, 1997).

A successful policy designed to reduce NPL ratios can put this chain into reverse. Availability of bailout funds in the parent's jurisdiction or sales of NPLs to AMCs can free up capital resources that are, in turn, redistributed through internal capital markets. The resulting *support effect* enhances subsidiary's ability to address NPLs and strengthens management incentives to pursue strong financial results. In addition, NPL resolution at the parent bank level may free up management resources to focus on the performance of subsidiaries.

4.3.3. Consolidated supervision

Over time, global financial markets have become increasingly complex and intertwined. In response, bank supervisors moved to supervision regimes on a consolidated basis, whereby supervisors examine the prudential risks of an institution and all its international establishments, including branches and subsidiaries. This holistic view gives home country supervisors indirect oversight over banks' subsidiaries operating in foreign jurisdictions. The principles of consolidated supervision were formalised by the Basel Committee on Banking Supervision in Concordat in 1975 (Goodhart, 2011) with further refinements in 1983 and 1992 when the Minimum Standards for supervisory cooperation

between Basel member countries were established.

The guidance and moral suasion that supervisors use to address high and rising NPL ratios can apply to the supervised subsidiaries. For example, NPL Guidance first issued by the European Central Bank's (ECB) Single Supervisory Mechanism in March 2017 and by the European Commission in March 2018 is applicable to all significant institutions including their international subsidiaries and branches. The guidance also calls for harmonisation of NPL definitions at a group level. It is not legally binding but high-NPL banks deviating from the reduction targets may see additional capital add-ons imposed (European Central Bank, 2017a).

In sum, consolidated supervision both imposes additional implicit costs associated with NPLs in subsidiaries and prompts banks to harmonise approaches to dealing with NPLs across the banking groups. Under certain circumstances, a parent bank burdened with high NPLs and operating in an economy with a relatively weak growth outlook (such as Greece or Italy in the mid-2010s) may find it more cost-effective to prioritise NPL reduction in its subsidiaries abroad.

4.3.4. Transfer of knowledge and management expertise

The existence of multi-national banking corporations can be partially explained by the value of replicating certain practices and techniques in foreign markets. Such replication involves flow of information from the parent to the subsidiary. The competitive allocation of resources through internal markets and use of common technological platforms foster such knowledge transfer (Özsomer and Gençtürk, 2003; Ambos and Ambos, 2009).

The transfer of knowledge is common in credit risk management (for example, when it comes to credit scoring). It extends to dealing with impaired exposures - in terms of identifying substandard loans, monitoring collateral valuation, modelling provisions and making decisions about sales of non-performing assets at a discount, repossession or loan write-offs. If a parent bank adopts new ways of managing NPLs such as sales to AMCs,

subsidiary banks may follow the new practice (see Boissel et al. 2015 for the evidence of aligning loan loss provisions policy when a subsidiary gets acquired in line with the new parent group strategy).

The extent of successful knowledge transfer may depend on the value of knowledge (which may be higher when NPLs are high), motivation to share knowledge (which may be enhanced in the presence of consolidated supervision), richness of transmission channels (for instance, the extent of IT integration or cultural proximity) and absorptive capacity of the knowledge acquirer. The latter may be higher where subsidiary staff are offered regular trainings by the parent (see Gupta and Govindarajan 2000, for a general discussion of knowledge transfer).

4.4. Identifying cross-border spillovers from changes in the stock of NPLs

4.4.1. Data

To test whether changes in NPLs may be transmitted across borders within banking groups we match international parent banks and subsidiary banks operating in Central, Eastern and Southern-Eastern Europe (CESEE) using the dataset compiled by De Haas et al. (2015). In this dataset, we observe 468 banks that are subsidiaries of global parent banks and 1,834 domestic banks in the region between 1999 and 2010. Parent banks come from a total of 43 countries. The data on ownership are combined with data from bank balance sheets and income statements as reported in Bankscope. We use a panel of 27,500 banks located in 190 countries. For these banks we observe NPL ratio over the period 1990-2015. We exclude banks with less than US$100,000 in total assets, those that report multiple financial statements within the same calendar year and those whose core activity does not include granting credit. Descriptive statistics are reported in Table 4.2.

[Insert Table 4.2]

Under the Basel definition a loan is classified as non-performing when a borrower is 90 days or more behind on their contractual payments or whenever a debtor is considered "unlikely to pay its credit obligations to the banking group in full, without recourse by the bank to actions such as realising the security". The exact definition can vary from country to country and certain jurisdictions may not report the quality of loans meaningfully. At the same time, consistent under-reporting of NPLs in certain emerging markets, if anything, would lead to the extent of transmission of changes in NPLs being underestimated in our analysis.

4.4.2. Cross-border spillovers within banking groups

The following specification is used to estimate the cross-border transmission of changes in NPLs:

$$\begin{aligned}\Delta ln(NPL)_{idt} =& \beta_1 F_{id,t-1} \times \Delta ln(NPL)_{if,t-1} + \beta_2 F_{id,t-1} \times NPLR_{if,t-1} + \\ & \beta_3 F_{id,t-1} \times TCR_{if,t-1} + \gamma Z_{id,t-1} + \theta F_{id,t} \times MF_{ft} + \\ & \delta_i + \delta_{dt} + \varepsilon_{it}\end{aligned} \tag{4.1}$$

Where the dependent variable is the change in the logarithm of the stock of NPLs of bank i, located in host country d in year t. Bank i may be owned by a parent bank operating in foreign (home) country f. Effectively, the dependent variable captures the percentage change in the stock of NPLs. On the right-hand side, the foreign-ownership dummy ($F_{id,t-1}$) is interacted with the (lagged) logarithm change in NPL stock of the foreign parent bank ($\Delta ln(NPL)_{if,t-1}$), the NPL ratio of the parent bank ($NPLR_{if,t-1}$) and its total capital ratio ($TCR_{if,t-1}$).

The approach broadly follows estimation of cross-border spillovers in lending in De

Haas and van Lelyveld (2014) and Allen et al. (2014). The set of bank-level control variables $Z_{id,t-1}$, include the (lagged) non-performing loans ratio , return on average assets, change in bank's total assets, the change in bank's total deposits and the total capital ratio, in addition to bank fixed effects (δ_i). Some specifications also include a set of macro-economic factors in the foreign jurisdiction f (MF_{ft}) such as inflation, growth in GDP per capita and a change in the ratio of investment to GDP. Bank fixed effects control for bank time-invariant heterogeneity. Except in cases where bank ownership changed, they also subsume domestic country fixed effects thus accounting for time-invariant differences between countries such as the origin of the legal system. The specifications also include a set of domestic country-year fixed effects, δ_{dt}, to control for time-varying macro factors that affect both domestic- and foreign-owned banks in the same jurisdiction d. Standard errors are clustered at the domestic (host) country level.

The results reported in Table 4.5 point to an co-movement association between the changes in NPL stock of subsidiary banks and those of their parents , as well as parent's NPL ratio . The estimated effect is weakly significant for the changes of parent's NPL stock, with magnitude of 0.4, and strongly significant for the parent's NPL ratio, where 1 percentage point increase in NPL ratio of a parent leads to 0.1 percentage points increase of subsidiary's NPL stock. This association is much stronger in the case of parent banks with high NPL ratios, 1 percentage point reduction of NPL stock of parent bank is associated with a 0.6 of a percentage point reduction in the stock of NPLs of a subsidiary bank operating in a foreign jurisdiction, and is absent in the case of parent banks with low NPLs (see Table 4.6)[28]. To estimate these effects separately we interact the log changes in the stock of NPLs of the parent with the dummy variables that take the value of one if parent's NPL ratio is above (below) the 5 percent threshold. We choose the 5 percent cut-off point since it is commonly considered by supervisors as an

[28]The results are similar when the split into high-NPL and low-NPL category is based on the NPL ratios of subsidiary banks.

indication of excessive risk taking. It is close to the median for the entire sample of banks although, applied to parent banks, the dummy takes the value of 1 in approximately one fifth of cases.

$$\begin{aligned}\Delta ln(NPL)_{idt} =& \beta_1 F_{id,t-1} \times \Delta ln(NPL)_{if,t-1} \times highNPLR_{if,t-1} + \\ & \beta_2 F_{id,t-1} \times \Delta ln(NPL)_{if,t-1} \times lowNPLR_{if,t-1} + \\ & \beta_3 F_{id,t-1} \times NPLR_{if,t-1} + \beta_4 F_{id,t-1} \times TCR_{if,t-1} + \\ & \gamma Z_{id,t-1} + \theta F_{id,t} \times MF_{ft} + \delta_i + \delta_{dt} + \varepsilon_{it}\end{aligned} \tag{4.2}$$

Where parent bank NPL ratios exceed 5 percent, a one percentage point reduction in the NPL stock of a parent bank is associated with an approximately 0.6 of a percentage point reduction in the stock of NPLs of the subsidiary; the corresponding coefficient is statistically significant at the 5 percent level (and at the one percent level in most specifications). Inclusion of domestic country-year fixed effects provides assurances that this result is not driven by the economic cycle, which equally affects domestic banks. We discuss possible channels underpinning the estimated cross-border transmission in Section 4.5.5 later on.

The coefficients on control variables are by and large intuitive. The stock of NPLs is more likely to decline significantly if the NPL ratios are higher to start with and if the bank is more profitable, as reflected in the higher return on assets. The opposite is true for the level of NPL ratio of the parent bank: higher NPL ratios of the parent are associated with greater increases in NPLs of subsidiaries.

[Insert Tables 4.5 and 4.6]

4.5. Identifying cross-border effects of NPL policies

4.5.1. Identification strategy

Having established that changes in NPLs spill over to banks' subsidiaries abroad, we can use this finding to estimate the effectiveness of policies targeting reductions in NPLs - by looking at the cross-border impact of such policies.

A straightforward way to estimate the impact of NPL policies on NPL ratios involves linking country-level outcomes (the average NPL ratio of a banking system) or bank-level outcomes (a bank's NPL ratio) to the adoption of specific policies using country-year or bank-year data. When interpreting these estimates, it is important to acknowledge that policymakers' decision to intervene, the timing of intervention and the choice of policy instrument are likely to be non-random, influenced by external circumstances. The estimates of the effect of policies may thus be subject to endogeneity bias. For instance, if a certain policy comes into effect late in the economic cycle, on the back of improving economic conditions, its impact may be overestimated. If policies are adopted at the height of a crisis when the health of the financial sector is deteriorating rapidly, their impact may be underestimated.

In contrast, when estimating cross-border effects of measures aimed at reducing NPLs, we look at an exogenous source of timing of adoption of various policies from the perspective of foreign subsidiary. In particular, we focus on the performance of foreign-owned banks and policy changes in jurisdictions where the corresponding parent holding bank operates. We compare changes in behaviour of foreign-owned subsidiaries with changes in behaviour of locally-owned banks operating in the same jurisdiction as well as subsidiaries of foreign banks whose parents are not affected by a certain policy intervention. The two groups of banks are subject to the same set of economic conditions and domestic policy environment - except some foreign-owned banks are also indirectly exposed to

changes in policy and economic environment affecting their parents.

[Insert Figure 4.1]

The introduction of policies targeting NPL reduction in the home country where a parent bank operates may have a *direct* effect on behaviour of banks in that jurisdiction and a *cross-border effect* on NPLs of subsidiary banks located in a foreign jurisdiction (see Figure 4.1 for a schematic representation). In a typical host country, we find foreign-owned subsidiaries with parents located in different home jurisdictions that are subject to different policy environment. For example, the Greek banking sector in 2005 comprised 32 domestic banks and 4 foreign subsidiaries with parents located in Cyprus, Germany, France and Portugal. At the same time, Greek banks owned subsidiaries in nine jurisdictions ranging from South Africa to Bulgaria. Such multiplicity of cross-border links strengthens the difference-in-difference identification strategy.

4.5.2. Basic empirical specification

The analysis can be performed on a large sample of banks where we do not observe exact ownership links beyond the country of origin. Data on foreign ownership of banks in this larger sample is taken from Claessens and Van Horen (2015). A bank is identified as foreign-owned when at least 50 percent of bank's shares are held by foreigners. The corresponding foreign policy in regressions is set to reflect the policy changes in the home country of the largest foreign shareholder. The ownership data is available for 5,102 banks in 111 countries. In approximately 9 percent of cases foreign ownership status of a bank changed during 1995-2013.

We estimate a reduced-form model where NPL policies can have an impact on bank affiliates abroad. The dependent variable in the basic model (Equation 4.3) is the change in the logarithm of stock of NPLs for bank i between years $t-1$ and t. As before, bank

i operates in domestic jurisdiction d but may be owned by a parent bank operating in a foreign jurisdiction f. The specification further includes interaction terms between the foreign ownership dummy ($F_{id,t}$) and a set of dummy variables capturing policies in place in the home jurisdiction f of the respective parent banks in year t (denoted POL_{ft}). For instance, an AMC dummy variable is equal to one if an asset management company was in operation in the past 3 years in the jurisdiction of the parent holding bank. The coefficients on these interaction terms (β) capture the cross-border effects of policies on the subsidiaries of foreign parent banks.

$$\begin{aligned}\Delta ln(NPL)_{idt} =& \beta F_{id,t} \times POL_{ft} + \gamma Z_{id,t-1} + \lambda F_{id,t} + \theta F_{id,t} \times MF_{ft} + \\ & \delta_i + \delta_{dt} + \varepsilon_{it}\end{aligned} \tag{4.3}$$

Bank fixed effects, δ_i, subsume foreign ownership except for banks that changed ownership during the sample period. The coefficient on the foreign ownership dummy thus reflects the average movement in the stock of NPLs upon a bank changing ownership from domestic to foreign or vice versa. Domestic (subsidiary jurisdiction) country-year fixed effects, δ_{dt}, capture both changes in demand for credit and any changes in domestic policies that apply to all banks.

In this difference-in-difference approach only foreign banks are eligible for treatment (having a parent subjected to certain policies aimed at reducing NPL levels). Reassuringly, we find no large systematic difference between NPL ratios in domestic and foreign-owned banks (see Table 4.3). In both groups of banks, average NPL ratios evolved in similar ways and reached similar levels.

[Insert Figure 4.2]

4.5.3. Results

The estimation first distinguishes between three mutually exclusive policy scenarios: establishment of an asset management company (AMC); use of public funds to recapitalise banks (bailouts); and a combination of the two policies (see Table 4.4 for a summary of incidence of various policies in the sample).

Establishment of AMCs in the parent bank's jurisdiction is associated with a statistically significant reduction in the NPL of subsidiary banks - the stock of NPLs declines by around 12 percentage points (see Table 4.7). The effect does not increase if the introduction of AMCs in a foreign jurisdiction is packaged with provision of bank bailouts. In some specifications the effect in fact becomes smaller, with weaker statistical significance - possibly because bailouts come with the pressure to ringfence the use of public funds for domestic purposes reducing the extent of cross-border transmission. In light of the theoretical findings by Segura and Suarez (2019), the establishment of AMC, depending on the severity of NPL problem, may need to be assisted by public bank recapitalisation to ensure that entities incurring losses on the NPL disposals meet the participation constraints instead of deciding to go into bankruptcy. In the absence of AMCs, the provision of bailouts is associated with a small and statistically insignificant reduction in the stock of NPLs, reflecting the fact that recapitalisation itself does not enforce reduction of credit risk exposure and in fact may enhance moral hazard problem in the long term.

[Insert Table 4.7]

The differences in estimated effects of bailouts in the presence and in the absence of AMCs are insightful, assuming that any pressure to ringfence public funds for domestic use is comparable in both scenarios. In the absence of structural reforms aimed at creating market for distressed debt, bailouts may do little to strengthen incentives for resolving non-performing loans. In some circumstances, bailouts may encourage greater

provisioning (and thus recognition) of bad debts in the hope of increasing the amount of public funds being made available. Furthermore, bailouts may also encourage banks to pursue riskier new borrowers in search of higher upside expecting the downside risk to be limited. The overall impact on NPLs may thus be ambiguous. As this study focuses on relatively short-term impact of various financial sector policies, no inference can be made about the long-term effects of financial sector bailouts on banks' risk appetite.

The cross-border effects of asset management companies on NPLs appear to be strongest one year after a policy is adopted, with effects gradually becoming weaker. The results reported in Figure 4.3 are obtained by estimating specification allowing for dynamic lags; the specification is otherwise similar to Equation 4.3.

[Insert Figure 4.3]

When it comes to changes in NPLs, we do not find any significant cross-border effects of changes in loan classification, provisioning stringency or macroprudential tightening (see Table 4.8). This might reflect the propensity of international banking groups to apply stricter loan classification and provisioning standards than the minimum required by the regulation.

[Insert Table 4.8]

4.5.4. Discussion: Inference about the domestic effects

The estimated cross-border effects could be seen as the lower bound of the domestic effect of various policies on NPL ratios - due to the fact that any cross-border transmission is partial. Some back-of-envelope estimates may further give us some sense of a possible magnitude of the underlying domestic effect of asset management companies. Establishment of AMCs is estimated to be associated with a 12 percent per annum reduction in

the stock of NPLs of foreign affiliates. From estimation in the previous section, such a reduction corresponds to a 15 to 20 percent reduction in the NPL ratio of a parent bank, on average (based on transmission coefficients in the range of 0.6 to 0.8). In other words, the introduction of AMC would need to lower the NPL ratio of domestic banks by 15-20 percent per annum (over a three-year window) to induce the observed cross-border spillovers.

In principle, cross-border policy transmission could surpass the domestic effect in a case where AMCs purchase a significant amount of NPLs from the balance sheet of a bank subsidiary abroad. Nonetheless, the anecdotal evidence suggests that such situation is unlikely to arise in practice, not least because AMC's comparative advantages in dealing with problem loans do not easily extend to foreign jurisdictions.

For example, Ireland's National Asset Management Agency was set up to purchase NPLs exclusively from the Irish domestic banks. NAMA's 2017 financial statement show that 83 percent of loans on its balance sheet are backed by collateral from Ireland, 12 percent from the UK and 5 percent from the rest of the world. Similarly, Spain's SAREB portfolio consists exclusively of loans backed by collateral in Spain, as reported in its 2017 annual statement. Unfortunately, we do not have the access to data that would categorically show that such transfer of bad assets from foreign subsidiaries to parent's AMCs is not in place.

The presented analysis is conducted under the assumption of limited (or non-existent) cross-border AMC transfers. Given the large fiscal outlays needed to establish the publicly-funded AMCs, we remain positive that such assumption can be rationalised. The local governments are likely to ensure that the positive policy effects remain concentrated mostly in the domestic banking sector through the design of the AMC transfer policy limiting it to either domestic loans or loans originated in the local jurisdiction.

4.5.5. Transmission channels

Next, we discuss the evidence regarding various possible transmission channels underpinning cross-border spillovers from an NPL reduction. First, we note that the coefficient on the parent bank total capital ratio in our estimations (Table 4.5 and 4.6) is negative and statistically significant, consistent with the presence of the internal capital markets channel: higher capitalisation of the parent enables subsidiary banks to tackle non-performing assets more actively, as discussed in section 4.3. In particular, an extra one percentage point in terms of a parent's capitalisation is associated with an extra 5 percentage point reduction in the stock of NPLs of a subsidiary.

To shed light on the existence of the consolidated supervision channel we investigate if the spillover effect is stronger when parent banks reside in member countries of the Basel Committee for Banking Supervision (BCBS). The holistic supervisory approach at the heart of the BCBS work is based on the banking supervisors' multinational cooperation. It requires multinational banks to apply consistent approach to NPL recognition and management across their subsidiaries. If a parent bank is domiciled in a country where the banking supervisor is a member of BSBC, its foreign subsidiaries are subjected to indirect supervision in the home jurisdiction. The membership of the Basel committee grew from 11 economies in the 1990s to subsequently include the European Union as well as 18 jurisdictions outside the EU. In the empirical specification (equation 4.2) the variables of interest are additionally interacted with the dummy variable for BCBS membership.

The results, reported in Table 4.9, are consistent with consolidated supervision playing an important role in facilitating cross-border transmission of changes in NPLs. In particular, the effect is present for subsidiaries of parents with high NPL ratios and located in the Basel-member countries. The effect is approximately two times smaller, and is statistically insignificant, for subsidiaries of non-Basel parent banks (again, condition-

ing on parents' high NPL ratios).

[Insert Table 4.9]

Testing for the transfer of knowledge channel relies on assumptions about observable traits of bank pairs that are associated with greater likelihood of transfer of knowledge taking place. One such trait is the physical distance (Ambos and Ambos, 2009) as higher cost of travel, time difference and cultural differences make it harder for bank staff to communicate. On the other hand, distance should have limited, if any, impact on the consolidated supervision and internal markets transmission channels. In the empirical analysis distance is measured between capital cities and the largest cities in banks' jurisdictions, weighted by relative population size, using the CEPII dataset. Its logarithm is interacted with the change in the stocks of NPLs of parent banks.

The transmission of changes in NPLs is estimated to be somewhat weaker with distance (see Table 4.10) although the role of the distance is not very pronounced. When we include the interaction between parent's changes in NPL stock and the log distance to the parent we find weakly negative coefficient on the triple interaction. The results are similar if interactions with dummy variables for long and short distances are included instead, where long distance is defined as above 2000km. Similar results (available on request) can also be obtained by using common language and (or) common colonial history as a measure of cultural proximity that may facilitate exchange of information while having no bearing on consolidated supervision or internal capital markets. In sum, transfer of knowledge appears to play some role, albeit possibly limited.

On balance, the evidence is consistent with the cross-border effects of changes in NPLs being driven primarily by the workings on internal capital markets, application of consolidated supervision and, to some extent, exchange of knowledge within banking groups.

[Insert Table 4.10]

4.5.6. Robustness checks

To further address concerns that the results may be driven by common economic cycle, or perhaps global policy coordination, we run a series of robustness checks. These checks probe the three key building blocks of our estimation strategy: the cross-border linkages, the identification of policies aimed at reducing non-performing assets and the timing of these policies. In the first exercise, foreign-owned banks are randomly assigned their parents' domiciles, keeping the frequency of home-host country pairs in the dataset unchanged. The results of the exercise yield no statistically significant cross-border spillovers of NPL policies (see Table 4.11) confirming that actual ownership linkages matter for cross-border spillovers and such spillovers are not a product of global policy coordination or common trends.

[Insert Table 4.11]

Another placebo test preserves the actual ownership linkages but uses bailouts of subnational government, state-owned enterprises, private-public partnership (PPPs) and other types of non-financial-sector bailouts reported in Bova et al. (2016) in lieu of financial sector bailouts when constructing a measure of policy intervention. We observe 195 such non-financial recapitalisations in 40 countries (excluding instances of disaster relief). The non-financial government bailouts, as predicted, have no meaningful international spillover effect on NPL ratios, the estimates being several times lower than for financial sector bailouts (see Table 4.13).

Having established that ownership linkages and the definition of policies play a meaningful role in driving the results we do the same for the timing of policies. In particular,

we create "placebo" policies that were enacted two years earlier than in reality (see Table 4.12). Reassuringly, the cross-border effects of, say, placebo asset management companies are statistically insignificant and several times smaller than the properly estimated effects. This also suggests that introduction of policies to address high levels of NPLs is not commonly anticipated by banks.

[Insert Tables 4.12 and 4.13]

4.6. Conclusion and policy implications

This paper investigated whether changes in NPL stocks spill over to banks' foreign affiliates and whether policies trying to reduce the level of non-performing loans have cross-border spillover effects. The analysis reveals that a one percent reduction in the stock of NPLs is associated with an approximately 0.6 of a percent reduction in NPLs of a subsidiary bank operating in a foreign jurisdiction. This transmission appears to be driven largely by the workings of internal capital markets within banking groups, consolidated supervision and, to some extent, by the transfer of knowledge in the area of NPL resolution, although we are unable to quantify the magnitude of each channel.

As a result of such transmission, policies aimed at reducing NPLs can have cross-border effects. In particular, the introduction of asset management companies with the view to develop a secondary market for distressed debt is associated with a sizeable reduction in the stock of NPLs of foreign affiliates of parent banks, where parent banks are based in the jurisdiction in which a policy package is implemented. The stock of NPLs in a foreign affiliate bank falls by an additional 12 percentage points per annum compared with the stock of NPLs of locally-owned banks operating in the same jurisdiction. The

cross-border effect of the introduction of AMCs does not appear to become stronger in the presence of public bailouts in the jurisdiction of the parent banks.

To the best of our knowledge, this is the first paper to find evidence of positive international spill-overs due to the establishment of AMCs. In contrast, the analysis did not find evidence of significant cross-border spillovers of other policies deployed to address the problem of high and persistent NPL ratios - including financial sector bailouts not accompanied by establishment of AMCs, changes to the stringency of loan classification, revision to provisioning rules and macroeconomic tightening.

The estimated effects are averages across various designs of AMCs. A relatively small sample size and lack of more detailed data do not permit us to make inference about the importance of the institutional setup of asset management companies or their specific features. The findings are nonetheless highly relevant for the policy debate in the EU on the potential establishment of a pan-European AMC. In particular, they suggest that the returns to deploying measures to address NPLs may be higher than previously thought on account of sizeable cross-border spillovers.

The results are also indicative of the lower bound of effectiveness of various NPL policies in terms of reducing NPLs within the jurisdiction where they are deployed. In particular, deployment of an AMC appears to be associated with an approximately 12 to 20 percent reduction in the NPL ratio of banks operating in the jurisdiction (12 being the estimated indirect effect 20 being the higher-end estimate of the domestic effect that would induce the estimated cross-border effect).

This estimate, even if imprecise, is valuable as direct estimates of the effectiveness of policies aimed at reducing NPLs may be subject to large biases on account of non-random timing of the adoption of NPL policies while the direction of any such bias is ambiguous as it, in turn, depends on the timing and speed of adoption of various policy measures.

4.7. Tables and Figures

Table 4.1: Data description and sources

Variable	Description	Data Source
NPLR	Ratio of non-performing loans to gross loans, %	Bankscope
ΔNPL stock	The change in logarithm of total stock of non-performing loans in the past year, %	Bankscope
ROAA	Return on average assets	Bankscope
Δ Total assets	Precentage increase in total assets, %	Bankscope
Δ Deposits	Percentage increase in total deposits, %	Bankscope
TCR	Total capital ratio over RWA, %	Bankscope
Total assets	Total assets in mln of USD	Bankscope
High NPLR	Dummy varible equal to one when NPL ratio exceeds 5%, zero otherwise	
Foreign - CESEE	Dummy variable equal to one when the bank has foreign owner, zero otherwise	De Haas et al. (2015)
Foreign	Dummy variable equal to one when the bank has foreign owner, zero otherwise	Claessens and Van Horen (2015)
AMC only	Dummy variable equal to one when AMC was in use in the past 3 years and was not assisted by bailout, zero otherwise	Hallerberg and Gandrud (2015)
Bailout only	Dummy variable equal to one when financial recapitalisation of bank was in use in the past 3 years and was not assisted by AMC, zero otherwise	Bova et al. (2016)
AMC and Bailout	Dummy variable equal to one when AMC was in use in the past 3 years and was assisted by bailout, zero otherwise	
Macroprudential tightening	Dummy variable equal to one when macroprudential policy index increased, zero otherwise	Cerutti et al. (2015)
Loan classification tightening	Dummy variable equal to one when number of days before which a loan needs to be classified as non-performing went down, zero otherwise	Barth et al. (2013)
Loan provisioning tightening	Dummy variable equal to one when loan provisioning requirements became more stringent, zero otherwise	Barth et al. (2014)

Data description and sources (continued)

Variable	Description	Data Source
Basel	Dummy variable equal to one when the parent bank is located in a country that belongs to Basel Committee of Banking Supervision, zero otherwise	
Distance	Distance between biggest cities in two countries, weighted by the city's population share	CEPII
Inflation	Percentage increase in the Consumer Price Index	IFS
ΔGDP	Percentage increase in the gross domestic produced per capita in PPP	IFS
ΔInvestment	Percentage increase in the ratio of gross capital formation over aggregate GDP	IFS

Table 4.2: Descriptive statistics for full sample.

Variable	N	Mean	Std. Dev	Min	Max
NPL, %	267,508	3.21	5.37	0	32.73
ΔNPL stock, %	205,497	0.12	0.90	-2.59	3.32
ROAA, %	384,333	0.85	1.74	-6.52	10.19
Δ Total assets, %	347,992	0.08	0.25	-7.91	8.42
Δ Deposits, %	344,310	0.08	0.35	-11.32	11.87
Total capital ratio, %	247,582	21.51	39.30	-747.38	993.90
Total assets, mln $	386,486	11793.83	92606.16	0.1	3807892
Foreign - CESEE	20,698	0.19	0.40	0	1
Foreign - full sample	44,757	0.31	0.46	0	1

Table 4.3: Descriptive statistics by ownership type in the full sample.

	Domestic banks		Foreign banks		T-test	
Variable	N	Mean	N	Mean	Δ	t-value
NPL, %	18,617	6.36	7,458	6.80	-0.43	-3.96***
ΔNPL stock, %	15,460	0.14	6,036	0.16	-0.02	-1.71**
ROAA, %	30,550	1.07	13,956	1.02	0.05	2.24***
Δ Total assets, %	27,601	0.12	12,701	0.12	0.00	0.49
Δ Deposits, %	27,429	12.55	12,652	12.61	-0.05	-0.17
Total capital ratio, %	16,208	17.73	6,654	22.97	-5.24	-15.79***
Total assets, mln $	30,710	32,277	14,047	8,870	23,407	17.29***

Table 4.4: Policies targeting NPLs

NPL policy type	Number of observations	Number of countries
Asset Management Company	853	62
Public	740	58
Internal	83	10
Deposit guarantee scheme	111	6
Bank bailouts	279	66
Macroprudential policy tightening	254	119
Tightening loan classification stringency	74	64
Tightening provision stringency rules	60	53

Figure 4.1: Identification strategy

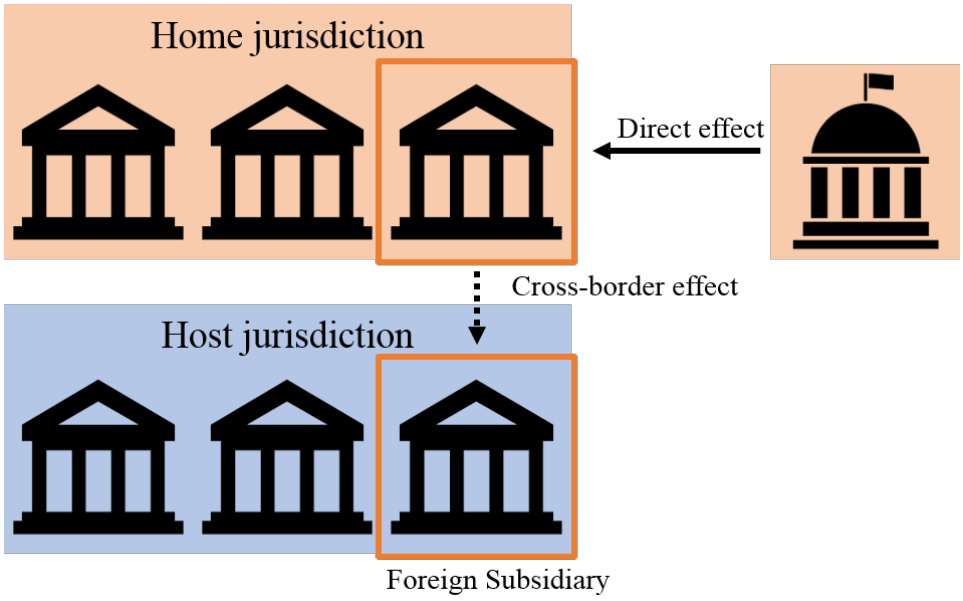


Figure 4.2: Time trend in NPLs for domestic- and foreign-owned banks in the full sample

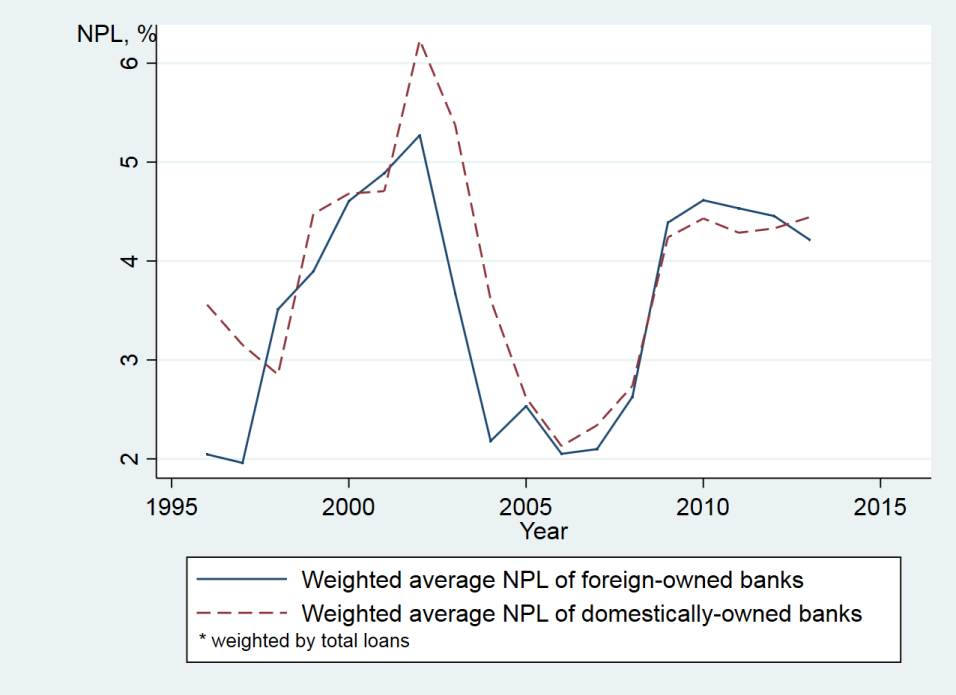


Table 4.5: Transmission of NPLs from parent to subsidiary

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes the observation of 2107 unique banks located in 31 countries from CESEE region over the 1999-2010 period. All columns include the three interactions between foreign-ownership dummy and the parent bank lagged change in the stock of NPLs, NPL ratio and total capital ratio. Columns 2-5 include lagged bank controls. Columns 4 and 5 include additionally lagged total capital ratio. Columns 3 and 5 include foreign (host) country macro controls.
Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
			Δ NPL stock		
Foreign×ΔNPL stock$_{if,t-1}$	0.398*	0.427*	0.393	0.314	0.302
	(0.204)	(0.210)	(0.272)	(0.216)	(0.244)
Foreign ×NPLR$_{if,t-1}$	0.0969***	0.107***	0.0987***	0.0800***	0.0891***
	(0.0301)	(0.0232)	(0.0239)	(0.0257)	(0.0270)
Foreign ×Total Capital Ratio$_{if,t-1}$	-0.0419**	-0.0566***	-0.0561***	-0.0536***	-0.0508***
	(0.0187)	(0.0146)	(0.0120)	(0.0176)	(0.0168)
NPLR$_{i,t-1}$	-0.115***	-0.120***	-0.0941***	-0.0950***	-0.0939***
	(0.0209)	(0.0210)	(0.00959)	(0.00624)	(0.00678)
ROAA$_{i,t-1}$		-0.0692***	-0.0710***	-0.105***	-0.103***
		(0.0155)	(0.0145)	(0.0305)	(0.0297)
ΔAssets$_{i,t-1}$		0.0948	0.0226	0.474	0.546*
		(0.0736)	(0.108)	(0.285)	(0.297)
ΔDeposits$_{i,t-1}$		-0.133***	-0.0569	-0.327	-0.380*
		(0.0226)	(0.0504)	(0.220)	(0.204)
Total Capital Ratio$_{i,t-1}$				-0.00166	-0.000159
				(0.00638)	(0.00678)
Foreign ×Inflation^F			0.981		2.113
			(2.355)		(3.806)
Foreign ×ΔGDP^F			-0.916		-0.621
			(1.971)		(1.672)
Foreign ×ΔInvestment^F			-0.0192		0.0178
			(0.523)		(0.578)
Observations	3641	2901	1429	982	933
R^2	0.339	0.381	0.460	0.570	0.572
Adjusted R^2	0.049	0.056	0.153	0.290	0.286
Bank FE	Yes	Yes	Yes	Yes	Yes
Domestic country-Year FE	Yes	Yes	Yes	Yes	Yes

Table 4.6: Transmission of NPLs from parent to subsidiary - breakdown

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes the observation of 2107 unique banks located in 31 countries from CESEE region over the 1999-2010 period. . All columns include the triple interactions between foreign-ownership dummy, the parent bank lagged change in the stock of NPLs and the dummy variable for high (low) NPL ratio of the parent in addition to double interactions between foreign ownership dummy and lagged parent bank NPL ratio and total capital ratio. Columns 2-5 include lagged bank controls. Columns 4 and 5 include additionally lagged total capital ratio. Columns 3 and 5 include foreign country macro controls.
Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
			Δ NPL stock		
Foreign × ΔNPL stock$^{PB}_{t-1}$ × High NPL$^{PB}_{t-1}=0$	0.126	0.122	0.151	0.0247	0.0465
	(0.273)	(0.287)	(0.304)	(0.322)	(0.310)
Foreign × ΔNPL stock$^{PB}_{t-1}$ × High NPL$^{PB}_{t-1}=1$	0.690***	0.746***	0.723**	0.583**	0.621***
	(0.173)	(0.186)	(0.269)	(0.211)	(0.207)
Foreign ×NPLR$_{if,t-1}$	0.0943***	0.103***	0.0957***	0.0756***	0.0842***
	(0.0281)	(0.0228)	(0.0236)	(0.0260)	(0.0264)
Foreign ×Total Capital Ratio$_{if,t-1}$	-0.0438**	-0.0571***	-0.0574***	-0.0532***	-0.0512***
	(0.0165)	(0.0133)	(0.0109)	(0.0163)	(0.0152)
NPLR$_{i,t-1}$	-0.115***	-0.120***	-0.0942***	-0.0951***	-0.0941***
	(0.0208)	(0.0209)	(0.00958)	(0.00619)	(0.00676)
ROAA$_{i,t-1}$		-0.0691***	-0.0710***	-0.105***	-0.101***
		(0.0154)	(0.0146)	(0.0316)	(0.0304)
Total Capital Ratio$_{t-1}$				-0.00180	-0.000594
				(0.00636)	(0.00681)
ΔAssets$_{i,t-1}$		0.101	0.0376	0.468	0.542*
		(0.0742)	(0.108)	(0.283)	(0.293)
ΔDeposits$_{i,t-1}$		-0.139***	-0.0728	-0.337	-0.382*
		(0.0229)	(0.0506)	(0.217)	(0.198)
Foreign ×Inflation^{F}			1.574		3.049
			(2.360)		(3.869)
Foreign ×ΔGDP^{F}			-0.886		-0.878
			(2.042)		(1.683)
Foreign ×ΔInvestment^{F}			0.186		0.305
			(0.492)		(0.594)
Observations	3641	2901	1429	982	933
R^2	0.340	0.382	0.461	0.572	0.574
Adjusted R^2	0.050	0.057	0.155	0.292	0.288
Bank FE	Yes	Yes	Yes	Yes	Yes
Domestic country-Year FE	Yes	Yes	Yes	Yes	Yes

Table 4.7: Cross-border policy effects

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes 5102 unique banks located in 111 countries over the 1995-2013 period. All columns include the interactions between foreign-ownership dummy and policy dummy, equal to one when the policy was in place in the parent's jurisdiction between $t-3$ and $t-1$. Columns 1-5 include lagged bank controls. Columns 1-4 include foreign country macro controls.
Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Column 2 includes also foreign country fixed effect in place of foreign ownership dummy. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)	(6)
			Δ NPL stock			
Foreign ×AMC only^{F}	-0.0813*	-0.137**	-0.0719*	-0.144***	-0.119**	-0.0482
	(0.0452)	(0.0610)	(0.0424)	(0.0540)	(0.0544)	(0.0450)
Foreign ×Bailout only^{F}	-0.0578	-0.0543	-0.00941	-0.0488	-0.0350	-0.0612
	(0.0391)	(0.0448)	(0.0364)	(0.0535)	(0.0550)	(0.0453)
Foreign ×AMC and Bailout^{F}	-0.133**	-0.176***	-0.0478	-0.107*	-0.0867	-0.138***
	(0.0570)	(0.0632)	(0.0500)	(0.0632)	(0.0615)	(0.0498)
$ROAA_{t-1}$	0.0266***	0.0270***	-0.0125**	-0.0282***	-0.0260***	
	(0.00642)	(0.00626)	(0.00605)	(0.0104)	(0.00960)	
Δ $Assets_{t-1}$	0.154***	0.148***	0.0422	0.0867	0.103	
	(0.0530)	(0.0518)	(0.0452)	(0.0738)	(0.0752)	
Δ $Deposits_{t-1}$	0.0562**	0.0572**	0.0264	-0.0130	-0.0207	
	(0.0271)	(0.0267)	(0.0250)	(0.0586)	(0.0595)	
$NPLR_{t-1}$			-0.0564***	-0.0594***	-0.0589***	
			(0.00339)	(0.00368)	(0.00364)	
Total Capital $Ratio_{t-1}$				0.000617	0.000387	
				(0.00133)	(0.00145)	
Foreign ×Inflation^{F}	-0.125	-0.208	-0.104	-0.500		
	(0.367)	(0.370)	(0.361)	(0.811)		
Foreign ×ΔGDP^{F}	-1.498**	-1.575**	-1.624**	-1.089		
	(0.746)	(0.774)	(0.687)	(0.708)		
Foreign ×ΔInvestment^{F}	0.246	0.272	0.194	0.328*		
	(0.191)	(0.192)	(0.165)	(0.186)		
Foreign	0.187***		0.135***	0.206***	0.155**	0.137***
	(0.0504)		(0.0492)	(0.0777)	(0.0734)	(0.0468)
Observations	18426	18426	18426	12199	12375	20672
R^2	0.330	0.332	0.405	0.442	0.440	0.320
Adjusted R^2	0.127	0.124	0.225	0.257	0.256	0.123
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Domestic Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Foreign Country FE		Yes				

Figure 4.3: Dynamic cross-border policy effects from $t-1$ to $t-3$

The results come from regression of dynamic cross-border policy spillovers analogous with equation 4.3. The navy dots visualise the coefficients on the $F_{id,t-x} \times POL_{f,t-x}$ interaction term and the bars represent corresponding 95% confidence intervals. The results are corresponding to column (1) of Table 4.7where the policy dummies are included dynamically. The dependent variable is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile.
The regression includes 16 059 bank-year observations and yields R^2 of 0.332 and Adjusted R^2 of 0.123. The regression includes the dynamic interactions between foreign ownership dummy at time $t-x$ and policy dummy equal to one when the specified policy was in place at time $t-x$ in the parent's country of jurisdiction (where $x = 1, 2, 3$). The policy choice is limited to AMC and Bailouts without further split into exclusive AMC and those assisted by Bailouts for simplicity. The controls include lagged return on assets, growth of total assets, growth of deposits and further foreign macro controls: inflation, GDP growth and investment growth. The regression includes bank and domestic country-year fixed effects. Standard errors clustered at domestic country level.

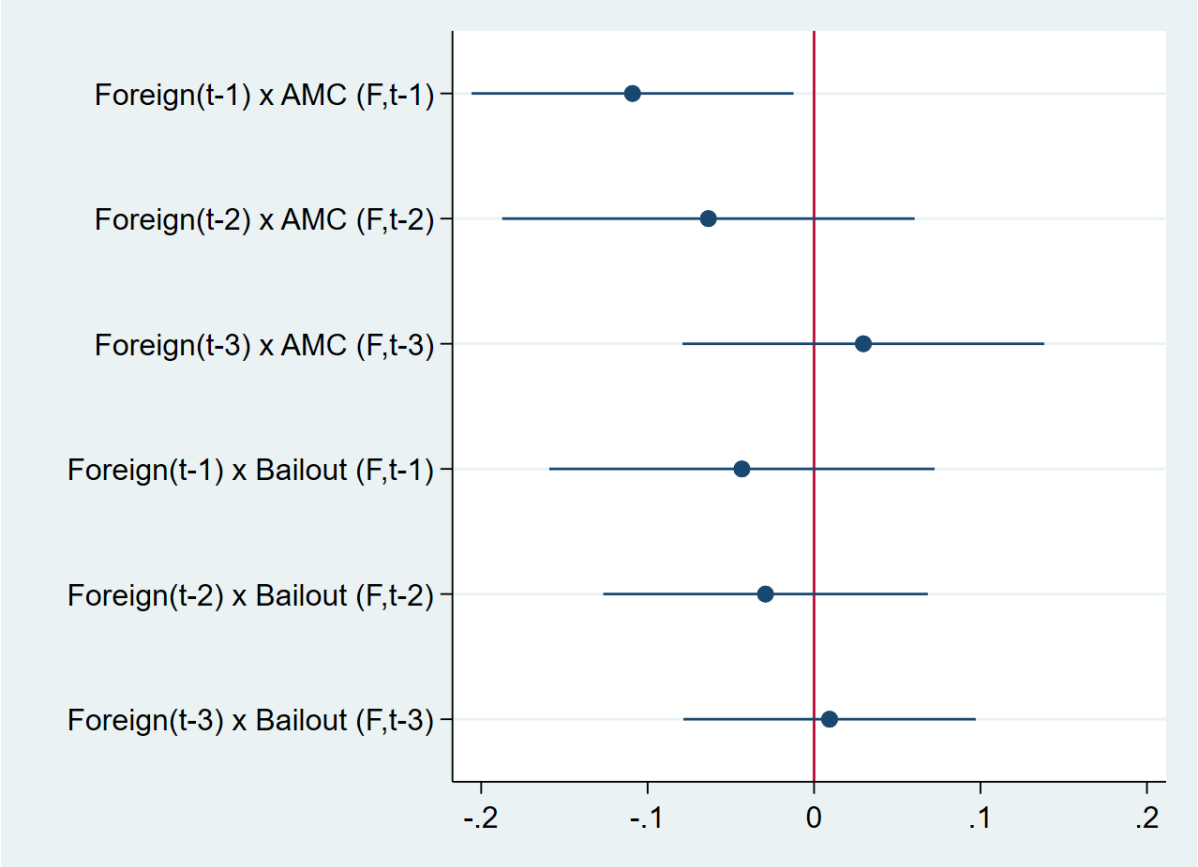


Table 4.8: Cross-border policy effects - regulation

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes 5102 unique banks located in 111 countries over the 1995-2013 period. All columns include the interactions between foreign-ownership dummy and policy dummy, equal to one when the policy was in place in the parent's jurisdiction between $t-3$ and $t-1$. Columns 1-5 include lagged bank controls. Columns 1-4 include foreign country macro controls. Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Column 2 includes also foreign country fixed effect in place of foreign ownership dummy. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)	(6)
			Δ NPL stock			
Foreign ×Loan classification^F	-0.0299	-0.0235	-0.0441	-0.0510	-0.0626	-0.0323
	(0.0502)	(0.0576)	(0.0441)	(0.0716)	(0.0726)	(0.0522)
Foreign × Provision stringency^F	0.0463	0.0773	0.0549	0.117	0.163**	0.0898
	(0.0819)	(0.0928)	(0.0794)	(0.0901)	(0.0803)	(0.0719)
Foreign × Macroprudential policy^F	0.0182	0.0108	0.00827	-0.00795	-0.0180	0.0428
	(0.0372)	(0.0376)	(0.0358)	(0.0414)	(0.0405)	(0.0389)
$ROAA_{t-1}$	0.0258***	0.0264***	-0.0128**	-0.0279***	-0.0275***	
	(0.00659)	(0.00643)	(0.00613)	(0.0104)	(0.0104)	
Δ $Assets_{t-1}$	0.156***	0.153***	0.0395	0.0921	0.0982	
	(0.0547)	(0.0535)	(0.0460)	(0.0761)	(0.0753)	
Δ $Deposits_{t-1}$	0.0586**	0.0595**	0.0295	-0.0111	-0.0130	
	(0.0275)	(0.0269)	(0.0248)	(0.0601)	(0.0598)	
$NPLR_{t-1}$			-0.0565***	-0.0598***	-0.0597***	
			(0.00336)	(0.00362)	(0.00363)	
Total $Capital\ Ratio_{t-1}$				0.000578	0.000708	
				(0.00134)	(0.00136)	
Foreign ×Inflation^F	0.141	0.0851	0.168	-0.0537		
	(0.380)	(0.386)	(0.449)	(0.903)		
Foreign ×ΔGDP^F	-1.543**	-1.636**	-1.790***	-1.034		
	(0.756)	(0.777)	(0.680)	(0.769)		
Foreign ×ΔInvestment^F	0.307	0.322	0.282	0.357		
	(0.206)	(0.205)	(0.177)	(0.226)		
Foreign	0.144***		0.130***	0.149**	0.130**	0.134***
	(0.0470)		(0.0429)	(0.0632)	(0.0633)	(0.0450)
Observations	18182	18182	18182	12097	12193	20229
R^2	0.330	0.332	0.406	0.443	0.441	0.321
Adjusted R^2	0.127	0.124	0.225	0.258	0.257	0.123
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Domestic Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Foreign Country FE		Yes				

Table 4.9: Transmission channel - consolidated supervision

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes the observation of 2107 unique banks located in 31 countries from CESEE region over the 1999-2010 period.
All columns include the quadruple interactions between foreign-ownership dummy, the parent bank lagged change in the stock of NPLs, the dummy variable for high (low) NPL ratio of the parent and the dummy variable capturing parent's country Basel Committee membership. Additional double interactions are included between foreign ownership dummy and lagged parent bank NPL ratio and total capital ratio.
Columns 2-5 include lagged bank controls. Columns 4 and 5 include additionally lagged total capital ratio of the subsidiary. Columns 3 and 5 include foreign country macro controls.
Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
			ΔNPL stock		
Foreign × ΔNPL stock_{t-1}^{PB}×	-0.366	-0.357	-0.436	-0.491	-0.359
low NPLR_{t-1}^{PB} × Basel=0	(0.439)	(0.554)	(0.557)	(0.873)	(0.850)
Foreign × ΔNPL stock_{t-1}^{PB} ×	0.376	0.359	0.428	0.230	0.209
low NPLR_{t-1}^{PB} × Basel=1	(0.245)	(0.226)	(0.281)	(0.201)	(0.231)
Foreign × ΔNPL stock_{t-1}^{PB} ×	0.0929	0.162	0.304	0.378	0.501
high NPLR_{t-1}^{PB} × Basel=0	(0.299)	(0.294)	(0.261)	(0.255)	(0.339)
Foreign × ΔNPL stock_{t-1}^{PB} ×	0.858***	0.904***	0.823**	0.609**	0.633***
high NPLR_{t-1}^{PB} × Basel=1	(0.281)	(0.274)	(0.302)	(0.235)	(0.218)
Foreign × NPLR_{t-1}^{PB}	0.0811**	0.0887***	0.0797***	0.0642*	0.0752**
	(0.0298)	(0.0263)	(0.0243)	(0.0332)	(0.0335)
Foreign × TCR_{t-1}^{PB}	-0.0396**	-0.0518***	-0.0509***	-0.0479***	-0.0468**
	(0.0162)	(0.0129)	(0.0109)	(0.0165)	(0.0169)
NPL_{t-1}	-0.115***	-0.120***	-0.0939***	-0.0948***	-0.0937***
	(0.0210)	(0.0210)	(0.00959)	(0.00618)	(0.00676)
ROAA_{t-1}		-0.0690***	-0.0710***	-0.105***	-0.101***
		(0.0154)	(0.0145)	(0.0309)	(0.0301)
$\Delta\text{T.assets}_{t-1}$		0.0944	0.0187	0.430	0.521*
		(0.0735)	(0.114)	(0.303)	(0.305)
$\Delta\text{Deposits}_{t-1}$		-0.130***	-0.0533	-0.310	-0.363*
		(0.0267)	(0.0545)	(0.224)	(0.204)
TCR_{t-1}				-0.00165	-0.000254
				(0.00656)	(0.00698)
Foreign × Inflation^{F}			1.867		3.088
			(2.380)		(3.762)
Foreign × ΔGDP^{F}			-0.0974		-0.514

Transmission channel - consolidated supervision (continued)

	(1)	(2)	(3)	(4)	(5)
			ΔNPL stock		
			(2.253)		(1.674)
Foreign × ΔInvestment^{F}			0.100		0.253
			(0.482)		(0.555)
Observations	3641	2901	1429	982	933
R-squared	0.340	0.383	0.463	0.573	0.575
Adjusted R-squared	0.050	0.057	0.156	0.292	0.286
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Table 4.10: Knowledge transfer

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes the observation of 2107 unique banks located in 31 countries from CESEE region over the 1999-2010 period.
All columns include the three interactions between foreign-ownership dummy and the parent bank lagged change in the stock of NPLs, NPL ratio and total capital ratio. Additional triple interaction between foreign dummy, change in parent bank lagged change in the stock of NPLs and the logarithm of weighted distance between parent's and subsidiary's countries biggest cities (data from CEPII, weighted by population). Columns 2-5 include lagged bank controls. Columns 4 and 5 include additionally lagged total capital ratio. Columns 3 and 5 include foreign country macro controls. Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
			Δ NPL stock		
Foreign×ΔNPL stock$_{t-1}^{PB}$	1.175	1.434**	1.328**	1.282***	1.312***
	-0.741	-0.641	-0.544	-0.45	-0.423
Foreign×ΔNPL stock$_{t-1}^{PB}$×Log Distance	-0.101	-0.139	-0.137	-0.144*	-0.147*
	-0.115	-0.106	-0.097	-0.081	-0.0809
Foreign×NPLR$_{t-1}^{PB}$	0.109***	0.111***	0.0983***	0.0771***	0.0869***
	-0.0313	-0.0254	-0.0244	-0.0261	-0.0274
Foreign×Total Capital Ratio$_{t-1}^{PB}$	-0.0439**	-0.055***	-0.057***	-0.0479**	-0.051***
	-0.0205	-0.0146	-0.0118	-0.018	-0.0166
NPLR$_{t-1}$	-0.115***	-0.121***	-0.094***	-0.095***	-0.094***
	-0.0211	-0.021	-0.00934	-0.00691	-0.00686
ROAA$_{t-1}$		-0.068***	-0.071***	-0.107***	-0.103***
		-0.0161	-0.0146	-0.0294	-0.0297
ΔT.assets$_{t-1}$		0.0693	0.0169	0.467	0.524*
		-0.0766	-0.108	-0.299	-0.304
ΔDeposits$_{t-1}$		-0.121***	-0.0536	-0.334	-0.370*
		-0.0224	-0.0499	-0.232	-0.209
TCR$_{t-1}$				-0.000818	-0.000512
				-0.00721	-0.00694
Foreign×Inflation^{F}			0.904		1.971
			-2.372		-3.874
Foreign× ΔGDP^{F}			-0.834		-0.559
			-2.017		-1.731
Foreign× ΔInvestment^{F}			-0.0959		-0.0452
			-0.528		-0.585
Observations	3606	2869	1427	961	931
R-squared	0.338	0.381	0.461	0.576	0.573
Adjusted R-squared	0.047	0.054	0.154	0.296	0.286
Bank FE	Yes	Yes	Yes	Yes	Yes
Domestic country-Year FE	Yes	Yes	Yes	Yes	Yes

Table 4.11: Placebo test - random assignment of parent countries

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes 5102 unique banks located in 111 countries over the 1995-2013 period. Foreign-owned banks are randomly assigned their parents' domiciles, keeping the frequency of home-host country pairs in the dataset unchanged. Column 1 corresponds to Table 4.7 (Column 1); and Column 2 corresponds to Table 4.8 (Column 1) with the random parent country assignment. Both columns include the interactions between foreign-ownership dummy and policy dummy, Table 4.1 gives detailed variable description. Both columns include bank and domestic country-year fixed effects. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1) ΔNPL stock		(2) ΔNPL stock
[0.5em] Foreign × AMC only^{RF}	-0.0197	Foreign ×	-0.0146
	-0.0512	Tightening loan classification^{RF}	-0.0495
Foreign × Public Bailout only^{RF}	-0.0148	Foreign ×	0.0132
	-0.0542	Tightening provision stringency^{RF}	-0.0625
Foreign × AMC and Public Bailout^{RF}	-0.0262	Foreign ×	0.00176
	-0.0457	Macroprudential tightening^{RF}	-0.0348
$ROAA_{t-1}$	0.0266***	$ROAA_{t-1}$	0.0246***
	-0.00649		-0.00665
$\Delta T.assets_{t-1}$	0.158***	$\Delta T.assets_{t-1}$	0.149***
	-0.0533		-0.0545
$\Delta Deposits_{t-1}$	0.0551**	$\Delta Deposits_{t-1}$	0.0588**
	-0.0274		-0.0275
Foreign × Inflation^{F}	-0.0906	Foreign × Inflation^{F}	-0.148
	-0.35		-0.404
Foreign × ΔGDP^{F}	-1.335*	Foreign × ΔGDP^{F}	-1.418*
	-0.724		-0.766
Foreign × ΔInvestment^{F}	0.223	Foreign × ΔInvestment^{F}	0.237
	-0.188		-0.209
Foreign	0.149***	Foreign	0.150***
	-0.0509		-0.0477
Observations	18426	Observations	18124
R-squared	0.329	R-squared	0.331
Adjusted R-squared	0.126	Adjusted R-squared	0.126
Bank FE	Yes	Bank FE	Yes
Domestic Country-Year FE	Yes	Domestic Country-Year FE	Yes

Table 4.12: Placebo test - timing of policies moved arbitrarily 2 years earlier

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes 5102 unique banks located in 111 countries over the 1995-2013 period. All columns include the interactions between foreign-ownership dummy and policy dummy, equal to one when the policy was in place in the parent's jurisdiction at time $t+2$. Columns 1-5 include lagged bank controls. Columns 1-4 include foreign country macro controls. Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Column 2 includes also foreign country fixed effect in place of foreign ownership dummy. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)	(6)
			Δ NPL stock			
Foreign_{t+2} ×AMC^{F}_{t+2}	0.0522	0.0593	0.0656	0.00952	0.0165	0.0128
	(0.0438)	(0.0508)	(0.0411)	(0.0489)	(0.0481)	(0.0359)
Foreign_{t+2} ×$\text{Public Bailout}^{F}_{t+2}$	-0.0134	-0.0188	0.00967	0.0184	0.0141	0.0518
	(0.0444)	(0.0423)	(0.0397)	(0.0649)	(0.0645)	(0.0435)
ROAA_{t-1}	0.0198**	0.0209***	-0.0190**	-0.0383***	-0.0375***	
	(0.00799)	(0.00785)	(0.00754)	(0.0135)	(0.0132)	
Δ Assets_{t-1}	0.127**	0.117*	0.0350	0.199**	0.207**	
	(0.0619)	(0.0625)	(0.0498)	(0.0877)	(0.0871)	
Δ Deposits_{t-1}	0.0351	0.0416	-0.00544	-0.136*	-0.130*	
	(0.0398)	(0.0414)	(0.0350)	(0.0721)	(0.0704)	
NPLR_{t-1}			-0.0595***	-0.0655***	-0.0652***	
			(0.00453)	(0.00540)	(0.00531)	
$\text{Total Capital Ratio}_{t-1}$				0.000347	0.000525	
				(0.00178)	(0.00175)	
Foreign ×Inflation^{F}	0.212	0.0642	0.123	0.110		
	(0.341)	(0.375)	(0.367)	(1.058)		
Foreign ×ΔGDP^{F}	-1.511*	-1.530*	-1.856**	-1.501**		
	(0.846)	(0.881)	(0.767)	(0.753)		
Foreign ×$\Delta\text{Investment}^{F}$	0.118	0.136	0.0563	0.192		
	(0.188)	(0.190)	(0.158)	(0.167)		
Foreign	0.114*		0.108*	0.0991	0.0988	0.0881
	(0.0580)		(0.0552)	(0.0748)	(0.0687)	(0.0534)
Observations	12949	12949	12949	8559	8682	14545
R^2	0.366	0.369	0.439	0.481	0.480	0.356
Adjusted R^2	0.144	0.141	0.242	0.281	0.282	0.142
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Domestic Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Foreign Country FE		Yes				

Table 4.13: Placebo test - non-financial sector bailout

The dependent variable in all regressions is the logarithm of total non-performing loans in time t divided by total non-performing loans at time $t-1$, winsorised at 1st and 99th percentile. The observation unit is at bank-year level. Sample includes 5102 unique banks located in 111 countries over the 1995-2013 period. All columns include the interactions between foreign-ownership dummy and policy dummy, equal to one when the public bailout of non-financial sector was introduced by the governemnt in the parent's jurisdiction between $t-3$ and $t-1$. Columns 1-5 include lagged bank controls. Columns 1-4 include foreign country macro controls.
Table 4.1 gives detailed variable description. All columns include bank and domestic country-year fixed effects. Column 2 includes also foreign country fixed effect in place of foreign ownership dummy. Standard errors clustered at domestic country level. * p<0.10 ** p<0.05 *** p<0.01

	(1)	(2)	(3)	(4)	(5)
			ΔNPL stock		
Foreign × Placebo Bailout^F	0.0181	0.0105	0.00241	-0.0253	-0.0182
	(0.0350)	(0.0364)	(0.0355)	(0.0442)	(0.0431)
$ROAA_{t-1}$	0.0262***	0.0266***	-0.0118*	-0.0288**	-0.0286**
	(0.00676)	(0.00661)	(0.00630)	(0.0114)	(0.0114)
$\Delta T.assets_{t-1}$	0.150***	0.150***	0.0365	0.0770	0.0791
	(0.0537)	(0.0534)	(0.0457)	(0.0771)	(0.0762)
$\Delta Deposits_{t-1}$	0.0611**	0.0590**	0.0273	-0.00598	-0.00741
	(0.0271)	(0.0272)	(0.0249)	(0.0614)	(0.0614)
$NPLR_{t-1}$			-0.0564***	-0.0597***	-0.0596***
			(0.00352)	(0.00388)	(0.00388)
TCR_{t-1}				0.000352	0.000463
				(0.00135)	(0.00137)
Foreign × Inflation^F	0.190	0.0840	0.169	0.807	
	(0.359)	(0.361)	(0.455)	(1.280)	
Foreign × ΔGDP^F	-1.030	-1.199	-1.587**	-0.536	
	(0.774)	(0.780)	(0.737)	(0.656)	
Foreign × $\Delta Investment^F$	0.152	0.175	0.133	0.212	
	(0.235)	(0.222)	(0.189)	(0.228)	
Foreign	0.0811		0.0695	0.107	0.123
	(0.0502)		(0.0490)	(0.0711)	(0.0747)
Observations	17655	17655	17655	11816	11856
R^2	0.329	0.330	0.404	0.442	0.442
Adjusted R^2	0.127	0.124	0.224	0.256	0.256
Bank FE	Yes	Yes	Yes	Yes	Yes
Domestic Country-Year FE	Yes	Yes	Yes	Yes	Yes
Foreign Country FE		Yes			

Chapter 5

Conclusion

5.1. Conclusion and policy implications

This thesis addresses two major financial frictions that were exposed by the global financial crisis and subsequent Eurozone debt crisis, namely the sovereign-bank nexus and the prevalence of non-performing loans.

Chapter 2 explores the relationship between banks' decisions to hold sovereign bonds and the institutional characteristics of the home country. It finds that the quality of political and economic institution, the monetary policy framework, the ownership structure of the banking sector, the regulatory and supervisory environment all play a role in bank's choice of sovereign bondholdings. Furthermore, this portfolio choice has an impact on the bank lending behaviour, as banks with large exposure to sovereign risk tend to contract credit supply more during recessions thus increasing the amplitude of the business cycle. The strength of supervisory framework, however, can partially offset this effect. Thus the institutional characteristics play a role by both preventing the formation of sovereign-bank nexus and by limiting the potential cost of financial crisis.

In the aftermath of the banking crises or business cycle downturn, banks often experienced large increases in the non-performing exposures on their balance sheet, caused by economic decline. Chapter 3 presents the stylised facts about instances of high non-performing loans and the government policies used to address them. It finds that governments can mitigate high NPLs by the introduction of an asset management company and that such policy can be further assisted by the bailouts of particularly affected banks. The combination of AMCs and bailouts is found to be the most effective way to reduce

NPLs quickly, in the home jurisdiction, and as a result is associated with extra economic growth in excess of 1.5 percentage points annually over several years. However, the effectiveness of government policies to address the NPL crisis may be affected by the bank's initial exposure to sovereign risk and the fiscal space.

Finally, chapter 4 takes a closer look at the issue of NPLs and exploits more granular data to estimate the cross-border effects of the policies used to deal with NPL problems. It finds that changes in the non-performing loans of a parent bank affect the exposure to toxic assets of their foreign subsidiary, to the magnitude of approximately 60%. The existence of a link between parent and subsidiary banks as well as the complexity of global banking network imply that NPL targeting policies can have cross-border consequences for credit risk. We show evidence, exploring an arguably exogenous identification strategy, that in particular the use of asset management companies can have positive international spillover effects on reduction of non-performing loan stock. This transmission can be partially attributed to the workings of internal capital markets, consolidated supervision and knowledge transfers.

The empirical findings reported in this thesis have important implications for the design of optimal government policies. Firstly, this thesis highlights the importance of a strong and transparent institutional environment. Countries with independent central banks, strong supervisors and regulators are naturally more insulated from distorting banks' incentives to hold sovereign bonds. Strong supervision, regulation and counter-cyclical macroprudential policies can also encourage timely recognition and provisioning of the non-performing loans. The importance of those factors has been highlighted in numerous previous studies[29], yet has not been systematically explored in the context of banks' sovereign bond exposure to my knowledge.

Despite the prevalence of large non-performing loans across the globe and through

[29]See for example Olson (1996); La Porta et al. (1997, 1999); Hall and Jones (1999) or Beck et al. (2006) for the discussion of institutional characteristics in the context of economic growth, development or access to finance.

the time dimension; financial literature remains largely scarce on the topic. Chapter 3 is the first study, to the best of my knowledge, to investigate the anatomy of a typical high NPL episode and to assess the effectiveness of various policies designed to address the problem of NPLs. A particularly important lesson is that a successful resolution may be particularly challenging when the malaise is of a more chronic rather than acute nature, as the most recent instances suggest. Despite its data limitations, this work can provide a starting point for policy makers that are interested in addressing the issue of bad debt overhang. Further research in the topic of asset management companies would be particularly interesting in order to evaluate the importance of institutional set up of the AMC, ownership structure, or the pricing of the NPLs. Our research also sheds light on the political economy aspect of the non-performing loans that has not been investigated previously. Given that the benefits of NPL reductions are often spread out across longer time horizons, myopic politicians may be reluctant to take actions, that are potentially costly in terms of fiscal outlays, promptly due to the short election cycle. Our results should also provide a warning as some policies can backfire, if the government relies on the domestic banks for the financing of the NPL package.

The final policy lesson comes from the existence of cross-border NPL spillovers. Given the level of interconnectedness of large banking groups and their implications for financial stability, keeping non-performing loans in check has positive consequences not only for the countries where the banks are operating but also for the countries that are hosts to foreign subsidiaries. Naturally, this implication works both ways, should a major global banking player allow its banking system to accumulate large stock of toxic assets, the cost can be expected to be exported partially abroad. From this perspective, the international coordination of banking regulation plays an even greater role than previously reported, as it can act both as a lightening rod and a hand brake to the international spread of credit risk. This insight, has a particularly important implications for Europe, which has been particularly plagued in the recent years by the issue of bad loans in

the periphery and simultaneously has significant cross-border bank links. This paper provides empirical support to the idea of introducing a pan-European AMC, that could be financed jointly by European countries and would help ailing banks to offload their non-performing exposures.

Despite the positive implications for the European policy on the NPL policy coordination, a word of caution is necessary. The design of such an AMC is likely to have important implications for its success and remains an important research question. More generally, this research focuses on a relatively short horizon and does not take into account potential costs of such policy in terms of moral hazard (distorting bank's incentive to screen and monitor loans).

Finally, one must also consider the consumer protection side of the argument. The establishment of an active secondary market for non-performing loans may help to relieve an ailing banking system and share the risk with investors that are more risk-tolerant and not subject to strict banking regulation. However, such sales of the non-performing loans can potentially increase the burden of the exposure for the debtors, by decreasing the opportunities to default and exacerbating her subsequent access to credit markets. Those social welfare implications remain an important topic outside of the scope of this thesis for further investigation.

5.2. Limitations and avenues for further research

This thesis presents a number of novel results in the literature on the banks' exposures to sovereign bondholdings and non-performing loans. However, no research is without its limitations. This subsection summarises the biggest challenges and lists potential solutions that were beyond the scope of this work.

Endogeneity poses the single biggest research challenge for this thesis. In Chapters 2

and 3, I attempt to address this concern by using lagged dependent variables and changes of the independent variables. It is however, worth pointing out that this approach only reduces the endogeneity and is not able to fully ensure unbiasedness or consistency of the results. For this reason, the results from those two chapters should be taken with a grain of salt and shall not be interpreted as causal. Despite this obvious limitation, the results remain an extension of the related literature and provide new stylised evidence of the cases of high exposures to sovereign debt and non-performing loans on the bank's balance sheet.

The potential endogeneity in Chapter 3 has prompted me to explore more exogenous sources of NPL policy adoption. This process, led me to the idea of using a more granular data to exploit the bank-level heterogeneity in an international setting. Despite the adoption of multiple techniques to address the endogeneity problem, this remains a single most challenging aspect of almost all social science research. It would be interesting, for example, to investigate individual episodes of policy interventions that satisfy the exogeneity condition. Such approach should allow to estimate the causal impact of the policy on non-performing loans at the cost of external validity. Such individual case studies are beyond the scope of this research, cannot give insight into more detail institutional background of the policy package and do not allow for global comparisons.

Secondly, this thesis relies to a large extend on the Bankscope dataset. Bankscope provides a data on large fraction of financial institutions across the globe, however, it does not cover the full population of banks. In particular, the coverage of banks located in less developed countries with poorer disclosure requirements or simply smaller (regional) banks may exhibit selection bias. In terms of the time dimension, the reliability of data reporting may be heterogeneous. For this reason, I made decision to use data from 1990, to limit this concern.

The findings reported in this thesis lead to a number of promising research questions for the future. One such direction is investigation of the institutional details of Asset

Management Companies and their effects on the work-out of the non-performing assets. For example, it would be interesting to evaluate if the size of the government financial contribution plays a significant role in the probability of future repayments on the loan-level.

Similarly one may ask, if sales of non-performing assets, that remain a burden to banks across Europe, to outside investors could provide a relief for the banking system. In particular, it would be interesting to investigate how the market reacts to a NPL sales to AMCs vis-á-vis sales to other banks or vulture funds or if securitisations (or packages of standardised collateralised assets) could help to reduce the adverse selection in the market of such legacy assets.

The topic of non-performing loans has gained more attention following the European debt crisis, however, remains still a largely unexplored topic in both theoretical and empirical research. There remain a number of literature gaps that provide an exciting direction for future work.

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