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Bank performance and stability

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Declaration: I, Natalia Kryg, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed: **Date:** 30/04/2020

Abstract

This thesis presents a collection of essays into bank performance and stability. The introduction provides an overview of the topic as well as the broader context behind the subsequent chapters. The first chapter focuses on empirical investigation into factors determining performance of investments of a multinational development bank. I construct a unique database of almost 1,600 EBRD investments. It is a first study of all EBRD investments which complements the literature on the project performance of MDBs. My findings suggest that the probability of project success is higher with larger investments and projects under framework. Also, projects with state clients are less likely to be successful. I address the selection bias and this further contributes to the related literature. The second chapter is a cross-bank, cross-country and cross-time empirical study of bank performance in the context of government interventions into failing banks during financial crises. I use a novel database consisting of banks which received government intervention and their non-intervened peers in 39 countries between 1990 and 2017. The findings contribute to the latest empirical literature which is far from conclusive by identifying no clear winner among the studied interventions with gains as well as potential losses under each intervention. I argue that a 'one-size-fits-all' intervention approach is suboptimal. The final chapter of my thesis looks at the bank performance analysis in the context of financial stability. I apply the model of financial stability by Goodhart et al. (2004, 2005) to illustrate the impact of government interventions on banks' behaviour using data for UK banks. The model has been widely used by central bankers and regulators to illustrate the trade-offs between bank's performance and financial stability. This is its first application in the context of government interventions. The final chapter concludes my thesis.

Impact Statement

Impacts Within Academia

The analyses presented in this thesis use novel datasets. In the first chapter I constructed a project-level database of all EBRD investments. My research on this database is a first ever all-sector study on EBRD investments since its origination in 1992. To best of my knowledge, this dataset is one of the broadest databases on EBRD's projects. My research builds on a strand of literature that investigates determinants of investment outcomes of MDBs, measuring the extent to which project design or structure and client differences can explain the likelihood of project success. The existing research on this topic is limited and heavily focused on World Bank's projects. In the second chapter of my thesis I use an extended version of a novel database consisting of banks which received government interventions and their non-intervened peers in 39 countries between 1990 and 2017. To the best of my knowledge, it is a first comprehensive bank-level database which covers a wide range of interventions across a large number of countries and over a long time period. The most frequent cross-country databases on government interventions found in the literature are at the country-level (e.g. Laeven and Valencia, 2018). In my third chapter I apply a well-known model of financial stability by Goodhart et al. (2004, 2005) in the context of government interventions triggered by high NPLs. It is a first ever application of this model in such context. The findings illustrate various bank contagion channels in the economy which impact the intervention effectiveness and may even contribute the financial instability. The findings echo the conclusion from the previous chapter that there is no 'on-size-fits-all' solution for bank interventions and governments need to carefully assess the trade-offs between their policy actions prior to stepping into the banking sector.

Impacts Outside Academia

The findings from my first chapter have benefited EBRD as well as other multinational development banks. I presented my findings at World Bank in 2018. This led me to do more research on this topic as well as triggered fruitful co-operation on this topic with colleagues from World Bank, IFC, Asian Development Bank, among the others. This research area has become one of my top areas of expertise at EBRD. My further research on my database feeds

into the bank's new country strategies, new investment project selection and design, as well as knowledge sharing and institutional learning. This proves crucial at current times with shrinking pools of donor funds available for new investments by contribution towards the most efficient and informed allocation of resources for future investments.

My analyses behind the second and third chapters of my thesis are currently explored deeper with two professors with the desire to produce a joined paper. It would be a very timely paper which could contribute towards the future policy responses to yet another financial crisis which has just been triggered by the Covid-19 pandemic. Banks will soon face an alarming level of non-performing loans on their balance sheets and may, once again, require government assistance to survive. Thus, my findings could help by contributing to the discussions on the on the best approach to intervene into banks as well as by feeding into more comprehensive analyses on the inevitable trade-offs which are likely to be caused by the interventions in the banking sector.

Acknowledgements

My deepest gratitude goes to my academic supervisors, Prof Julia Korosteleva, Dr Raphael Espinoza and Prof Dimitrios Tsomocos, without whose guidance this research would not have been possible. I feel extremely lucky to have had their support and mentoring over the years of my PhD journey. Special thanks go to my primary supervisor, Prof Julia, who has taught me ever since I was pursuing my B.A. degree at UCL in 2008. I am extremely grateful to her for introducing me to the field of economics during my undergraduate studies and for her continuous support and encouragement during my postgraduate degree programme at UCL and then finally as my PhD supervisor and mentor.

I would like to thank the management at EBRD, in particular Anita Taci, Christoph Denk and Alexander Plekhanov. My work on my Ph.D. whilst working full-time at EBRD would not have been possible without their unwavering support. I am particularly grateful for their support on approving my 12 months research sabbatical during 2018/2019 academic year which enabled me to undertake a visiting PhD placement at University of Oxford. I would also like to thank my colleagues at EBRD, World Bank and IFC for thoughtful meetings, and helpful feedback over the course of my PhD.

My research focus and development behind the second chapter of my thesis has greatly benefitted from the support of Prof Aneta Hryckiewicz, who has involved me in relevant projects, provided me with crucial advice towards their advancement, and has greatly helped me in extending the database used in the second chapter of my thesis.

This thesis is dedicated to my parents, Violetta and Zbigniew Kryg. They have always been there to support me throughout the years of my academic journey. I am extremely grateful for their constant encouragement which helps me immensely in embracing new opportunities and challenges in my life.

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List of Abbreviations

A-B - Arellano-Bond

ADB – Asian Development Bank

AIC – Akaike's Information Criteria

AMC – Asset Management Company

AR1 – Autocorrelation of the First Order

AR2 – Autocorrelation of the Second Order

ATET – Average Treatment Effect on the Treated

BBRD – Bank Recovery and Resolution Directive

BIC – Bayesian Information Criteria

BvD – Bureau van Dijk

CA – Central Asia

CGE – Computable General Equilibrium

CMP – Conditional Mixed Process

CoO - Country of Operation

DID – Difference-in-Difference

EBRD – European Bank for Reconstruction and Development

EEC – Eastern Europe and Caucasus

ESH – Efficiency-Structure Hypothesis

ETI – Expected Transition Impact

FE – Fixed Effects

FI – Financial Institutions

FOD - Forward Orthogonal Deviations

FSA – Financial Services Authority

GDP – Gross Domestic Product

GEM – General Equilibrium Model

GMM - Generalized Method of Moments

ICA – Industry, Corporate and Agriculture

IFC – International Finance Corporation

INFRA – Infrastructure

LPM – Linear Polynomial Model

MDB – Multinational Development Bank

MECBD – Monetary Equilibrium with Commercial Banks and Default

NIM – Net Interest Margin

OIR - Over-Identifying Restrictions

OMO – Open Market Operation

PD – Probability of Default

PTI – Portfolio Transition Impact

ROAE - Return on Average Equity

ROC – Receiver Operating Characteristic

RMPH – Relative Market Power Hypothesis

SCP – Structure-Conduct-Performance

SDID - Semiparametric Difference-in-Difference

SEE – South-Eastern Europe

SEMED – Southern and Eastern Mediterranean

SLE - Logic Specification Model

S&P - Standard & Poor's

TA – Total Assets

TARP – Troubled Assets Relief Program

TCR – Total Capital Ratio

TI – Transition Impact

TIMS – Transition Impact Monitoring System

VCE – Variance-Covariance Matrix

VIF – Variance Inflation Factor

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Introduction

My Ph.D. portfolio consists of a collection of chapters on the topic of bank performance and stability. The purpose of this introduction is: (i). to provide the outline of these chapters and to illustrate how they are connected with each other; (ii). to explain their importance to the relevant fields of literature as well as to describe their contribution to the literature and areas outside of academia; (iii). to outline a wider context behind my thesis' research topic by looking into banks' role in the economy; (iv). to provide an overview of academic approaches to measuring bank performance. I finish the introduction by outlining the structure of my thesis.

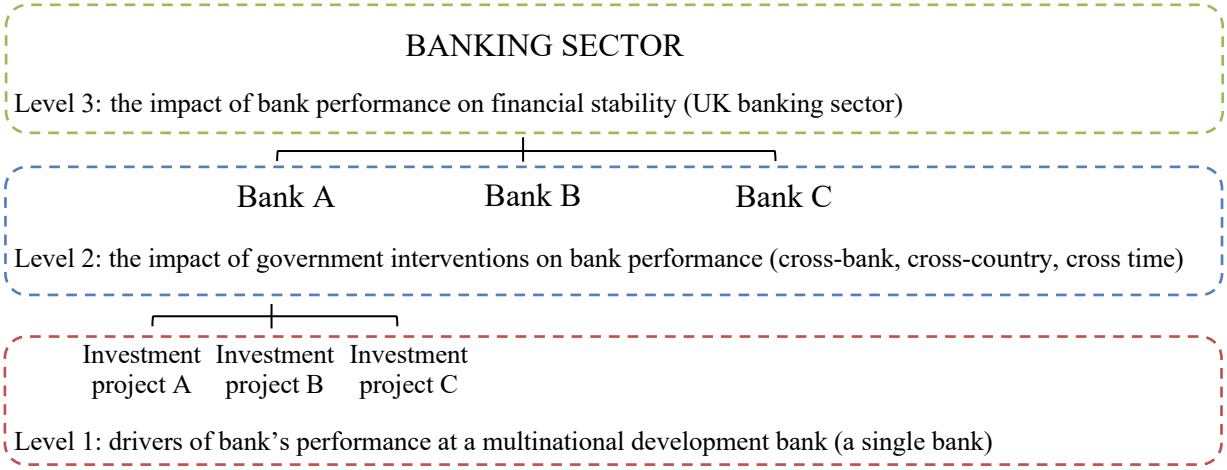
1.1. Overview of the thesis' chapters and their interlinkages

The first of the three chapters of this thesis looks into the performance of a bank's investment units. It is a work-based analysis into EBRD investment projects and the factors which influence the likelihood of their non-financial success in terms of 'transition' delivery, e.g. factors related to investment project design and structure, client-related characteristics. It is a first ever comprehensive research analysis into EBRD investments from all sectors and countries of its operation over a longer time period. My second chapter looks into the cases of unsuccessful, failing banks. Specifically, I use a novel bank-level database consisting of 215 failing banks which were subject to government intervention during the systemic banking crises between 1990 and 2017 and 708 non-intervened banks as a control group. I cover 39 countries in my analysis. I analyse the impact of the most popular government interventions, such as bank nationalisation, government-assisted merger and 'bad-bank' approach, on banks' performance and I assess their effectiveness in the systemic context. In the third chapter, on the other hand, I look at the banks' performance through a theoretical angle by applying a computable general equilibrium (CGE) model and testing the impact of government interventions on banks' performance and stability in the banking sector as a whole. I place a special attention on the non-performing loans (NPLs) of the failing banks that require government interventions. I review the literature on the determinants of NPLs. I then assign the NPL ratio as a key factor in the calibration exercise of the applied CGE model. Specifically, I apply the financial stability model by Goodhart et al. (2004, 2005) in the context of government interventions into a failing bank using UK banking sector data. The model assumes

that contagion between banks could occur and conceivably contribute towards financial instability and eventually systemic risk in the banking sector. I study the directional changes in the endogenous variables through the application of this model under different intervention scenarios. I carry out the assessment of responses of these variables to the 'shocks' in the economy triggered by different bailouts. I conclude my thesis by bringing together the key takeaways from all of the thesis's chapter. I explain the contribution my research brings to the field of bank performance and stability, as well as I draw some potential policy implications based on my research findings.

Figure 1 maps the thesis' chapters into a joined conceptual framework of a banking sector. I align the chapters by the level of their analysis using this framework. At its lowest level I investigate a single bank's investment projects which drive its performance (level 1 – first chapter). At the next level I look into cross-bank, cross-country and cross-time performance of multiple banks (level 2 – second chapter). At the highest level of the applied framework I explore banks' performance through an application of a CGE model by Goodhart et al. (2004, 2005) and test the impact of government interventions triggered by NPLs of the failing banks on banks' performance and stability in the banking sector as a whole (level 3 – third chapter).

Figure 1: Bank performance and stability – a joined conceptual framework.



Source: Author (2020).

The applied framework is meant to illustrate the interlinkages between my thesis' chapters. Namely, bank performance and its impact on the wider banking sector and the economy as a whole follows a bottom-up structure. This is not to say that a failure on a single investment

project could lead to the instability of the entire banking sector in a given economy. Also, the bottom-up interlinkages between each of the levels do not imply casual-effect relationship.

1.2. Contribution of the thesis' chapters to the relevant fields

Starting from the lowest level of the bank performance analysis, namely an investment project, my first chapter's findings bring several contributions to the relevant fields of literature. Firstly, my research contributes to the literature that investigates determinants of investment non-financial outcomes. The existing research on this topic among MDBs is limited and heavily focused on World Bank's projects (e.g. Denizer et al., 2013; Bulman et al., 2017; Kilby, 2000). By focusing on the EBRD investments I contribute to the field by bringing in novel findings from a MDB which has not been studied in the past. I also confirm earlier findings based on other banks and, thus, contribute to cross-institutional validity of research findings published by other scholars.

Secondly, my findings contribute to the literature on the social impact objectives by focusing on non-financial performance of EBRD's investment projects. In today's world institutional investors, banks and other organisations increasingly look at social impact objectives alongside traditional goal of profit maximisation when making their investment decisions. This is partially driven by their increasing realisation that maximizing shareholder welfare is not necessarily equivalent to achieving highest return on equity (Hart and Zingales, 2017). In this respect, experience of development banks, and, in particular, MDBs may be insightful as these institutions have been investing under non-financial objectives mandate for decades. Some of them, for instance, EBRD and International Finance Corporation (IFC) have explicit focus on private-sector investments, similar to many banks and investment funds. The mandate of EBRD, which started operations in the early 1990s, specifically stresses that projects need to satisfy both sound banking (i.e. financial returns) as well as non-financial social impact by facilitating transition of economies where the bank invests to sustainable market economies (as EBRD was set up to facilitate transition from central planning in post-communist economies). Unfortunately, due to data limitations, I am not able to explore the trade-offs between financial and non-financial project performance which would have bring additional value added to the social impact literature on project's performance.

Thirdly, my findings bring several operational lessons for EBRD and other organisations. Future investment projects can benefit from lessons on the project design and structure from my analysis of almost 1,600 investment projects. With a rather limited amount of funding being available for future investment, the lessons on the design and structure from past projects are highly valuable. These lessons have already attracted a high interest at EBRD and other MDBs and the further research on this topic is ongoing.

The next two chapters of my thesis contribute to a field of literature tackling government interventions into banking sector. The financial crisis of 2007-2008 has called for the need of creating orderly intervention frameworks for restoring distressed banks in the case of the next financial crisis which is likely to unfold soon due to Covid-19 pandemic. At the centre of the debate are banking bailouts which are highly controversial due to the fiscal burden they impose on the taxpayers. Despite all of this, the empirical studies on the effectiveness of government interventions are varied and provide inconsistent results. Some point to the harmful effects of the interventions on the future bank behaviour (e.g. Berger et al. (2010) on a decline in bank liquidity; Duchin and Sosyura (2014) on higher risk). Others, often by the same authors, find some positive evidence of government interventions on the troubled banks (e.g. Li (2013) on higher lending; Berger et al. (2010) on increase in banking capital; Hackenes and Schnabel (2010) on lower risk; Giannetti and Simonov (2013) on higher lending). My contribution to this literature comes from the use of a novel bank-level database of government interventions from 39 countries over almost 20 years of financial crises. To the best of my knowledge, this is the first analysis looking at such a large number of countries over a long period of time.

In addition to this, I further look into the impact of government interventions through a financial stability model of Goodhart et al. (2004, 2005) in my third chapter. This is the first application of this well-known model in the context of government interventions into failing banks. This CGE[1] model considers interactions among various entities in the UK economy that could detect some risks in the banking system which may not be detected by other models. I

[1] Computable general equilibrium (CGE) model is defined as an economy-wide model that describes the motivations and behaviour of all consumers and producers in an economy and the linkages between them (Burfisher, 2011). A set of equations is used to describe the economy and the interactions of the various parts. The model comprises of two distinct variables (exogenous and endogenous) as well as market clearing constraints. The user of the model provides or inputs the exogenous variables whilst the values of the endogenous variables are determined as solutions to the equations of the model. The solutions of the equations at equilibrium are the set of prices which make the quantities of supply and demand equal in every market.

place a special attention on NPLs of the failing banks which further enrich the application of the model and brings valuable lessons.

1.3. Importance of banks in the economy

Good performance of banks as well as their stability are of major importance for bank regulators, investors, as well as the public at large because of the potential harmful contagion risks across the financial sector and consequent financial meltdown, as clearly manifested in the last financial crisis of 2007-2008. Fell and Schinasi (2005) see stable banks as a public good. This could be because, as claimed by Chau-Lau and Sy (2006), banks' instability and their consequent default have substantial welfare costs to the society. For these reasons, the stability of banks should be prioritised and managed carefully.

Academics and policy makers agree that banks play a crucial role in the effective functioning of market economies, owing to their comparative advantage in terms of information gathering, screening and monitoring (Diamond, 1984). Researchers proved that well-functioning financial sector, which includes banks and capital market, can improve the efficiency of allocation of capital resources, encourage savings and lead to more capital formation (e.g. Levine, 1997; Wachtel, 2001; Levine, 2005). As explained by Levine (1997) financial systems facilitate the allocation of resources across space and time in uncertain environment. He, as well as others (e.g. King and Levine, 1993), explains that there are at least four ways in which the banking sector improves allocations First, banks improve screening of fund-seekers and monitoring of the recipients of funds which subsequently improves the allocation of resources. Second, the banking industry encourages the mobilization of savings by providing attractive instruments and savings vehicles. This may increase the savings rate. Third, economies of scale in financial institutions lower costs of project evaluation and origination, and facilitate the monitoring of projects through corporate governance. Finally, financial intermediaries provide opportunities for risk management and liquidity. They promote the development of markets and instruments with attractive characteristics that enable risk sharing in the market economies.

Moreover, Moradi et al. (2016) argue that banking sector development can reduce income inequality through reallocation of economic resources in productive investment across the country, such allocation creates an opportunity to generate income throughout the economy

instead investment in the single area. Apart from that banking sector development also ensure liquidity in the economy along with lower long-term investment risk (Beck, 2010).

Banks are part of the financial system together with stock and bond markets. The paramount importance of banks is typical of the bank-based financial system, which is based on the premise that companies obtain external resources above all from banks, particularly in such financial markets where banks are the main investors in stocks and bonds (Allen and Gale, 2001). Demirguc-Kunt et al. (2011) define financial structure as a ratio between bank private credit to securities market capitalization. The higher the ratio, the closer the system is to a market-based structure. Elston (1995) explains the difference between bank-based and market-based system from the orthodox perspective. In her words, "bank-based systems are better at overcoming asymmetrical information and principal-agent problems arising when ownership and control of firms are separated" (Elston, 1995:475).

In more general terms, the structure of financial markets tends to change as a country becomes more developed. Empirical studies have confirmed that market-based financing becomes increasingly important as the financial system evolves. As explained by Demirgüç-Kunt et al. (2013) the association between an increase in economic output and an increase in bank development becomes smaller, with markets becoming relatively more important for economic activity. Similarly, Boyd and Smith (1996, 1998) show in their earlier studies that banks are important at low levels of development, while markets become more important as income rises. Rajan and Zingales (1999) suggest that banks are less dependent than markets on strong legal systems. Hence, banks do better when the legal system is weak and markets do better when the legal system is more developed. Many scholars such as Demirguc-Kunt and Maksimovic (1998), Levine and Zervos (1998), and Beck and Levine (2004) provide evidence that better-functioning banks as well as securities markets exert robust, independent, and positive effects on economic activity. Table 1 presents a summary of these studies and others which explore the banks - economic growth nexus in more details.

As can be noted from Table 1, majority of the relevant studies rely on cross-country analyses covering a wide range of developed and developing countries over a significant period of time in order to draw valid conclusions. Scholars such as King and Levine (1993a, b), Levine and Zervos (1998), Beck et al. (2000), Beck and Levine (2001, 2002a, 2002b), Evans et al. (2002), all confirm the existence of the banks – economic growth nexus. Other scholars, such as

Rousseau and Wachtel (2005), Favara (2007), find that the nexus is weaker with the most recent data and that it tends to vary widely depending on the country's level of development. There is no doubt, however, that banks play a crucial role in the economy and, thus, need to be treated with the appropriate importance by the governments and policy makers in order to deliver financial stability.

Table 1: Review of the literature on the empirical links between banking sector development and economic growth.

Author(s)	Sample coverage, data and methods	Key findings
King and Levine (1993a, b)	Sample: 80 countries Time period: 1969 - 1989 Theoretical framework: "Barro" growth regression[2] Research method: cross-country analysis Financial segment(s): banking sector	Banking sector development found to be strongly associated with the economic growth of the studied countries. This was also found to be correlated with the growth rate of physical capital and technology growth. These results may, however, be impacted by the endogeneity bias.
Demetriades and Hussein (1996)	Sample:16 countries (less developed) Time period: n/a Theoretical framework: n/a Research method: Time series analysis Financial segment(s): financial sector in general	The causality between financial sector and growth varies considerably across studied countries. In about half the examined countries a feedback relationship was detected, but in several countries the relationship ran from growth to finance, suggesting that it is by no means universal that financial sector development can contribute to economic growth.
Levine and Zervos (1998)	Sample: 47 countries Time period: n/a Theoretical framework: "Barro" –regression Research method: cross-section analysis Financial segment(s): banking sector, stock market	Banking sector development as well as stock market development were found to be both positively and robustly correlated with contemporaneous and future rates of economic growth, capital accumulation and productivity growth.
Fufa and Kim (2018)	Sample: 40 countries Time period: 1989-2012 Theoretical framework: n/a Research method: convergence tests to capture nonlinear transitional dynamics; OLS and GMM regressions Financial segment(s): financial sector in general	Strong evidence of multiple convergence clubs is observed, implying that the clubs are formed based on the initial level of real output per capita and average growth rate. The authors explain that the stage of economic growth of each country plays an important role for the composition of the convergence clubs of financial development.

[2] "Barro" - regression refers to the regression specialisation developed by Barro (1991).

Author(s)	Sample coverage, data and methods	Key findings
Qamruzzaman and Jianguo (2018)	Sample: 8 Asian countries Time period: 1974-2016 Theoretical framework: asymmetric relationships between studied variables Research method: Autoregressive Distributed Lag (ARDL) bound testing; Granger-causality Financial segment(s): banking sector	The results show evidence for the feedback hypothesis between financial innovation and economic growth and banking sector development and economic growth both in short and long run.
Ram (1999)	Sample: 93 countries Time period: n/a Theoretical framework: "Barro" – regression Research method: cross-section analysis Financial segment(s): banking sector	In this cross-country sample the studied regression structure was found to be permitted to vary across all levels of country development. A huge parametric heterogeneity was also observed and the overall indication was that of a negligible or negative association between financial development and economic growth.
Beck et al. (2000)	Sample: 77 countries Time period: 1990-2000 Theoretical framework: "Barro" – regression Research method: cross-section analysis and panel analysis Financial segment(s): banking sector	A positive impact of banking sector development on real per capita growth and productivity per capita growth was found. The results were robust to the use of different estimation procedures, conditioning information sets, and indicators of financial development.
Durusu-Ciftci et al. (2017)	Sample: 40 countries Time period: 1989-2011 Theoretical framework: Solow-Swan growth model; Research method: cross-section analysis based on augmented mean group, common-correlated effects Financial segment(s): banking sector and capital market	The empirical findings reveal that both banking and capital markets have positive long-run effects on steady-state level of GDP per capita, and the contribution of the credit markets is substantially greater. The paper advocates implementing policies that result in deepening of the financial markets, including institutional and legal measures to strengthen creditor and investor rights and contract enforcement.
Čihàk et al. (2013)	Sample: 205 countries Time period: 1960-2010 Theoretical framework: 4x2 measurement framework Research method: n/a	No empirical assessment carried out. The paper focuses on the presentation of the database through which illustrations are drawn as to the role of financial sector in the economy.

Author(s)	Sample coverage, data and methods	Key findings
	Financial segment(s): banking sector and capital market	The database highlights the multidimensional nature of the financial system which impacts financial stability.
Beck et al. (2014)	Sample: 132 countries Time period: 1980-2005 Theoretical framework: standard empirical growth equation Research method: dynamic panel regressions Financial segment(s): banking sector and capital market	The role of banks on the economic growth is confirmed by the finding that an expansion of credit has a positive effect on per capita output growth but only till a certain point. Further development of banks may have a negative impact on growth in mature financial systems.
Manganelli and Popov (2013)	Sample: 41 countries Time period: 1989-1990 Theoretical framework: Research method: cross-industry, cross-country regression approach instead of on a cross-country one Financial segment(s): financial sector in general	They find that financial development has a non-monotonic effect on growth in the Rajan and Zingales (1998) and Fisman and Love (2007) sample. Beyond a threshold, financially dependent industries and industries facing good growth opportunities grow disproportionately more slowly.
Iyare and Moore (2011)	Sample: 4 countries Time period: 1960-2003 Theoretical framework: Granger casual relationships Research method: long- and short-run Granger causality tests Financial segment(s): financial sector in general	The authors' findings show that there is a positive association between financial development and growth in all four studied countries. However, the long-run causality tests show that growth tends to lead financial development in Singapore and Jamaica, financial development leads growth in Trinidad and Tobago and there is a bidirectional link in Barbados. These results therefore suggest that cross-country studies could overstate the impact of financial development on growth, since they ignore differences – even in relatively homogenous groups.
Cojocaru (2016)	Sample: 23 countries Time period: 1989-2008	The findings show some evidence that financial system efficiency and competitiveness is more important than the amount of private sector credit provided by the banking system. The results show, in particular, a particularly strong

Author(s)	Sample coverage, data and methods	Key findings
	Theoretical framework: standard model of economic growth augmented with measurers of financial development and efficiency. Research method: system GMM regressions Financial segment(s): financial sector in general as well by category	evidence for the role of interest rate spreads and bank overhead costs.
Benhabib and Spiegel (2000)	Sample: n/a Time period: n/a Theoretical framework: growth accounting regression and factor accumulation regression Research method: panel analysis Financial segment(s): banking sector	The results indicated that banking sector development positively influences economic growth. However, the relationship was found not to be robust to the use of different banking sector development indicators and estimation techniques.
Kahn and Senhadji (2000)	Sample: 159 countries Time period: n/a Theoretical framework: "Barro" – regression Research method: cross-section analysis and panel analysis Financial segment(s): banking sector, stock and bond market	The authors found a strong positive and statistically significant relationship between financial development and economic growth. Their results were robust under testing with different financial development indicators.
Levine, Loayza, Beck (2000)	Sample: 71 countries Time period: 1960-1995 Theoretical framework: traditional cross-section, instrumental variable procedures, recent dynamic panel techniques Research method: cross-sectional instrumental-variable estimator, GMM dynamic panel estimator Financial segment(s): banking sector and financial sector in general	They found that the exogenous components of financial intermediary development is positively associated with the economic growth. They also found that legal and accounting reforms that strengthen creditor rights, contract enforcement, and accounting practices can boost financial development and accelerate economic growth.
Beck and Levine (2001)	Sample: 40 countries Time period: 1980-1999 Theoretical framework: "Barro" – regression	They found that banking sector development together with stock market development could jointly enter all of the growth regressions significantly using alternative

Author(s)	Sample coverage, data and methods	Key findings
	Research method: panel data regression analysis Financial segment(s): banking sector, stock market sector	conditioning information sets and alternative panel data estimators. Thus, after controlling for country specific effects and potential endogeneity, the data were consistent with theories that emphasize an important positive role for financial development in the process of economic growth.
Deidda and Fattouth (2001)	Sample: 199 countries Time period: 1990-2000 Theoretical framework: "Barro" – regression Research method: Cross – section analysis Financial segment(s): banking sector and financial sector in general	For the whole sample there was a positive relationship between banking sector development and the economic growth. While examining the sub-groups of the sample they found a positive relationship between the level of financial development and economic growth only for countries with high income per capita at the initial stage. They found no significant relationship between banking sector development and economic growth for low income countries.
Rousseau and Sylla (2001)	Sample: 50 countries Time period: 1850-1997 Theoretical framework: "Barro" – regression Research method: panel data regression analysis Financial segment(s): banking sector	They found a strong, positive effect from financial intermediation in the pre-depression period.
Beck and Levine (2002a)	Sample: 40 countries Time period: 1980-2001 Theoretical framework: "Barro" – regression Research method: panel data regression analysis Financial segment(s): banking sector, stock market	Banking sector as well as stock market sector development were both found to be important for the economic growth in the studied sample of countries.
Evans et al (2002)	Sample: 80 countries Time period: 1985-1998 Theoretical framework: growth accounting regression Research method: panel data regression analysis Financial segment(s): banking sector	They found that banking sector development made a significant contribution to the economic growth. Specifically, they found that banking sector development and human capital were both complements in the growth process suggesting that the productivity enhancing potential

Author(s)	Sample coverage, data and methods	Key findings
		of human capital could just be exploited in the presence of a developed banking sector.
Rioja and Valev (2004)	Sample: 74 countries Time period: 1960-1995 Theoretical framework: generalized method of moments dynamic panel techniques Research method: panel data regression analysis Financial segment(s): financial sector in general	The finance-growth relationship was found to differ between the different stages of economic development. In the low income countries, additional improvements in financial markets had an uncertain effect on growth. In the intermediate income countries, financial development had a large, positive effect on growth. Finally, in the high income countries, the effect was positive, but smaller.
Rousseau and Wachtel (2005)	Sample: 84 countries Time period: 1960-2003 Theoretical framework: rolling regression technique Research method: cross-country and panel analysis Financial segment(s): financial sector in general	The finance-growth relationship was not as strong with more recent data as it was in the original studies with data for the period from 1960 to 1989. Among poorer counties, the relationship was positive but imprecisely measured. They found that the measures of financial depth in the standard growth equation are strongly biased by other unobserved country-specific factors which needs to be controlled for.
Favara (2007)	Sample: 87 countries Time period: 1960-1998 Theoretical framework: one-step GMM estimator, pooled mean group estimator of Pesaran, Smith and Shin (1999) Research method: panel data regression analysis Financial segment(s): banking sector, stock and equity market	They found that the financial development and economic growth were correlated but financial development did not cause economic growth. They also found that there was evidence that this relationship was heterogeneous across countries.

Source: Author (2020).

Furthermore, there has been an increased interest by both policy makers and academics to assess the extent in which macroeconomic conditions and banking sector performance depend on one another (e.g. Benink and Benston, 2005, Gupta, 2005, Goodhart et al., 2006). The link between macroeconomic conditions and the banking sector performance could be of particular interest to policy makers, because they often base their monetary policy decisions on economic forecasts. For instance, research focusing on understanding whether banking performance should be considered in the setting of monetary policy has investigated the informational advantages of the central bank, and, in particular, whether bank related information can be used to improve macroeconomic forecasts.

There has been an extensive amount of research on the definitions and identification of banking crises. Researchers generally agree that banking crises show up in many different ways and that identifying them implies a certain degree of subjectivity. Athanasoglou et al. (2008), for instance, point out that profitable banking systems are likely to absorb negative macroeconomic shocks, thus maintaining the stability of the economic system. Albertazzi and Gambacorta (2009) made it clear that the identification of the factors driving bank performance can be an important predictor of unstable economic conditions. The scholars agree that banking crises have usually coincided with, or preceded, a substantial economic slowdown (e.g. Serwa, 2007; Kroszner et al., 2007).

As flagged by Monin and Jokipii (2010), the existing literature is not clear on whether or not the banking sector is the main trigger of the economic slowdown, as it is difficult to separate cause and effect in the banking sector versus macroeconomic nexus (e.g. Demirguc-Kunt and Detragiache 2005, Hilbers et al. 2012). Monin and Jokipii (2010) focused on investigating the impact of banking sector performance on real output growth. They took banking sector instability as given without examining its causes. They measured banking sector stability based on the banking sector's probability of default. They followed Aspachs et al. (2007)'s approach by exploring the impact of banking sector stability on real output growth and inflation rates in the subsequent quarters with a panel vector autoregressive model.

Others such as Jappelli and Pagano (1994) as well as Eichengreen et al. (1999) showed that although saving surpluses allow a move toward capital account convertibility, it can be argued that in an environment of imprudent lending strategies in the banking sector, growth in the level of available finances may precipitate a financial crisis and harm economic development.

In addition, the liquidity of the banking system and the quality of its loan portfolio can be at stake if the expansion of domestic loans is fuelled by enormous capital inflows in circumstances such as a balance of payments crisis or exchange rate instability (e.g. Calvo and Mendoza, 2000).

1.4. Bank performance in the context of literature review

The literature on bank performance covers a wide range of approaches taken by scholars to tackle this topic in relation to their specific research question. As explained by Hahn (2008) modern economic analysis of banking industry exclusively builds on the economics of industrial organization. Within the banking literature, theoretically and empirically, the structure-conduct-performance (SCP) paradigm receives the most attention.

In its simplest form, the SCP paradigm views market structure as exogenous, in the sense that it is the structural characteristics of markets that tend to influence both the conduct and, ultimately, the performance of banks. Most early empirical research based on the SCP paradigm focused on the relationship between concentration and performance measured by profitability. A positive correlation between concentration and profit was typically interpreted as evidence that banks act collusively in order to achieve high profits.

According to Hahn (2008) the most rigorous foundation of the SCP paradigm in banking is given by Hannan (1991). The SCP model as defined by Hannan (1991) has the following form:

$$\Pi_i = \alpha_0 + \alpha_1 CR_j + \sum_{j=2}^{P} \alpha_j Z_{ij} + \varepsilon_i \qquad \text{(Eq. 1)}$$

where Π is the return on assets for the ith bank. CR is a measure of market structure usually proxied by either a n-bank concentration ratio, and Z_{ij} are additional explanatory variables included to control for individual bank risks and market demand factors. The term ε_i represents the stochastic disturbance term. The support for the hypothesis that market structure influences bank performance is found when the coefficient α_1 is, in a statistical sense, larger than zero.

This simple SCP model has been challenged by many scholars who introduced alternative models such as the efficiency-structure hypothesis (ESH; Demsetz, 1973; Brozen, 1982), relative market power hypothesis (RMPH; Shepherd, 1982), naming just few models among the others.

During the last few years there have been extensive effort among the scholars on measuring the impact of various factors on banking profitability. Table 2 summarizes some of these papers. I outline the empirical relationships the scholars tackled, their data and methodology as well as main results.

Table 2 covers a wide range of studies which looked from the broader angle of the nexus of bank profitability and financial structure (e.g. Demirgüç-Kunt and Huzinga, 2000) to a more specific details such as the relationship between bank profitability and commercial property prices (Davis and Zhu, 2005). The goal of this table is to display the wide range of topics authors explored in the field of bank performance as well as the diversity of the methods used.

The paper by Athanasoglou et al. (2005) is worth emphasising because of their choice of looking into a multi-perspective range of factors which could influence bank profitability i.e. bank-specific, industry-specific and macroeconomic factors. Similar holistic approach would be applied in the first chapter of this thesis. Also, the study by Pasiouras and Kosmidou (2007) is worth flagging due to the variety of bank characteristics used to analyse the bank profitability which they proxy with the use of ROAA. Similarly, the study by Ngo (2006) uses a range of regression methods and tests which provide useful lessons learnt for my empirical undertakings in the second chapter of my thesis.

Table 2: Summary of the main literature on bank profitability from methodological perspective.

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
Demirgüç-Kunt and Huzinga (2000)	Bank profitability and financial structure	44 countries; 1990-1997	Bank profitability: profits/total assets, net margins/total assets Financial characteristics: equity/total assets, loan/total assets, earning assets/total assets, overhead/total assets Financial structure: bank/GDP, central bank/GDP, bank credit/GDP, stock market capitalization/GDP, stock traded/GDP Macro variables: GNP/cap, GDP growth rate, inflation, tax rate	Cross-country regressions with different specifications, no fixed or random effects; Robustness check: additional control for institutional variables (i.e. legal and regulatory controls)	Linear single equation	Controlling for both bank and market development, financial structure does not have an independent effect on bank performance; for countries with underdeveloped financial systems, convergence towards a more developed financial system reduces bank profitability, ceteris paribus.
Goddar et al. (2004a)	Bank profitability versus size, diversification, risk and ownership type and dynamic effects	665 banks; 6 EU countries; 1992-1998	Bank profitability: ROE Size: total assets Diversification: value of OBS/total assets Risk: capital assets ratio Dummies: type of banks	Cross-sectional (OLS), pooled cross-sectional time series (OLS), dynamic panel models (GMM)	Linear single equation	The evidence of any consistent or systematic size-profitability relationship found to be relatively weak. The relationship between the capital-assets ratio and profitability is positive.
Athanasoglou et al. (2005)	Bank profitability versus bank-specific, industry-specific	Greece; 1985-2001; commercial banks	Bank profitability: ROA, ROE Bank-specific: capital (equity/assets), credit risk (NPL/total loans), productivity growth, operating expenses/assets, size (real assets)	Dynamic panel model (GMM)	Linear single equation	All bank-specific determinants, with the exception of size, affect bank profitability significantly. No

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
	and macroeconomic determinants		Industry-specific: ownership dummy, concentration (Herfindahl-Hirschman index) Macroeconomic: inflation expectations (CPI, 10 year government bond), cyclical output (actual output-segmented trend)			evidence found to support SCP hypothesis. Business cycle found to have positive but asymmetric effect on bank profitability being significant only in the upper phase of the cycle.
Arthur and Rabarison (2018)	Bank profitability and deposit-lending synergies	US commercial banks, 1985-2013	Market level control: Federal funds rate Economic condition controls: employment growth, bank-level controls, total assets (size proxy), liquid assets, capital adequacy ratio, set of bank-based dummies Liquidity exposure Bank profitability: ROE	panel regressions of bank profitability (ROE) on previous quarter liquidity exposure and transaction deposit ratio	Linear single equation	The deposit-lending synergies translate to increased profitability only for small publicly traded banks. However, pre-crisis deposit-lending synergies do not appear to lead to higher profitability during or after the crises.
Tran et al. (2016)	Bank profitability, liquidity creation, regulatory capital	All US banks, 1996-2013	Main variables: liquidity creation, regulatory capital (Tier 1, Basel III capital ratio), profitability (ROE, ROA) Bank control variables: risk-weighted assets, total assets, gross total revenue, operating expenses. Market control variables: market concentration (Herfindahl-Hirschman Index of deposit concentration), stock market volatility.	vector autoregressive model (VAR), two-step system GMM dynamic panel estimators	Two equation reduced form vector auto regression (VAR) model	Regulatory capital and liquidity creation affect each other positively after controlling for bank profitability. However, this relationship is largely driven by small banks and primarily during non-crisis periods. The relationship

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
			Macro control variables: real GDP growth, business cycle indicator			between regulatory capital and bank performance is not linear and depends on the level of capitalization.
Davis and Zhu (2005)	Bank profitability and commercial property prices	15 industrialized economies, 904 banks, 1989-2002	Dependent variable: real loan growth rate, net interest margin, ROA, Explanatory variables: real commercial property prices growth rate. Controls: macroeconomic (real GDP growth, inflation), bank-specific variables (loan-to-asset ratio, loan growth rates, NIM, capital ratios, bank size dummies)	OLS panel estimation with country dummies, use of clustered standard errors grouped by country-year	Linear single equation	Commercial property prices tend to be positively associated with bank lending and profitability, and negatively associated with banks' net interest margin and bad loans ratios. Further extension shows the importance of banks' size on the regression coefficients.
Sahyouni and Wang (2018)	Bank profitability and liquidity creation	11 developed and emerging market countries; 4995 banks; 2011-2015	Dependent variables: ROAA, ROAE, net interest margin Bank-specific factors: liquidity creation / total assets, operating income, total assets, capital adequacy ratio, loan loss provisions/ total loans, interest paid/ total deposits; others Macroeconomic factors: GDP growth, inflation.	Fixed effects regressions	Linear single equation	Banks that create more liquidity, are found to have lower profitability. Asset management, bank size and capital ratio are positively correlated with bank profitability. While, credit quality and operating efficiency affect bank's profits negatively.

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
Goddar et al. (2004b)	Bank profitability and growth	Five EU countries, 583 banks, 1992-1998	Bank profitability: ROE Growth: change in logarithmic size (total assets) of a given bank over a one year period Size: total assets (log) Control variables: capital (capital-to-assets ratio), liquidity ratio (liquid assets to total assets), share (bank's share in country's total assets), concentration (Herfindhahl index), Macroeconomy (annual growth rate of real GDP)	Regressions: Univariate, bivariate and multivariate versions of dynamic growth models; [for profit regressions}: cross sectional regressions	Two equation reduced form vector auto regression (VAR) model	The growth regressions reveal little or no evidence of mean-reversion in bank size. Banks that mention high capital-assets or liquidity ratios tend to record low profitability. They found some evidence of a positive relationship between concentration and profitability, but little evidence of a link between bank-level and x-inefficiency and profitability.
Ngo (2006)	Bank profitability and capital	2500 banks, 1996-2005	Bank profitability: ROE, ROA Capital: CAR (Capital-to-asset-ratio) Size: logarithm of total assets [square of natural log of total assets to capture any nonlinearities in the size-profit relationship] Diversification: ratio of nominal OBS business to the sum of total assets and nominal OBS business Credit risk: ratio of loan-loss provisions to loans Operating expenses: ratio of operating expenses to total assets	Regressions: Pooled instrumental variables (IV)/two-stage least squares (2SLS), fixed-effects IV/2SLS, GMM IV, dynamic panel models (differenced GMM) Tests: Tests for unit root, Hausman test, Davidson-MacKinnon test	Two equation structural form	They found no significant relationship between capital and profitability. Also, they found that when capital structure is endogenously determined in a profit maximising equilibrium, no systematic relation between capital and profit is expected.

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
			Concentration: Herfindahl-Hirschman Index (HHI) Macroeconomy: CPI, real GDP growth Dummies: year, location, bank's charter authority			
Hahn (2008)	Bank profitability and contestability in banking	700 Austrian banks, 1996-2002	Bank profitability: ROA Market concentration: Hirschman-Herfindahl index Market share: capital-asset ratio, fixed cost ratio Various efficiency measurers	Robust fixed effects panel regressions	Linear single equation	Austrian banks do exert, on average, some local market power. However, the gains in terms of excess profits are small as a result of low deterrence powers of the incumbent banks.
Yuanita (2019)	Bank profitability and competition	Indonesia, 93 banks, 2000-2015	Dependent variable: ROA Explanatory variables: concentration ratio, cost to income ratio, equity to assets ratio, ownership concentration ratio, NPLs.	Lerner's index, Arellano Bond GMM	Linear single equation	Market structure affects bank behavior as well as bank performance. Increase in market concentration causes a decrease in price. It shows that merger increase economies of scale so that bank can offer lower price. A decrease in price brings down bank profitability.

Scholars	Relationship	Coverage	Variables	Methods	Type of framework	Main Results
Pasiouras and Kosmidou (2007)	Banks profitability and its determinants	584 commercial banks, 15 EU countries, 1995-2001	Bank profitability: ROAA Bank characteristics: equity/total assets, cost to income ratio, total loans, total assets Macroeconomic and financial structure: inflation, GDP growth, concentration ratio, total assets/GDP, stock market capitalization/GDP	Regressions: fixed effects OLS Tests: Hausman test, Breusch-Pagan test	Linear single equation	Profitability of domestic and foreign banks is affected by bank's specific characteristics as well as financial market structure and macroeconomic conditions.

Source: Author (2020).

1.5. Structure of my thesis

The core of my Ph.D. thesis is structured around three research chapters. I provide a brief abstract at the opening of each of these chapters. The first chapter presented under section 2 of this thesis consists of introduction which is immediately followed by the review of the literature on investment project performance of MDBs and project success factors in general. I also refer to project management literature in this sub-section and construct the summary of the main factors which are associated with successful project performance. I use this summary to draw hypotheses in reference to EBRD projects. The next section outlines the empirical methods used in this chapter. Namely, I start with the description of the data and estimation techniques including the reference to the selection bias which is one of the main empirical factors I tackle in my chapter. I then move to the diagnostic tests. I dedicate the next section to the empirical set-up which includes project selection bias method, moderated mediation analysis to tackle the indirect effects, and methods to tackle the potential endogenous regressors in the outcome equation. Next, I present the empirical results in the following order: (i). selection bias model results which show no evidence of such bias in my sample, (ii). regression results based on the multiple probit models which identify factors which influence project success at EBRD, (iii). moderated mediation analysis which investigates the indirect channels for a range of factors impacting project success, (iv). additional robustness checks of the results. I follow this with the discussion of my results which includes the commentary on the project design and structure, client characteristics, as well as trade-offs between non-financial and financial performance of investment projects. I then conclude this first chapter and outline further research which is currently ongoing.

The second chapter of my thesis follows a similar order. After a brief abstract I begin with the introduction and the review of the related literature. This includes: (i). the concepts of systemic banking crises and systemic risk; (ii). the typology and effectiveness of government interventions into troubled banks, and (iv). the overall literature contribution of my chapter. Next, I move to the empirical analysis which is the core of this chapter. I start with the outline of the data, variables as well as descriptive statistics. The following section captures the methodology which outlines the three interrelated empirical approaches I follow. This is then followed with the results and robustness checks. The conclusion closes this chapter.

The last chapter of my thesis also starts with the abstract and introduction. This is then followed by literature review which includes several strands of the related fields, i.e.: (i). defining financial stability, (ii). financial stability and systemic risk (iii). financial stability and NPLs, (iv). financial stability and bank bailouts, and, finally, (iv). CGE modelling of bank risk assessment which introduces the next section which is at the core of this chapter. Specifically, it is the theoretical model of Goodhart et al. (2004, 2005). This key section of this chapter includes its detailed description, application to the research topic, model calibration exercise together with the results. I then move to the discussion of the results and conclude the chapter.

The thesis ends with the summary of the main takeaways from all three chapters as well as the discussion of the further research. The references are listed at the end of the thesis. The datasets used in this thesis are not enclosed due to their confidentiality.

2

Drivers of a bank's investment performance at a multinational development bank

Abstract

This chapter explores how various project- and client- related factors contribute towards performance of an investment project from European Bank for Reconstruction and Development (EBRD). The performance measure is focused on the development outcome which is non-financial. This is due to the nature of the investment objectives in multinational development banks which are founded by donor governments and partners which strive towards a contribution to development impact. For EBRD's investments, the project performance is derived from the assessment of ex-ante transition objectives under each investment project e.g. demonstration of new financing methods, market expansion, increase in business standards and corporate governance. I construct and use a unique dataset based on almost 1,600 EBRD investment projects completed between 2003 and 2016. The results based on the empirical analysis of these projects suggest that the probability of success is higher with larger projects, although the results are sensitive to potential endogeneity bias. Also, a project being part of a framework, i.e. 'repeat project', stands out as an important contributor towards success and its impact is mediated through project size. Lastly, my results also show that projects with state clients are less likely to be successful in comparison to projects from clients in the private sector. This 'state ownership' variable was also found to mediate the impact of project implementation speed on success likelihood, i.e. projects with state clients tend to take longer to implement which further reduces the chances of project success. I address any potential project selection bias on my results with the use of Heckman selection models. I found no empirical evidence of such bias in my sample. The chapter's scope was constrained by multiple data limitations at the time of the research which require technical and operational resolution within EBRD and that is beyond the control of the researchers. Still, future research in this topic could look into potential trade-offs, or complementarities, between non-financial performance success (i.e. transition-related) and financial performance success. This could serve as an important contribution to the fields of social impact investing and corporate strategies for hybrid organisations.

2.1. Introduction

Multilateral development banks (MDBs) have been under increasing pressure to demonstrate that they achieve the non-financial results for which they were originally set up for due to ever-shrinking pull of financial resources being available for them to invest with. This has put the spotlight on project selection applied by these banks to ensure their investments comply with their institutional mandates with results that meet their founding purpose. All of this interest led to an expansion of research into the factors driving project success in MDBs. The existing literature in this field is heavily focused on World Bank's analyses. Factors most frequently found to matter for their project success are project size, speed of project delivery, project novelty, among others.

This chapter focuses on a unique dataset from EBRD I construct in order to investigate what factors determine project success at EBRD. Unlike other MDBs, EBRD's principle mission is to help countries transition towards fully functioning, sustainable market economies. Thus, the bank is committed to include transition-related objectives in its project lending criteria and to report on their delivery.

The bank derives ex-ante transition impact objectives in a way that allows the subsequent evaluation of project success at the project completion. In the broader context, the bank's project could contribute to the structure and extent of the markets (e.g. greater competition in the project's sector), contributions to the institutions and policies that support markets (e.g. more widespread private ownership), contributions towards market-based conduct, skills and innovation (e.g. transfer and dispersion of skills, setting standards for corporate governance and business conduct).

Based on the project-level data I collected from almost 1,600 EBRD investments completed between 2003 and 2016, I carry out an empirical analysis of various factors behind project design and structure as well as client-related characteristics in order to determine which channels influence the likelihood of project success. The key factors were chosen based on the extensive literature review as well as the nature of EBRD's projects as explained in the next section.

My findings show that the probability of transition success is more likely with larger size projects, although the robustness of this finding is challenged due to the potentially endogenous nature of project size. This was discovered based on Lewbel's (2012) method using heteroscedasticity-based instruments. The results also show that projects being part of a broader framework of investment projects are more successful than standalone projects. This 'framework' factor is found to be mediated through project size which channels approximately 17% of its total effect on project success. Lastly, I show that projects with state clients are less likely to be successful; this variable is also found to mediate the impact of project implementation speed ('effectiveness delay') on project success likelihood.

This chapter contributes to the relevant literature in several ways. Firstly, project selection bias is directly addressed with the use of Heckman selection techniques. This is possible due to the data availability through the collected and cleaned pull of all the cancelled and rejected projects at EBRD. I have created the database consisting of over 2,000 such projects. Secondly, client-related success factors are explored which adds a valuable contribution to the literature. This is possible due to unique nature of EBRD investments which targets private sector clients. This links to yet another contribution - the very focus on EBRD projects which provides a useful value added to the existing literature. Lastly, from a broader perspective, this chapter contributes to the deeper understanding of how project design and structure affect performance delivery in a MDB which prioritises the delivery of its non-financial success rather than financial success as its primary objective as it is the case with corporate banks. Still, further analysis is required as there are obvious trade-offs, as well as complementarities between financial and non-financial objectives which any hybrid organisation faces and these are likely to impact the project success factors.

The chapter is structured as follows. The first section outlines the relevant literature behind project success factors in general as well as in relation to MDBs which is used to derive the predictions for the key factors are expected to influence the project success at EBRD. The next section describes the data used, estimation techniques, data distributions as well as outlines key aspects of the empirical set-up. Next, the results are outlined which is then followed by their discussion. This includes limitations of this chapter as well as some potential areas for further research. The final section concludes this chapter.

2.2. Literature review

Undoubtedly, identification of the reasons leading to project performance success could help in future project selection which is an important and recurring activity in many organisations, not just MDBs. Hence, many studies in the area of project management focus on investigating reasons for project success which, as explained by Shenhar et al. (1997), is one of the most debated topics in this field and one of the least agreed upon.

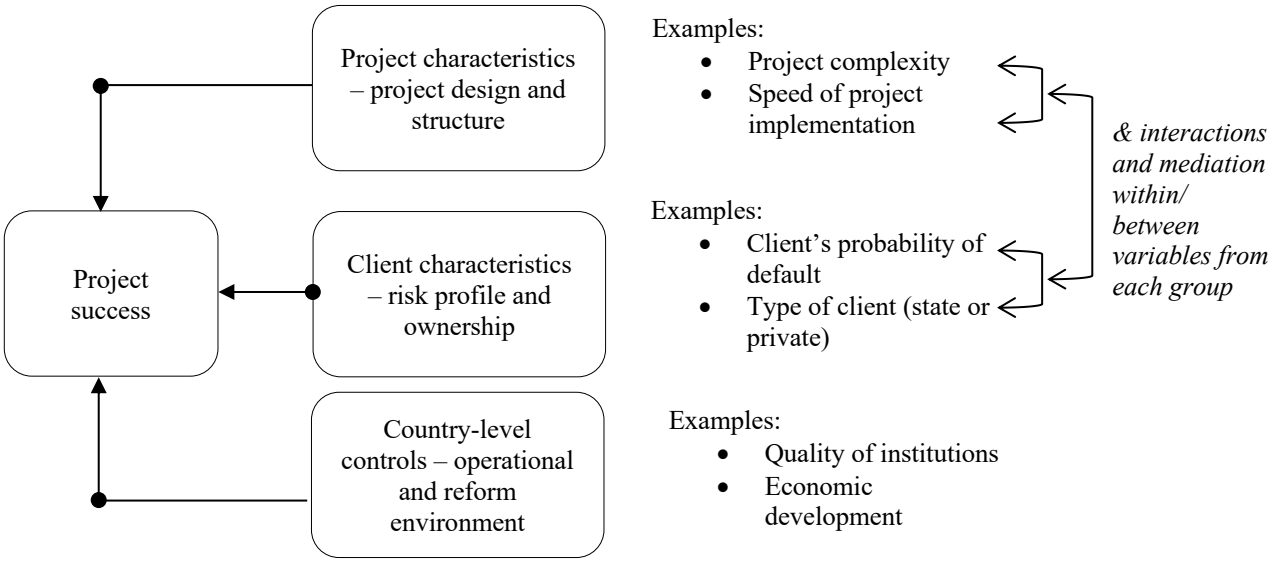
The earliest research from this field dates back to the 1960s. It focuses mainly on exploring project success criteria and claims that the main criteria for success are the so-called "golden tri-angle" of time, budget, and project quality. But, as described by Westerveld (2003), researchers fairly quickly established the impossibility of generating a universal checklist of project success criteria which could be suitable for all projects. This is because success criteria could differ from project to project depending on a number of factors, for example, project size, its uniqueness or complexity.

In response to this, many researchers, including Cooke-Davies (2002), separated the analysis of project success into two distinct topics – 'project success criteria' and 'project success factors'. The success criteria relate to the measures by which the success of a project is judged, which refers here to project transition-related targets, whereas the success factors are those factors that could lead to the success of the project e.g. project- or client-related characteristics. This chapter focuses on analysing the latter and it takes the former at its face value. It is also important to note the intentional focus placed on reasons influencing 'project success' rather than 'project performance'. This is because such reasons are likely to differ as the former cannot be measured until after the project is completed, whereas the latter can be measured during the life of the project.

Belassi and Tukel (2006) claim that although many studies in the project management literature have generated lists of factors for project success, each list varies in its scope and purpose. It is often found that the success factors are listed as either general factors or specific factors affecting only a particular project. They suggest a new approach of grouping success factors and explaining interactions between them. This chapter tests this approach through interaction terms and moderated mediation modelling. The reviewed literature (see Table 3) helped to

derive a holistic approach of two groups of factors: project-, and client-characteristics as well as a range of country-level controls which is summarised in Figure 2.

Figure 2: Summary of the main factor groups of interest.



Source: Author (2018).

Based on the reviewed literature, I expect the following factors to be associated with successful projects:

- Smaller project size
- Longer 'effectiveness delay' in project implementation
- Being part of a framework
- Presence of co-financing
- Client's characteristics

First, **'project size'** matters for project success and it can be used as one of the potential proxies for project complexity according to Bulman et al. (2017). Although there is considerable empirical evidence for the relationship between project complexity and its success, very little has been done in identifying the exact channels of this relationship as argued by Antoniadis et al. (2011). They explain that it is often presumed that as complexity increases, project success likelihood decreases. Some scholars justify this relationship from a purely conceptual level. For instance, Galbraith (1974) claims that the greater project complexity is the greater the amount of information that must be processed among decision makers during project execution in order to achieve a given level of project success. Only few scholars go beyond this level and investigate the nature of project complexity-success nexus further.

Table 3: Determinants of investment project success among MDBs - literature review.

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
Bulman et al. (2017)	Macro and micro correlates of project performance; sample: World Bank projects (n=3821, since 1995) and Asian Development Bank (n=1342, since 1973) projects	Provided an innovative insight into under investigated relative importance of country versus project characteristics in driving aid effectiveness; comparison the correlates of project success in Asian Development Bank with World Bank; studied similarities and differences across institutions in the relationship between project outcomes and country and project characteristics.	Project outcome (DV) based on project's development outcome; Country Policy and Institutional Assessment ratings; Real GDP per capita growth; Freedom House rating; Dummy for PAR/PPER evaluations; Dummy for ADB PVR evaluations; size log (total commitment); Planned project length; Effectiveness delay; Implementation day; Additional funding; Project manager track record; Project manager turnover; Negative rating in first half ('warning rating').	No (Did not addressed it empirically. Only mentioned that their results should be interpreted with some caution because of the influence of unobservable project characteristics on project selection)
Dollar and Levin (2005)	Institutional quality and project outcomes; Sample: World Bank development projects; 1990-1999.	Introduced macroeconomic evidence on factors conducive to the success of aid-funded projects in developing countries.	Project success rate (DV); Log of GDP/capita; Rule of law index; Freedom House index; single index of institutional quality from Kaufman, Kraay, and Zoido-Lobaton (1999); Aid/GDP; the percent of the country's territory situated in the tropics; country (not included in the regs), region (included in the regs).	No (Found little narrative evidence that selection bias problems were impacting the conclusions, so took no action)
Guillaumont and Laajaj (2006)	Effects of economic instability on projects success; sample: World Bank development projects; n=2,894; 1981-2002	Showed that the previous macroeconomic studies arguing that aid effectiveness is higher in vulnerable countries because it dampens the negative effects of shocks is inconsistent with the observation that the success of the projects is lower in an unstable environment.	Project outcome rating (DV); Index of economic instability (export variability); Official Development Assistance as a share of GNI; country log of the rate of exports during the project; initial level of education and quality of institutions; sector of the project, a dummy for IDA/IBRD, a dummy for Investment/Adjustment loans; country being oil exporter; political instability	Yes (addressed it by using instruments (i.e. IV method) based on the characteristics of the donors)

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
Kilby (2012)	Effects of donor agencies on project outcomes; sample: World Bank development projects; n=4691; approval dates 1986-2008	used a stochastic frontier model to generate a measure of World Bank project preparation duration based on a variation in political economy factors that are exogenous to latent project quality.	Outcome (IEG overall project performance rating); project preparation time; total project cost; IDA funds dummy variable; Structural Adjustment Loan dummy; Dummy indicating major conflict; population; PPP GDP per capita; Democracy dummy; Averaged Freedom House Rating; Alignment with US on UN votes important to US; Alignment with other G7 on other UN votes; Alignment with G7-1 important votes; Alignment with G7-1 other votes; Dummy for US military aid>0.5; Log of disbursements of US economic aid; Log average disbursements Like-minded donor aid; Indicator for country holding non-permanent UNSC seat; Country held World Bank ED seat in current year or past 3 years.	No (Excluded the projects which were cancelled before the implementation (e.g. the borrower never signed the project loan docs) and claimed that the sample selection bias does not appear to be an issue)
Denizer et al. (2013)	Macro and micro correlates of project performance; sample: World Bank development projects; n=6,000; 1983-2011	Found that the success of individual development projects varies much more WITHIN countries than it does BETWEEN countries. Applied their findings to potential implications for donor policies aimed at aid effectiveness.	World Bank IEG outcome rating; PPAR review; IEG Desk review; Real GDP per capita growth; CPIA score; Freedom House; Dummy for investment project; Fraction of project in largest sector; 'Repeater' projects; Original project commitment; Time b/t approval and completion; Preparation cost/commitment; Supervision costs/commitment; Time from approval to first disbursement; Project restructured in first half; Problem project flag in first half; Potential problem	No (Did not directly addressed it. Mentioned that due to the feasibility of the data on the project characteristics (e.g. unobserved project quality) not possible to find some plausibly-exogenous source of project-quality in order to reduce the scope of selection bias)

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
			project flag in first half; Temporary membership on the UNSC; Membership on WB Executive Board; lag between the end of implementation and evaluation & dummy for ratings based on audits; Task team leader quality; Task team leader's turnover.	
Winters (2018)	Division of financing and project performance; World Bank projects; n=2,024	Through a merger of a unique data on the number and concentration of financial collaborators in World Bank projects with the project outcome scores, the author found that projects with higher co-financing receive worse project rating.	Success of the project (DV) – IEG ratings, co-financing dummy, borrower government dummy, community vs. local, domestic NGO dummy, count of co-financers, concentration of financing, log (project size)	No
Chauvet et al. (2015)	Supervision and project performance; sample: World Bank projects; n=2,000; 102 countries	By using extended principal-agent theory, they found, consistent with the existing theory, that donor supervision of projects was significantly more effective in improving project performance where interests were widely divergent.	Success of the project (DV); Preparation time; Supervision; IDA dummy; lending instruments; duration of the project; Log of initial GDP per capita (in constant dollars); time leader in office; CPIA indices; LICUS countries; Co-financing dummy; NGO dummy; capacity dummy; Same language as donor; same religion as donor; distance from capitals; Total aid budget of donor.	Yes (used IV approach. Specifically, instruments which are uncorrelated with project performance but correlated with supervision and preparation. Also, used instruments for supply-side determinants of the amounts of aid received. Instruments for supervision and preparation: characteristics of the projects (co-financing dummy, NGO dummy, knowledge capacity building dummy); distance and supply-side variables (same

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
				language as donor, same religion as donor, distance from capitals, total aid budget of donor).
Geli et al. (2014)	Project characteristics and project outcome ratings; sample: World Bank projects; n=2,729; 1995-2012	Explored the in-sample and out-of-sample predictive performance of empirical models relating project outcomes to project characteristics observed in the life of a project.	Outcome ratings ISR-DO ratings; Project size; Preparation time; Elapsed time b/t approval and effectiveness; Initially planned project length; TTL track record; Country policy performance.	No
Isham et al (1997)	Civil liberties, democracy and the project performance; sample: World Bank projects	Used cross-national data set on the performance of government investment projects financed by the World Bank to expatriate the link between government efficacy and governance. Demonstrated a strong empirical link b/t civil liberties and the performance of government projects. The strong effect of civil liberties holds true even when controlling for the level of democracy.	Economic rate of return; Freedom House; various civil unrest indicators; Project complexity; Terms of trade shock; Black market premia; Fiscal surplus; GDP growth; Regional dummy; Sectoral dummy; Capital-labour ratio.	No
Dollar and Svensson (2000)	Factors driving the project performance of structural adjustment programmes; sample: World Bank projects, n=220	Used new database on 220 reform programmes to analyse the causes of success or failure of adjustment programmes. Found that this depends on domestic political-economy forces.	Reform outcome (0-1 dummy reflecting failure or success of each reform programme as determined by OED of World Bank); Ethnic fractionalisation; Political instability; Democratically elected; Time in power; Preparation staff weeks; Supervision staff weeks; Finance conditions; Macro & fiscal conditions;	Yes (used instruments in two-stage procedure to estimate probit regression model (i.e. exogenous variables that are correlated with the Bank's effort but that do not influence success or failure of reforms)

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
			Sectoral conditions; Trade conditions; No. of conditions in loan agreement; Loan size; Expected reform period; Prior analytical work; Region; Initial GDP per capita; Initial population.	
Kilby (2000)	Project supervision and performance; sample: World Bank projects; n=1426; 1981-1991	Explored the impact of donor supervision on World Bank development project performance. Used maximum likelihood estimation of a restricted ordered probit function.	Project success rating provided by WB IEG; No. of staff weeks of World Bank supervision; Region; Sectors; Loan amount; Supervision level; No. of staff weeks preparation; Growth of GDP per capita; Change in Index of Openness. Note: Loan amount was deflated using a US GDP deflator for middle year of the project i.e. the board approval date plus 1 year for 2-year periods, 2 years for 3- and 4-year projects and 3 years for longer projects	No
Pohl & Mihaljek (1992)	Project evaluation and uncertainty; sample: World Bank projects; n=1,015; 1974-87 (i.e. by date when the project completion report was issued)	Concluded that the project analysis suffers from a large degree of uncertainty which the traditional methods of project evaluation and selection have not been able to reduce.	Economic rate of return; Total project cost; Nominal cost overrun; Unexpected inflation; Time overrun; Unexpected change in commodity prices; Economic management rating; Agarwala price distortion index; GNP; Adult literacy.	No
Khwaja (2009)	Project performance and community-specific constraints; sample: Community-	Found that the community-specific constraints do matter in project success, but their impact can be mitigated by better project design.	Project total score; Project complexity; New project dummy; Government project dummy; Project leader exists; Leader quality; Project age; External funds in the	No

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
	maintained infrastructure projects in Northern Pakistan; n=99;		project; Project share inequality; Community variables.	
Mubila et al. (2002)	Determinants of project success in ADB; sample: ADB projects; n=146, up to 1995	Used simple OLS as well as probit models. Found that the rates of return at appraisal are at best weak indicators of project success for the studied projects.	Project success indicator; Economic rate of return; Sector; Project size; Cost overrun; Export/GDP ratio; Inflation; GDP growth; Population size; GNP per capita; Human Development Index.	No
Dobrescu et al. (2008)	Determinants of project success in EBRD infrastructure projects; sample: EBRD infrastructure projects; n=90; 1993-2005	Found that private participation without commercial risk tends to increase project success. Also, found that private participation with commercial risk has no significant effect on project performance. Sovereign guarantees reduce delays but also decrease financial discipline.	Total delay; Sign to disbursement; Political delays; Tariff covenants respected; Financial covenants respected; Private-sector participation with risk; Sovereign guarantee; District heating; Waste water; Regional dummies; Total investment; EBRD share; Municipal client; PSA; Municipal guarantee; No. of investors; Works or turnkey realised; Central participation; Private-sector participation with risk planned; Years since transition; EBRD transition indicator; BEEPS index; Project age.	Yes (used IV approach for sovereign guarantees and municipal guarantees. For the former: the number of years in transition at the time of project signing; the project age and the BEEPS indicator of quality of business environment. For the latter: whether the private sector participation was planned at the design stage; the respective shares of central and municipal governments' investments in the project)
Honig (2014)	Organizational autonomy and country context in driving project success; sample: n=14,000 from 9	Organizational autonomy matters to project success, with increasing returns to autonomy in fragile states and in project domains where it is more difficult to externally observe outcomes.	Project success (An ordinal variable ranging from 1-6. Used after z-transformation to allow to fit OLS models); State fragility index; Project size; Autonomy (1); Autonomy (2); Sector; Internal Evaluation; Independent	No

Scholar(s)	Topic & Sample	Contribution	Variables	Selection bias addressed
	international development organizations	Organizational features such as bureaucratic delivery channels have an important role to play in the variance of outcomes.	Evaluation Office; Commitment to Development Index; Quality of Official Development Assistance.	

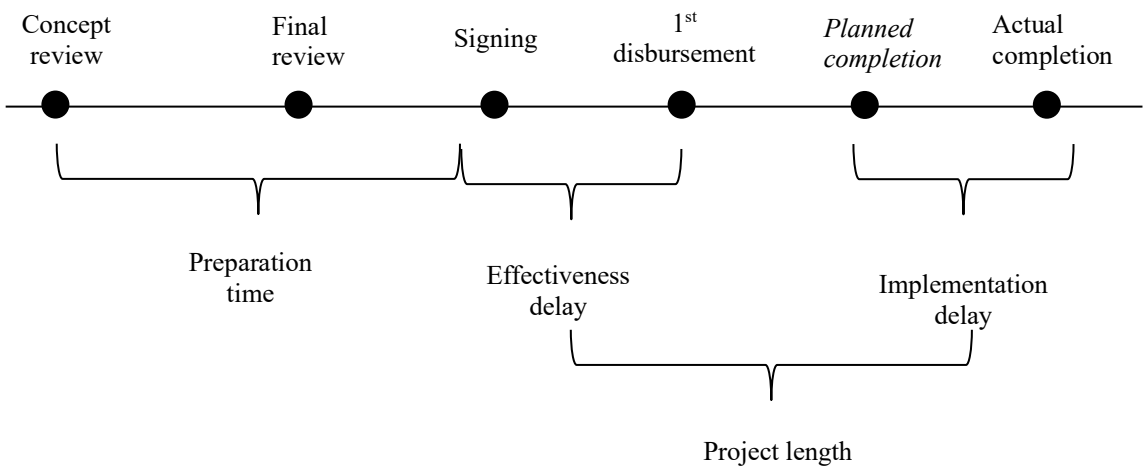
Source: Author (2018).

The causality of project size–success is in line with the project complexity-success argumentation. As project size increases, a greater risk is introduced to the project as claimed by Pinto and Kharbanda (1996). Specifically, the bigger the size of a project is, the wider its implications which, in turn, increase the degree of risk involved. They also point out that diminishing returns on the resources invested are often present in larger projects which is likely to suppress project success probability.

Within the existing literature, only one paper focused exclusively on EBRD projects. Dobrescu et al. (2008) investigate the determinants of EBRD project success in building infrastructure in the bank's countries of operation (CoOs) and they find that 'project size' plays no statistically significant role. In contrast to this, the preliminary statistical analysis of the studied sample used in this chapter found that the 'project size' increases the likelihood of project success. Thus, 'project size' is studied carefully through both direct and indirect modelling.

Second, the reviewed literature often refers to various project timeline related variables which may matter for project success. Figure 2 illustrates a selection of such variables applied to EBRD project lifecycle.

Figure 3: Illustration of selected variables in relation to a typical EBRD project lifecycle.



Source: Author (2018).

As explained by Bulman et al. (2017), '**effectiveness delay'** variable could capture delays in the project lifecycle and matters for project success. This variable measures the time from signing the loan to the time that all conditions of the loan agreement are fulfilled for the

disbursements to be made. The authors find that longer effectiveness delays contribute towards project success. They explain that a potential channel for this effect is that in some countries experienced executing agencies may wait to fulfil all conditions until detailed project designs are completed. This then reduces later delays for which special 'commitment' charges may be levied by the lender. The observed 'delay' to declaration of effectiveness, thus, indicates positive interventions which then enhance the speed of subsequent project implementation.

Third, the uniqueness of the project can affect the project manager's competence on the job as claimed by Belassi and Tukel (1996) and, thus, reduce the probability of project success. Finding a right proxy for project novelty could be challenging as proved by Denizer et al. (2013) who could not find any direct proxy for project novelty for studied World Bank's investments. As an alternative, they identified the sequences of projects that are follow-ups of previous investments, and so presumably are less novel that the original project in the sequence. Their argument is that the 'repeat' projects are less complex than 'non-repeat' projects. They find a positive relationship between 'repeat' projects and their success likelihood.

Other scholars have extended the definition of 'project novelty' towards 'portfolio interdependency' which describes the interdependency between projects both in terms of scope and content, i.e. the extent to which projects are dependent on the results of other projects and need to be aligned with each other as defined by Voss and Kock (2013). From the theoretical perspective, higher interdependency may be negatively correlated with the success due to the higher complexity of the associated processes, but some studies suggest the opposite as argued by Cusumano and Nobeoka (2015). A proxy for portfolio interdependency, as well as overall project novelty, used in this chapter is **'framework'** mapping, i.e. whether the project is part of an existing framework (i.e. 'repeat' project) or standalone operation (i.e. 'non-repeat' project) and a positive relationship between 'repeat' project and success probability is expected to be found. In EBRD's context, the use of frameworks is quite common. A good example could be a framework for projects targeting support towards women in business or green economy development in the bank's CoOs.

Fourth, based on the reviewed literature I investigate whether the presence of **project co-financing** impacts the probability of project success through project size. IMF (2014) defines co-financing as the joint financing of projects through loans or grants to countries provided by commercial banks, credit agencies, or other official institutions in association with other

agencies or MDBs. Kotchen and Negi (2016) study the determinants and impacts of co-financing based on the data from Global Environmental Facility and they find that greater co-financing increases the probability of a project success. They also find that co-financing tends to favour projects that are larger ('project size').

In contrast, Dobrescu et al. (2008) find that the project co-financing could have a negative impact on project success. Potential interpretation could be that other parties involved in the project reduce their efforts when the EBRD plays a major role, which is consistent with the expectation that parties involved in a project may free-ride on each other. From the theoretical perspective, the number of co-financing partners could have a non-linear effect on the project success, i.e. the higher the number of co-financing partners is more likely to increase the chances of free-riding as well as lead to higher maintenance costs, hence lower chances of project success.[3]

Due to these contractionary literature findings, I focus on testing the significance of the indirect relationship between project size and co-financing regardless of the direction of influence between co-financing and project outcome.

Last, there is no existing literature evidence for the role of **client-related factors** in driving project success among MDBs. This could be partially caused by the fact that the existing studies focus heavily on World Bank's projects which tend to lend to countries rather than to the clients from the private sector. The private sector focus is one of the unique characteristics of EBRD projects. Two client-related variables are used to investigate the significance of client-related factors in project success with the aim of contributing towards yet unexplored area in the literature.

Firstly, client risk, which is not only the function of the environment in which the client operates but also of the internal structure of the firm, could have a substantial impact on likelihood of project success (e.g. corporate governance, strength of management, financial performance). A large part of the client risk analysis, which is carried out by EBRD Credit department, is focused on the client, contrary to financial additionality, which puts emphasis

[3] The distribution of the number of co-financing partners among the EBRD projects was tested. Due to limited data variation, it was decided to use a dummy of co-financing presence rather than the quantitate count of co-financing partners.

on the overall environment in which the client is seeking financing. The overall client's probability of default (PD) is derived by comparing the counterparty PD rating of the borrower and that of the guarantor and selecting the better (i.e. lower risk as indicated by the counterparty risk rating) of the two. From a purely theoretical perspective, the higher the client's PD is likely to be associated with a lower probability of project success. Due to data availability, there are no alternative measures of client risk which could be tested in this chapter. Secondly, the Bank's focus is on private sector lending. This is because the bank aims to increase the private sector participation in its CoOs as per its mandate. However, the Bank also deals with state clients. Although the transition potential of dealing with a state client could be higher, so are the risks of a project failure. Thus, it is expected that a state client ownership is likely to be negatively associated with the probability of project success although there is no literature evidence to support this prediction.

2.3. Methodology

2.3.1. Data and estimation techniques

The analysis is based on a project-level data from EBRD covering all of the bank's CoOs as at the studied period (i.e. 35 countries). All of the analysed projects with a completed transition assessment between 2003 and 2016 are included in the uncensored sample, i.e. 1,573 observations. The analysis begins from 2003 because it was the first year in which EBRD used Transition Impact Monitoring System (TIMS) to measure and track transition performance of projects in a universal fashion during project implementation. Prior to that date, only ex-ante project assessment of transition was carried out.

In order to understand the data on project outcomes used in this chapter, some institutional background is helpful. Unlike World Bank and other MDBs that lend to governments in exchange for sector or economy-wide policy reforms, EBRD's main vehicle to fulfil its mission of building market economies is its investment portfolio. For this reason, the unit of observation in this analysis is an investment project. For each project, transition impact (TI) score is derived, so-called expected transition impact (ETI), defined as the combination of a project's ambition (TI potential) and likelihood of success (TI risk).

ETI score consists of ex-ante TI potential and ex-ante TI risk which are assessed at the concept review stage during project life cycle. The EBRD's economists have the task of ratings investment projects throughout the project approval cycle. These project ratings started on experimental basis in 1999 and were formally implemented from May 2000. Since then, the TI potential and TI risk ratings have become a key component of the transition impact assessment and related decision-making practices at EBRD. ETI is an internal scoring system based on the transition impact assessment of investment projects through TIMS. ETI incorporates both transition impact potential (i.e. setting the appropriate objectives for projects in the context of transition challenges in a country) and risks to achieving such objectives, thus reflecting the most likely "transition value" of a project. It has been calculated according to the ETI/PTI matrix which is presented in Table 4.

PTI, which is also derived using the below matrix, is used to monitor the progress of projects in the Bank's portfolio towards achieving their transition objectives. The EBRD's corporate scorecard contains an average PTI stock measure to benchmark the overall performance of projects in the Bank's portfolio from the perspective of achieving the originally set transition impact objectives. If the PTI at project's completion stage is equal or greater than ETI, the binary dependent variable used in this chapter treats it as 'success achieved' (1). If the PTI is smaller than ETI, then the dependent variable would treat it as 'success not achieved' (0). This is then used to calculate the probability of project success which is used in all of the probit regression specifications included in this chapter.

Table 4: ETI/PTI matrix.

		TI Risk rating					
		Excessive	High/ Excessive	High	Medium	Low	Negligible
TI Potential rating	Excellent*	25	60	100	x 1.3	x 1.8	x 2.2
	Strong Good*	10	45	80	100	x 1.25	x 1.5
	Good	5	25	60	75	85	90
	Moderate Good	5	20	45	55	60	60
	Satisfactory	0	10	30	35	40	40
	Marginal	0	0	0	5	10	10
	Unsatisfactory	0	0	0	0	0	0

Notes: The scores, expressed as an expected value of a project's transition impact, reflect the relative values of each pair of TI potential and TI risk ratings, which are based on incentive design and historical experience. Transition Multipliers are based on Excellent/High= 100: Excellent up to x2.2 for

Negligible risk; Strong Good up to x1.5. The shaded areas identify the TI potential/risk combinations within which majority of operations are expected to fall.
Source: EBRD (2013).

These transition scores are derived based on the detailed ex-ante performance assessment of each project from which transition objectives are set. These can target the following three broad economic areas: (i). improving structure and extent of the market (expansion of competitive market interactions); (ii). developing market-supporting institutions (private ownership, market-supporting policies, laws and institutions); (iii). market-based behaviour, skills and innovation (transfer of skills, demonstration effect of replicable products, processes, restructuring, financing, setting standards of corporate governance and business conduct).

In simple terms, the dependent variable is derived by comparing ex-ante ETI with ex-post PTI scores in order to categorise the project's success into the following binary variable (1,0) which are used to derive the probability of project success in the probit models:

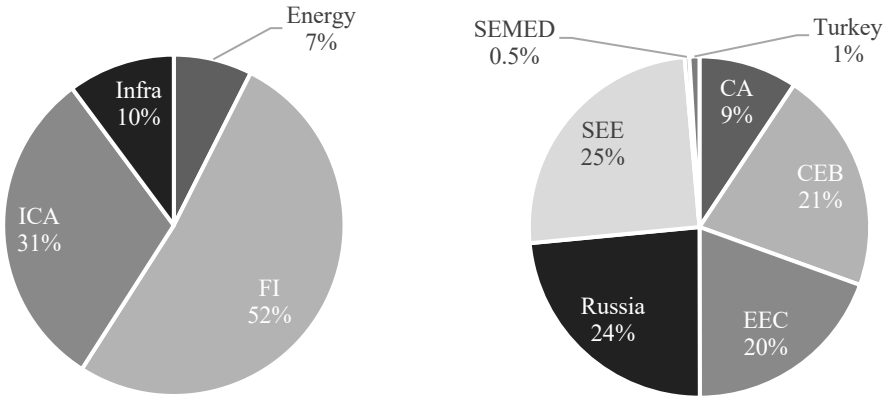
- 'Success achieved' (1): projects preserve or outperform their original transition scores at the completion stage, i.e. ETI ≤ PTI
- 'Success not achieved' (0): projects underperform on their original transition scores by either fully or partially failing, i.e. ETI > PTI.[4]

There are few reasons why a binary (1,0) dependent variable is used. Firstly, the categorisation of the PTI-ETI scores greatly simplifies the statistical analysis and leads to easy interpretation and presentation of the results. Secondly, although dichotomisation of the dependent variable could lead to some information loss on PTI-ETI trends, the distribution of the ETI and PTI scores tend to draw a clear categorisation among them. This is partially caused by the design of the ETI/PTI matrix which does not deliver a fully continuous distribution in its true meaning, but rather tends to allocate the scores in certain buckets. In addition to this, on average, ETI equals PTI among the Bank's portfolio. Thus, the categorisation of PTI-ETI does not come with a high information loss. Moreover, a more useful message for the sake of future projects is likely to refer to factors which lead to a full success of a project rather than in reference to an increase in its PTI-ETI delivery. Lastly, presence of a binary dependent variable is crucial to handle selection bias modelling which I explain later.

[4] In robustness checks, I test ordered probit set-up in which I break the dependent variable into additional sub-categories. Specifically, I assign 'success not achieved' category into (i). 'partially failed' and (ii). 'fully failed' based on the underlying PTI scores.

Overall, 67% of studied projects were successful, i.e. they achieved, or overachieved on their ex-ante transition objectives. On the other hand, less than 10% of projects fully failed which could indicate solid project selection and management mechanisms already at work at the bank. It is worth noting that the vast majority of the projects have a high ex-ante transition risk with a good transition potential. The majority of projects in the sample are of small to medium size of up to EUR 50 mln and there is a noticeable trend of higher probability of success with an increase in project size which goes against the evidence from the existing literature on this topic. The average project length at EBRD is 65 months. Infrastructure projects record the highest average length of 91 months. Projects from the financial sector, on the other hand, are much faster with an average duration of 60 months. Overall, the Bank's projects became less lengthy over time across all sectors. This trend is in line with the reduction in the 'effectiveness delays' which drastically decreased from nine months in early 2000s to just under two months in the most recent years. Such trends are consistent across all sectors. Figure 4 presents the distribution of the sample by sector and the region of operations.

Figure 4: Distribution of projects in the sample by sector and region of operations (n=1,573).



Notes: Infra (Infrastructure), FI (Financial institutions), ICA (Industry, Corporate and Agriculture); CA (Central Asia), EEC (Eastern Europe and Caucasus), SEE (South-Eastern Europe), SEMED (Southern and Eastern Mediterranean).
Source: Author (2018).

There is substantial regional variation in project outcomes with CEB region standing out with the highest success probability, while CA has the lowest (Table 5). This justifies further the importance of exploring geographical differences among projects rather than applying country

fixed effects, for instance. Almost one third of the sample is part of a framework (see Figure 5). Those projects appear to be more likely to be successful in comparison to standalone operations. There is no strong geographical concentration for such projects.

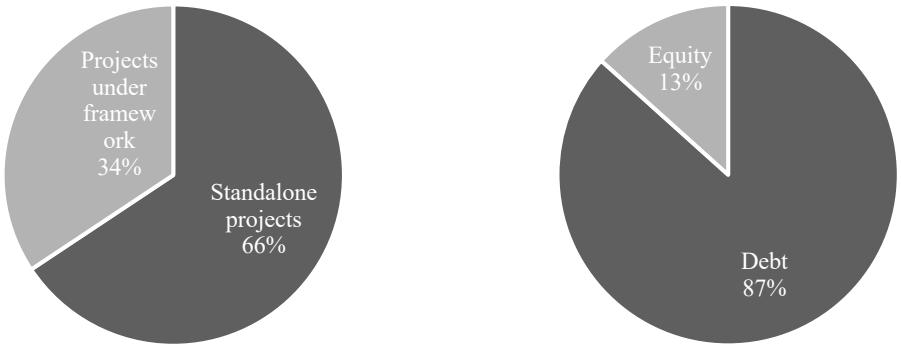
Table 5: Regional distribution of project performance (n=1,573).

Region	No. of projects	'Success achieved'	'Success not achieved'
CA	147	55.1%	44.9%
CEB	333	74.8%	25.2%
EEC	306	64.1%	35.9%
Russia	370	64.9%	35.1%
SEE	395	68.4%	31.6%
SEMED	7	71.4%	28.6%
Turkey	15	53.3%	46.7%
Total	1,573	66.7%	33.3%

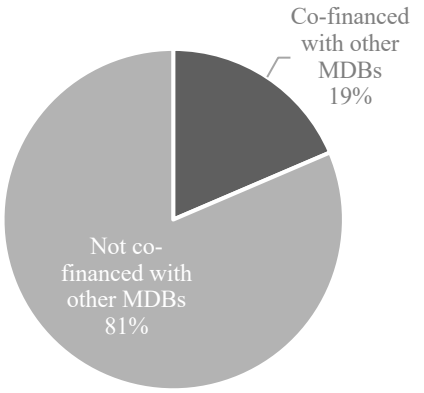
Source: Author's calculations (2018).

A vast majority of the sample is using debt financing (i.e. 87%; see Figure 5) and they also tend not to be co-financed with other MDBs or require technical assistance – see Figure 5 for details. Lastly, the majority of Bank's projects are carried out in financial institutions or corporate sectors and they tend to target the maximum of two transition objectives, frequently 'market expansion' and 'demonstration of setting standards of corporate governance and business conduct'.

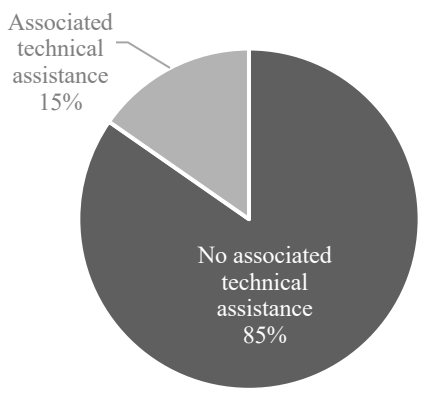
Figure 5: Distribution of projects in the sample by other key characteristics (n=1,573).



(i). by framework typology (ii). by the used financing instrument



(iii). by co-financing with other MDBs



(iv). by associated technical assistance

Source: Author (2018).

Table 6 outlines the variables used in this chapter. They are divided by the respective level of their typology, i.e. project-level, client-level. These are then followed by the country-level controls. Their definitions, sources and the unit of measurements are provided.

Table 6: Variable definitions and sources.

Variable name	Definition	Source	Unit
Project-level variables			
Project size	Total volume of EBRD investment in the project.	EBRD	Euros
Effectiveness delay	The time from signing of the loan to the time when all conditions of the loan agreement are fulfilled for disbursement to occur.	EBRD	Months
Preparation time	A difference between project concept review date and signing date.	EBRD	Months
Framework	Dummy =1 if project is part of an investment framework.	EBRD	0/1
Associated technical co-operation	Dummy =1 if project had any associated technical co-operation at any stage of its life.	EBRD	0/1
Co-financing with other MDBs	Dummy =1 if project is co-financed with other MDBs.	EBRD	0/1
Equity financing instrument	Dummy =1 if project is fully financed with equity. Otherwise, it captures debt or debt and equity financing.	EBRD	0/1
Number of TI objectives	The count of the transition impact objectives under each project.	EBRD	Count

Variable name	Definition	Source	Unit
EBRD sector	Four dummy variables representing the EBRD sector in which the investment project is based: (i). Financial institutions; (ii). Industry, Corporate and Agriculture; (iii). Infrastructure; (iv). Energy.	EBRD	0/1
Client-level variables			
Client's PD	Score of the client's probability of default at the time of project's signing with the range from (1=lowest) to (10=highest).	EBRD	Score
State owner	Dummy=1 if client is a state; otherwise it refers to private owner.	EBRD	0/1
Country-level controls			
GDP per capita growth	Annual percentage growth rate of GDP at market prices based on constant local currency.	World Bank DataBank	Percent
Domestic credit	Domestic credit to private sector by banks as a per cent of GDP.	World Bank DataBank	Percent
Bureaucracy quality	An index score which captures the institutional strength and quality of the bureaucracy with the range between 1 and 4. High scores are given to countries where the bureaucracy has the strength and expertise to govern without drastic changes in policy or interruptions in government services. In these low risk countries, the bureaucracy tends to be somewhat autonomous from political pressure and to have an established mechanism for recruitment and training.	International Country Risk Guide	Score
Change in foreign exchange rates	Domestic currency depreciation over project lifetime.	Datastream/ EBRD	Δ

Notes: this table shows variable definitions and data sources for all explanatory and control variables used in the empirical analysis.
Source: Author (2018).

It is important to note that the exercise of setting transition rating of the EBRD project is meant to take account of all the information available about the project and is carried out by economists at the bank. This information includes characteristics related to the context where the project is implemented, the transition challenges facing the client, sector or economy, and the way the project is legally and financially structured to address those transition challenges. Since this chapter is focusing on the 'completed' projects, the quality of transition ratings is taken as given as ratings have been agreed and signed off by the Board and then rigorously monitored and assessed till the completion stage of the project. Also, it is worth noting that the initial level of ex-ante transition potential was taken into the account in the regressions, but had

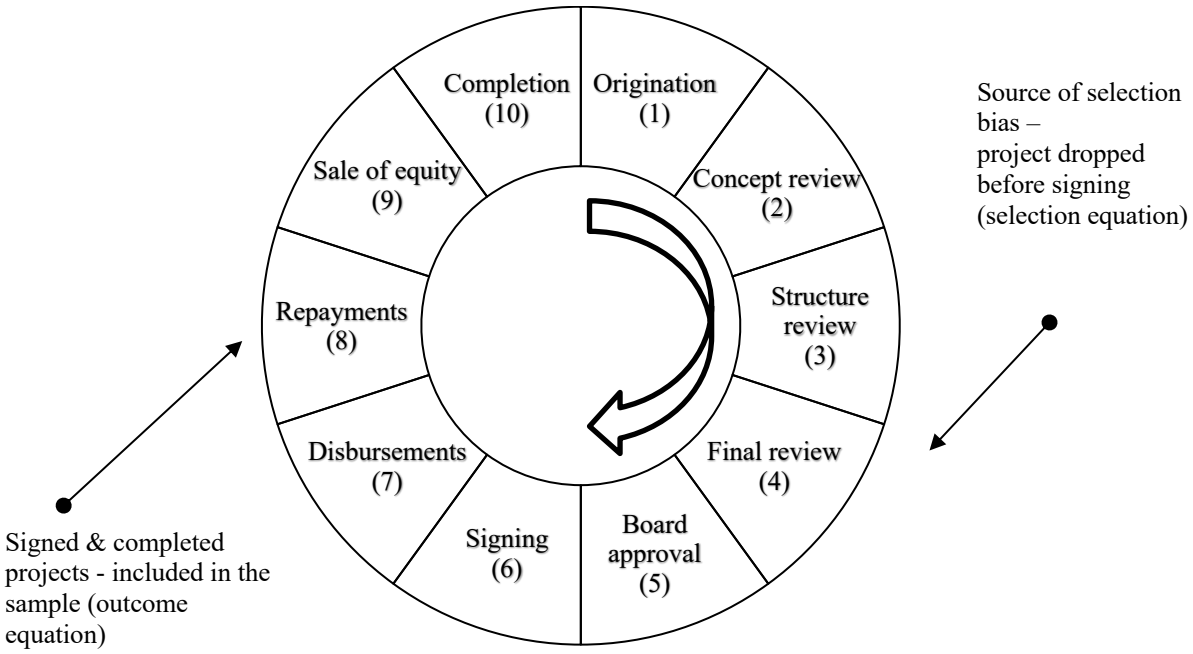
to be dropped out due to strong multicollinearity with other variables which were chosen to be kept for the sake of hypothesis testing.

Selection bias

Before outlining the data, it is important to introduce the issue of selection bias which is at the heart of my empirical analysis. Figure 6 aims to illustrate this concept. Such bias originates from a potential risk of looking only at the projects signed and approved by the EBRD's Board of Directors (i.e. left-hand side of the cycle – outcome equation) and not controlling for the rejected projects (i.e. right-hand side of the cycle – selection equation).

In more technical terms, selection bias, as defined by Cuddeback et al. (2004), could arise from the fact that 'treated' projects (i.e. all signed projects) differ from the 'non-treated' (i.e. projects never signed) for reasons other than 'treatment status' (i.e. project signing). As explained by Tucker (2011), selection bias occurs because project selection' decisions are not always random and the outcomes of choices not made are never observable.

Figure 6: Potential sources of selection bias in EBRD project lifecycle.



Source: Author (2018).

It is vital to address selection bias because it could be a threat to internal validity of this chapter's findings, i.e. project- or client- related variables could be correlated with a distribution term as theoretically proven by Cook and Cambell (1979). Selection bias can also threaten external validity because a final, biased sample might not be generalizable to the intended population (i.e. all EBRD investment projects).

In the reviewed literature on the determinants of project success across MDBs, there is limited reference to the selection bias and almost no universal solution to address it (see the final column in the literature review under Table 3). For instance, Denizer et al. (2013) highlight the issue of selection bias in their research and mention that instrumental variables (IV) method could have been used but, due to data limitations, they could not address it. Kilby (2012) studied the role of project preparation on project success, and was able to use the IV method by instrumenting for preparation time using country-level measures of political influence of donors on recipients. However, in addition to the usual concerns about justifying the validity of the exclusion restriction, which requires that political influence matters for project outcomes only through project preparation time, a further drawback of this approach, as claimed by Denizer et al. (2013), is that, by relying on country-level variation in the instrument, one cannot account for the substantial within-country across-project variation in project outcomes.

In this chapter, Heckman selection model is used to address selection bias and this choice shapes the form of the estimation techniques applied under my regression specifications. This is explained in more details in the next section.

Table 7 provides summary statistics behind each of the explanatory and control variables used in the empirical analysis. It is important to clarify the division between the explanatory and control variables applied in this chapter. The majority of the existing literature relates to public sector projects funded by World Bank individually or in comparison to other MDBs and, thus, putting a greater focus on country-related factors rather than project-related factors as well as differences between the two sub-groups.

Table 7: Summary statistics.

Variable name	n	Mean	Median	Minimum	Maximum	Standard deviation
Project-level variables						
Project size (ln)	1,573	16.3	16.3	10.1	21.2	1.3
Effectiveness delay (srt)	1,514	1.8	1.4	0	10.5	1.3
Preparation time (srt)	1,573	3.2	2.8	0	12.2	1.7
Framework (1=yes, 0=otherwise)	1,573	0.3	0	0	1	0.5
Associated technical co-operation (1=yes, 0=otherwise)	1,573	0.2	0	0	1	0.4
Co-financing with other MDBs (1=yes, 0=otherwise)	1,514	0.2	0	0	1	0.4
Equity financing instrument (1=yes, 0=otherwise)*	1,573	1.1	1	0	1	0.3
Number of TI objectives	1,442	1.9	2	1	5	0.9
Client-level variables						
Client's PD score	1,573	6.1	6	2	8	0.9
Client as state (1=yes, 0=otherwise)	1,573	0.1	0	0	1	0.3
Country-level controls						
GDP per capita growth	1,573	5.1	5.3	(14.6)	33	4.9
Domestic credit	1,555	33.5	32.8	0.2	101.3	17.6
Bureaucracy quality index	1,357	1.7	1	1	4	0.8
Change in foreign exchange rates	1,573	(0.0)	0	(2.0)	0.9	0.1

Notes: This table shows summary statistics for the explanatory and control variables used in the empirical analysis on measured project success sample (n=1,573). All variable definitions and data sources are provided in the Table 6. Equity financing instrument is tagged only under projects which used equity for 100% of its project financing.
Source: Author's calculations (2018).

For instance, Bulman et al. (2017) compare the correlation of project success in the World Bank with those in the Asian Development Bank (ADB). They find that project success rates vary more 'within' countries than 'across' countries. In terms of specific country-level factors, they identify GDP growth as well as a sound policy environment as the most important factors impacting project success. The authors do not find any evidence to their claim that the magnitude of the relationship between these country- and project-level correlates and project outcomes is the same across World Bank and ADB.

Denizer et al. (2013), more importantly, have aimed to bridge the visible gap between the country-level and project-level literature approaches. They build their argument on the observation that, while country-level factors are important for project outcomes, these outcomes vary more across projects 'within' countries than they do 'between' countries. They explained that much of the previous literature has relied on country-level variables to explain project-level success, even though country-level variation accounts for only about one-fifth of the variation in project outcomes. They added that, from the policy perspective, this

observation is particularly useful, given most aid donors' focus on country-level factors for determining conditionality and eligibility for their aid programmes. From the EBRD perspective, however, the opposite applies. The core of the Bank's business model is lending to private sector projects and the Bank is committed to fully factoring in project-level, not country-level, transition lending criteria and track their delivery. For this reason, project-related factors are of main importance in this chapter which brings a valuable contribution to the existing literature in this field.

There are few important practical caveats to note about the selected variables. Firstly, several country-level controls had to be dropped due to limited variation within countries, e.g. Freedom House indices. This is also a general weakness in the country-level controls actually used, particularly for indices where year-on-year change is often not substantial. Next, there is only one good proxy for client's strength which can be used in this chapter, i.e. client's PD. This shortage of good proxies originates from the fact that EBRD does not store client financials in an aggregated and consistent manner. One potential solution could be to externally source financials of the Bank's clients. This was carried out, but failed to deliver a robust coverage for the sample used in this chapter.[5] Still, client's PD is a strong proxy for client's strength.

Lastly, the time-lagged variables, e.g. effectiveness delay, all displayed signs of Poisson distribution and, thus, required square root transformations. In addition to this, project length variables tend to vary across sector and countries. This contributes to a difficulty in deciding what data point to use for the country-level variables as well as client's PD which could be measured at various stages of the project lifecycle. Different approaches are assessed under the robustness checks in order to validate the initial findings.

[5] The manual mapping of EBRD's client names against Bureau van Dijk (BvD) database was carried out under the lead of EBRD's OCE department, Cagatay Bircan (OCE) and Markus Biesinger (Equity Participation Fund) who kindly shared the mapped BvD codes with the Author (2017). Based on the pull of mapped clients' names against the sample used in this chapter, less than 75% of the Bank's clients were identified with multiple missing values, particularly for smaller countries (e.g. Turkmenistan, Tajikistan) as well as smaller companies which are common among the Bank's investments. Thus, they could not be used for any robust empirical analysis.

2.3.2 Diagnostic tests

Before moving to the empirical aspects of this chapter, it is important to note that multiple diagnostic tests have been carried out on a range of probit specifications in order to ensure that the most robust base models are selected for reporting on results. They ranged from simple normality diagnostics, multicollinearity as well as heteroscedasticity testing, among the others.

Normality diagnostics

Several checks had been carried out to test for normality. Summary statistics included in Table 7 reported skewness and excess kurtosis, however kernel density estimate plots were also plotted to check for normality across all of the project- and client- related variables. Several data transformations were required as indicated next to the name of the variable in the first column of Table 7, e.g. log transformation (ln), squared root transformation (srt). For instance, all of the project lifetime- related variables, such as effectiveness day, preparation time, displayed Poisson distribution and required a square root transformation.

Multicollinearity diagnostics

Multicollinearity can cause unstable estimates and inaccurate variances of the parameter estimates, and consequently incorrect inferences about the relationship between explanatory and response variables. In the presence of multicollinearity, the confidence intervals of the coefficients tend to become very wide and the statistics tend to be very small. Here, I carried out the examination of the correlation matrix which may be helpful to detect multicollinearity but may not be sufficient. Thus, I also calculate variance inflation factor (VIF) as an alternative method.

The correlation matrices for the core variables are displayed in Tables 8 and 9 on the next pages, but the assessment was carried out for the full range of variables as well as for the country controls. From the theoretical perspective, large correlation coefficients in the correlation matrix of predictor variables indicate multicollinearity. If there is multicollinearity between the two predictor variables, then the correlation coefficient between these two variables will be near to unity. It is agreed that for moderate to large sample sizes, the approach to drop one of the correlated variables was established entirely satisfactory to reduce

multicollinearity. The strongest indications of multicollinearity were found across country level variables within different bucket of project lifecycle stages (e.g. private domestic credit as of project's concept review date versus project's signing date) as expected. Similarly, some partial multicollinearity was found among client's PD ratings at concept versus exit dates. This suggests that the selection of variables should be applied to tie with one project lifecycle stage at the time, not multiple, in order to avoid multicollinearity. Lastly, some weak evidence of multicollinearity was found between project's size and cumulative disbursement amount figures which is not surprising considering the fact that these two can be the same. For this reason, disbursement figures are not used in my regression analyses in this chapter.

VIF has been calculated for all selected core variables as a second method to address multicollinearity and are available upon request. Since the multicollinearity is a characteristic of the explanatory variables alone, it does not matter which model is used to compute the VIF. Thus, the probit models have been replaced by a simple OLS regression to derive these VIF calculations. Overall, there was no difference in the VIF results across the tested specifications. Few variables such as project length or certain macroeconomic controls had to be removed due to high VIF coefficient. This was most likely caused by the fact that too many variables measuring the same thing were included in the model specification. Project length, for instance, and could capture the same time dimensions of project lifecycle as does an effectiveness delay for some projects. No interaction terms were able to be modelled into VIF testing as these types of variables inflate the VIF statistic. Nevertheless, they do not normally introduce mulicollinearity and, thus, could be accepted.

In some cases, variables involved in multicollinearity could be combined into a single variable which could serve as a potential solution to the problem. If combining variables does not make sense, then some variables causing multicollinearity need to be dropped from the model. The latter has been chosen here. It is also suggested collecting more data could be another solution. This would have been done in order to see whether the multicollinearity can be lessened. However, this is not possible in this chapter because of missing values that have already been addressed with the second dataset refresh carried out after the preliminary analysis from March 2017 and there is no more scope for further increase of coverage in the nearest future.

Table 8: Pairwise Pearson's correlation matrix for the core project- and client- related factors.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Full transition success (1=yes) (DV)	1.00															
(2) Size of EBRD inv. (ln)	0.05*	1.00														
(3) Effectiveness delay (srt)	-0.02	-0.09*	1.00													
(4) Preparation time (srt)	0.07*	-0.13*	0.10*	1.00												
(5) Framework (1=Yes)	0.07*	-0.36*	0.00	0.18*	1.00											
(6) Technical assistance (1=Yes)	-0.03	-0.10*	0.17*	0.12*	-0.02	1.00										
(7) Co-fin w/t others (1=Yes)	0.04	0.07*	0.10*	0.06*	-0.18*	0.11*	1.00									
(8) Financing instrument (1=Debt)	0.03	0.11*	0.14*	0.00	0.05*	0.09*	-0.04	1.00								
(9) No. of transition objs.	-0.03	0.02	0.03	-0.03	-0.09*	0.01	0.05	-0.05*	1.00							
(10). Prepayment (1=Yes)	0.04	0.12*	0.05*	-0.09*	-0.19*	-0.01	0.07*	0.25*	0.08*	1.00						
(11) Client's PD (entry)	-0.10*	-0.02	-0.08*	0.02	-0.01	0.07*	0.05	0.00	0.09*	0.03	1.00					
(12) Client as state (1=Yes)	-0.06*	0.03	0.30*	0.09*	-0.17*	0.32*	0.22*	0.17*	-0.02	0.07*	0.04*	1.00				
(13) Sector Energy	0.00	0.21*	0.07*	0.04	-0.19*	0.00	0.12*	0.02	0.03	0.10*	0.06*	0.06*	1.00			
(14) Sector FI	-0.03	-0.13*	-0.14*	-0.01	0.40*	-0.02	-0.27*	0.00	-0.17*	-0.23*	-0.07*	-0.28*	-0.28*	1.00		
(15) Sector ICA	0.08*	-0.03	-0.06*	-0.07*	-0.21*	-0.17*	0.07*	-0.11*	0.16*	0.13*	-0.01	-0.26*	-0.27*	-0.55*	1.00	
(16) Sector Infra	-0.06*	0.02	0.25*	0.10*	-0.17*	0.24*	0.22*	0.13*	0.00	0.09*	0.04*	0.64*	-0.17*	-0.34*	-0.33*	1.00

Note: The correlation matrix is produced based on the set of observations used in the outcome equation estimation (i.e. 1,573 observations).
Source: Author (2018).

Table 9: Spearman's correlation matrix for the core project- and client- related factors.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Full transition success (1=yes) (DV)	1.00															
(2) Size of EBRD inv. (ln)	0.08*	1.00														
(3) Effectiveness delay (srt)	0.00	-0.11*	1.00													
(4) Preparation time (srt)	-0.01	-0.03	0.20*	1.00												
(5) Framework (1=Yes)	0.05	-0.42*	0.06*	-0.01	1.00											
(6) Technical assistance (1=Yes)	-0.01	-0.12*	0.15*	0.17*	-0.03	1.00										
(7) Co-fin w/t others (1=Yes)	0.04	0.08*	0.06*	0.13*	-0.18*	0.11*	1.00									
(8) Financing instrument (1=Debt)	0.07*	0.07*	0.14*	0.02	0.09*	0.04	-0.05	1.00								
(9) No. of transition objs.	-0.04	0.02	0.04	-0.01	-0.07*	0.02	0.05	-0.06*	1.00							
(10). Prepayment (1=Yes)	0.05*	0.14*	0.06*	-0.02	-0.19*	-0.01	0.07*	0.25*	0.09*	1.00						
(11) Client's PD (entry)	-0.14*	-0.22*	-0.08*	-0.01	0.01	0.12*	0.03	-0.08*	0.13*	0.00	1.00					
(12) Client as state (1=Yes)	-0.05	0.02	0.24*	0.16*	-0.17*	0.39*	0.22*	0.11*	-0.02	0.07*	0.00	1.00				
(13) Sector Energy	0.01	0.24*	0.06*	0.09*	-0.19*	0.09*	0.14*	-0.06*	0.04	0.10*	0.01	0.15*	1.00			
(14) Sector FI	-0.02	-0.27*	-0.12*	-0.14*	0.44*	-0.05	-0.25*	0.07*	-0.19*	-0.25*	0.02	-0.33*	-0.32*	1.00		
(15) Sector ICA	0.06*	0.16*	-0.05	-0.01	-0.24*	-0.18*	0.06*	-0.06*	0.18*	0.15*	-0.03	-0.17*	-0.19*	-0.67*	1.00	
(16) Sector Infra	-0.06*	-0.02	0.20*	0.16*	-0.18*	0.27*	0.22*	0.04	-0.01	0.10*	0.00	0.66*	-0.10*	-0.36*	-0.2*	1.00

Note: The correlation matrix is produced based on the set of observations used in the outcome equation estimation (i.e. 1,573 observations).
Source: Author (2018).

Heteroscedasticity diagnostics

The potential risk of heteroscedasticity has been approached with the variables transformation as explained under normality diagnostic checks. Also, all of the probit regression specifications are performed with variance–covariance matrix (VCE) command for robust standard errors. The VCE (cluster) option was used to relax the independence assumption required by the probit estimator to independence between clusters (i.e. with sectors and years of project signing or completion). This option is a clustered version of the Huber/White/sandwich estimator of the variance. The reported standard errors are, thus, robust to the fact that the error term is not identically distributed. These can, then, be used to make valid statistical inference about the reported coefficients, even though the data are not identically distributed.

Also, the unobservable project-specific and time-varying heterogeneity were taken into account by augmenting the equation with a set of (sector x signing year) and (sector x completion year) dummies. As explained by Presbitero (2016), this could help in controlling for external (i.e. sector specific) aggregate shocks and unobservable changes in the project performance over time.

Lastly, as the number of projects in some countries is relatively small, the country fixed effects are not included jointly with macroeconomic variables in my regressions in order to allow for better identification of the spatial-specific variables. However, regressions with country fixed effects were run under the robustness checks and they did not change the reported results.

Goodness-of-fit diagnostics

Pearson χ^2 goodness-of-fit tests were estimated for all of the tested probit models. In majority of the cases, the models fitted reasonably well. However, in many cases the number of covariate patterns were close to the number of observations. This makes the applicability of the Pearson χ^2 tests questionable, but not necessarily inappropriate, as explained by Hosmer et al. (2013). They suggested regrouping the data by ordering on the predicated probabilities and then forming a pre-defined nearly equal-sized groups. This puts all observations with the same predicated probabilities into the same group. The tests with the grouping options were carried out and based on them, the tests could not be rejected.

Another check was to simply look at the Pseudo R-square which is a descriptive measure that indicates roughly the proportion of observed variation accounted for by the predictors (Knoke et al al., 2009). Majority of the tested regression specifications deliver a satisactionary level of variation in the dependent variables of the probability of project success. Lastly, the final check was to test whether the inclusion of the interaction term improves the goodness of fit of the models which was indeed the case.

Other diagnostics

Receiver operating characteristic (ROC) graphs were plotted after each of the probit regressions in order to quantify the accuracy of diagnostic tests carried out. Specifically, lroc command was used to graph the ROC curve and to calculate the area under the curve which it graphs the sensitivity versus one minus specificity as the cut-off c is varies, i.e. it shows the trade-off between sensitivity and specificity.[6] The tested regression specifications delivered a satisfactionary predictive power of results.

Based on the full estat classification, the best model yields predicted p-value >.5 for 978 projects, 654 of which fully achieved their transition objectives. Overall, all of the models do offer reasonable level of accurate predictions – approximately 91% of projects are correctly classified. Using a higher criteria of p-value>.6 increases the accuracy of predications to maximum of 98.83% of project being correctly classified. However, this is at the expense of sensitivity which decreases from 90.83% to 45.91%, whereas the specificity increases from 19.60% to 45.91%.

Next, estat ic command was used to commute Akaike's and Schwarz's Bayesian information criteria which calculates two information criteria to compare models. Unlike likelihood-ratio, Wald, and similar testing procedures, the models need not be nested to compare the information criteria. As with AIC, a smaller BIC indicates a better-fitting model. All of the models report a very high score on both tests.

[6] Sensitivity is the fraction of observed positive-outcome cases that are correctly classified; specificity is the fraction of observed negative-outcome cases that are correctly classified. A model with no predictive power has area 0.5; a perfect model has area 1.

Specification link tests were also ran. It is a test of the specification on the dependent variable which regress the dependant variable on the prediction and the prediction squared. If the model is specified correctly, then the prediction squared would have no explanatory power. The results showed that the prediction squared does not have explanatory power in all of the ten models suggesting a reasonable specification of the dependent variable (i.e. probability of full transition success).

From the theoretical perspective, the advantage of using probit model is that it automatically checks the model for identification and, if the model is under-identified, drop whatever variables and observations are necessary for estimation to proceed. Thus, maximum likelihood estimates could not be computed because few independent variables perfectly predicted the outcome, namely certain signing years (i.e. 1999, 2014 and 2015).

Lastly, a partial F-test, so-called Chow test, has been used to examine the group of variables such as sector or region/country in my probit regression specifications without interaction terms. Chow test compares the predictive power of the model with and without all the variables under consideration. If the group of variables does not collectively add predictive power, then the null that the group is irrelevant cannot be rejected.

Testing heckprob models

Heckprob regression specifications, which I use to check for the selection bias in my analysis and explain in the next section, were also separately tested. Based on Akaike's and Schwarz's Bayesian information criteria the regression specifications is preferable to the former with no country-level controls. Still, both regression specifications deliver a relatively high scores based on these tests.

'Rho' statistic tests the independence of the two equations in Heckman sample selection models. Stata's maximum likelihood estimator for a regression model with selection constrains the estimated correlation among the outcome and selection equation to be in the admissible range of correlation, [-1, 1]. This could lead to potential issue with the two-step estimator which could produce estimates of rho that lie outside the range [-1, 1], and thus, in some cases could lead to an estimated VCE that is not positive definite and may even have negative elements on the diagonal.

Stata provides four ways of handling two-step estimates of rho outside the admissible range, namely, rhosigma, rhothruce, rholimited, and rhoforce. The default is rhosigma which specifies that rho be truncated and that the estimate of sigma be made consistent with rho_hat, the truncated estimate of rho. Based on Greene (1993)'s simulations which compared the four methods, rhosigma consistently had coverage rates closest to nominal. Based on this finding as well as the results of testing I rely on the rhosigma estimates in the regressions for selection bias.

2.3.3. Empirical set-up

This section explains in more details the empirical methods I apply in this chapter. Specifically, there are three core econometrics issues identified in the studied sample which require special attention, namely (i). selection bias, (ii). indirect effects, and (iii). potential endogenous regressors.

In a nutshell, the selection bias issue is addressed with the help of Heckman techniques which works well with the binary set-up of the dependent variable. Also, it addresses the selection bias causes by unobservable factors impacting project selection which is at play here. Secondly, indirect channels through which certain explanatory variables may impact project success are investigated with the help of interaction terms and moderated mediation modelling. Interaction terms are widely used among scholars, but they do not quantify the exact magnitude of indirect effects. Moderated mediation technique, on the other hand, provides a robust way of exploring conditional indirect effects, albeit it has not been widely used in the existing literature. Lastly, Lewbel's (2012) approach is used to address potentially endogenous nature of 'project size' variable with the help of heteroscedastity-based instrument due to the absence of good external instruments.

Project selection bias

Although several selection bias correction procedures are now available to use, there is no agreement among scholars as to which one is the most effective. Stolzenberg and Relles (2011) claimed that there is currently no tool which offers a general solution to the selection bias.

Similarly, Winship and Mare (1992) reviewed a number of these techniques and concluded that none of them works well all the time.

In this chapter I use Heckman selection bias method to address the potential issue of selection bias. For this I use the pull of cancelled and rejected projects I collected and cleaned which have not been approved by the EBRD's Board of Directors. It is limited to situations in which the choices are binary which suits this chapter well due to the way the TI project success variable is derived. Also, this method helps with the selection bias due to unobservables which could be at play here. More formally, this method uses the inverse Mills ratio to take account of the selection bias. It is a two-stage model in which the probability of selection at the first stage is estimated and then the possible selection bias is removed at the second stage where the inverse Mills ratio is added as the additional variable. The probit model assumes that the error term follows a standard normal distribution. Specifically, the binary response model with sample selection is firstly tested, following Heckman's (1979) notation:

$$y_1 = 1[x_1\beta_1 + u_1 > 0] \qquad \textit{Eq. (1)}$$

$$y_2 = 1[x_1\delta_2 + u_1 > 0], \qquad \textit{Eq. (2)}$$

where y_1 (project success) is observed only if y_2=1 (project selection), and x_1 (explanatory variables explained below) and at least one more variable (project expired dummy as I explain later). In this case, probit estimation of β_1 (i.e. range of project- and client-related explanatory variables) based on the selected sample will lead to inconsistent results unless error terms u_1 and u_2 are uncorrelated as argued by Heckman (1979).

In terms of the main area for hypothesis testing which is based on the outcome equation only, the probability of project success can be expressed as follows:

$$p_i = Prob\left(Y_i = 1 \middle| X = \int_{-\infty}^{x_i'\beta} (2\pi)^{-1/2} \exp\left(-\frac{t^2}{2}\right) dt = \phi(x_i'\beta)\right. \qquad \textit{Eq. (3)}$$

where ϕ is the cumulative distribution function of a standard normal variable which ensures $0 \leq p_i \leq 1$, x is a vector of factors that explain the variation in probability of success and β is a vector of parameters that reflects the effect of changes in x on the probability of success. The

elements of vector x represent the independent variables in the model, namely project- and client-related characteristics.

There are several specification issues which I need to be addressed before running Heckman selection model. Firstly, as explained by Puhani (2000), when the same variables are used to model the selection and outcome equations, as well as when exclusion restrictions are not utilized, the model is only identified by the non-linearity inherent in the inverse Mills ratio. This does not apply here as the range of variables used in the selection equation differs from the variables captured in the outcome equation.

As for the exclusion restrictions outlined in Equations 1 and 2, the inverse Mills ratio and the X vector in the outcome equation will be less correlated when exclusion restriction is present. This could also help in reducing multicollinearity among predictors as well as the correlation between error terms as argued by Puhani (2000). Here, the chosen exclusion restriction variable is "expired project" dummy.[7] It refers to the projects which did not receive EBRD's Board of Directors' approval after 12 months period since their structure review and they have not been re-approved within a further 12 months which automatically leads to their cancellation. Based on the pull of cancelled projects I collected for the selection equation, i.e. 2,035 projects, the expired projects consisted of 53% of the overall sample. Based on the manual checks as well as confirmation from EBRD's Operational Committee Secretariat, none of the expired projects were re-cycled under a different project ID which I use as a unique identifier for all of the projects in my databases used in this chapter.

From the conceptual side, there are several factors which could explain the fact that some projects expire. The most likely reason is linked to the transparency of information. The due diligence procedure carried out by EBRD's Banking department may be time consuming due to the difficulties with the clients who may, for instance, not disclose the required information in a quick and effective manner. Another reason could be the complexity of the project, e.g.

[7] An alternative exclusion restriction candidate was considered, namely the 'new client' indicator. This has been defined as a dummy indicating that the client is new to EBRD. Unfortunately, this candidate has been rejected for two reasons. Firstly, from the conceptual perspective, the fact that the client is new to the bank is likely not just to drive the allocation to the signed projects, but also it is expected to influence the project success probability. This is because the new clients are likely to be riskier to deal with as well as require more resources, all of which may impact the probability of project success. Secondly, from the practical perspective, the aggregate mapping of client's novelty to the bank has proved to be almost impossible due to the lack of comprehensive mappings of client's ownership structure stored at the bank in aggregated and comparable manner.

use of a new financing instrument, blended financing solutions, all of which may prolong the length of the project assessment. Based on the selected review of the expired projects, the most frequent argumentation behind projects falling under 'expire status' is the complexity of the due diligence process, particularly for these projects which required environmental impact assessment. There is no possibility that the 'expire status' of a project is an outcome of a strategic decision by any of the counterparties to delay the approval of the project till more suitable timing or condition is being met.

Another common specification error in the application of the Heckman method is a failure to properly correct for mis-estimated standard errors. As stated by Heckman himself, 'the standard least squares estimator of the population variance is downward biased' and therefore 'the usual formulas for standard errors for least squares coefficients are not appropriate except in the important case of the null hypothesis of no selection bias' (Heckman, 1976, pp. 157-158). As a result, researchers need to correct these standard errors using a consistent errors estimator which is often referred to as robust standard errors. In this chapter, this is addressed by running all the regression specifications with the 'vce robust' option which uses the robust estimator of variance. This could partially resolve the issue as this estimator is robust to some types of misspecification as long as the observations are independent.

Lastly, Rodman (2009)'s conditional mixed-process (CMP) module for estimating fully observed recursive mixed-process models was used as an alternative set-up to test the selection bias specifications with a wider range of explanatory variables on both sides of the equations, in particular country-level controls. The rationale for this is the fact that there have been too many additional variables that did not enter the selection equation which made the Heckman selection model unstable and failing to converge.

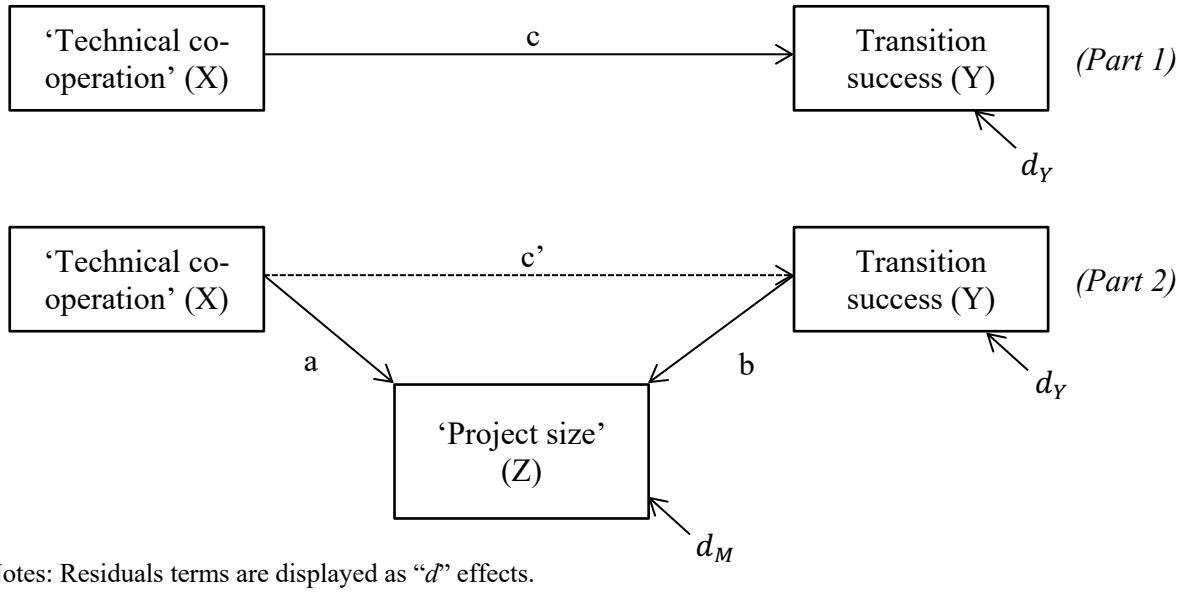
Indirect effects - moderated mediation analysis

As inferred from my initial analysis of this topic as well the indications from the correlation metrices in Tables 8 and 9, some variables, and in particular 'project size', may impact the probability of project success through indirect channels. For this reason, a special focus is dedicated to the indirect effects through which project - as well as client – factors may influence the dependent variable. This is firstly assessed through simple interaction terms and then followed by the moderated mediation modelling technique which I explain here.

As argued by Imai et al. (2010), mediation analysis plays an essential role in overcoming the limitation of any casual mechanisms, namely not telling how and why a treatment casually affects an outcome. Mediation analysis can help to identify intermediate variables, i.e. 'a moderator variable', that lie in the casual pathway between the treatment and the outcome. More formally, a moderator variable is defined a variable involved in an interaction with another variable in the model such that the effect of the other variable depends upon the value of the moderator variable (Judd and Kenny, 1981). This is often referred to as a conditional indirect effect, i.e., the value of the indirect effect is conditional on the value of the moderator variable.

In Figure 7 I illustrate the concept of moderation mediation mechanisms between two variables - 'project size' as a potential moderator variable and 'technical co-operation' dummy as a potential treatment variable. When mediation occurs the c' path in Part 2 of the chart is smaller than the c path in Part 1. As explained by Judd and Kenny (1981), as well as Baron and Kenny (1986), the first step is to establish that there is an effect that may be mediated and then to show that X is related to M by estimating the coefficient a in Part 2. The third step is to show that M is related to Y while X is held constant. The final step is to estimate and to test the path c' in Part 2 to determine if the data are consistent with complete mediation. If the data suggest that c is nonzero but its analogue c' in the multiple regression does not differ from zero, then it could be concluded that complete mediation has occurred as argued by Kenny et al. (1998).

Figure 7: Applied path models showing total effect (Part 1) and mediated effect (Part 2) of X ('technical co-operation') on Y ('probability of full transition success').



Notes: Residuals terms are displayed as "*d*" effects.
Source: Conceptual: Shrout and Bolger (2002). Application: Author (2018).

Until recently, researchers wishing to test the significance of indirect effect had to manually follow the outlined steps which involved running multiple regressions and using Sobel's (1982) large-sample test to confirm any findings. Fortunately, developments in statistical theory provide automated methods for testing indirect effects in mediation models with various mediation analysis programmes available in Stata, e.g. paramed (Emsley et al., 2012), ldecomp (Buis, 2010), medeff (Hicks and Tingley, 2011) and gformula (Daniel, De Stavola and Cousens, 2012). Here, I use medeff as it is superior to some of the other codes due to sensitivity analyses called 'medsens'. These analyses can be ran simultaneously which helps in providing the most reliable results of the calculations derived through the medeff programme.

Specifically, the 'medeff' and 'medsens' commands contained in the mediation package implement the procedures described in Imai, Keele, and Tingley (2010) and Imai, Keele and Yamamoto (2010) for a common set of statistical models. The calculation of how much of the treatment variable is transmitted by the mediating variable lies at the heart of this programme. Following Robins and Greenland (1992), the indirect effects, or casual mediation effects, for each unit i is as follows:

$$\delta_i = Y_i\{t, M_i(1)\} - Y_i\{t, M_i(0)\} \qquad \textit{(Eq. 4)}$$

for each treatment status t = 0, 1. This casual quantity is the change in the outcome corresponding to a change in the mediator (e.g. 'project size') from the value that would be realized under the control condition, $M_i(0)$, to the value that would be observed under the treatment control, $M_i(1)$, while holding the treatment status (e.g. technical co-operation) constant at t. For example, if $M_i(1) = M_i(0)$, then the treatment has no effect on the mediator and the causal mediation effect would be zero.

Medeff was also selected as it comes in handy after conducting mediation analysis due to the incorporated sensitivity analysis option called medsens.[8] The limitation of this option is that it does not handle the interaction between pre-treatment x variables for either the treatment or mediator. Also, a requirement for casual mediation analysis with this option is that the same observations are used in the mediator and outcome regressions which was not too restrictive in the applied specifications as explained in the results section.

[8] Medsens employs the correlation (Rho) between the residual variances (errors) of the models for the mediator and outcome and its effects are computed given different fixed values of the residual covariance. The proposed sensitivity analysis answers the question of how large does Rho have to be for the mediation effect (ACME) to disappear.

Potential endogenous regressors in the outcome equation

The last aspect of the empirical set-up I would like to explain has been triggered by the observation that some elements of 'project size' could be endogenous, and so may be correlated with the error terms. In addition, the latent error term ε may be heteroskedastic (e.g. some regressors could have random coefficients) and has an unknown distribution as argued by Dong and Lewbel (2015). There is a wide range of potential methods for estimating such models, e.g. maximum likelihood, control functions and frequently used IV approach, which in this case would require ivprobit with a valid instrument for 'project size'.

There are strict conditions which instruments must satisfy in order to be valid for IV application as outlined by Dong and Lewbel (2015). For instance: i). they must themselves satisfy orthogonality conditions (E[uZ]=0); ii). they must exhibit meaningful correlations with X; and iii). they must be properly excluded from the model, so that their effect on the response variable is only indirect. Unfortunately, there are no good instruments available for 'project size' to test in this chapter which would fulfil any of these conditions. This is due to data limitations at the bank which are beyond my control.

Many scholars investigating project success factors among other MDBs faced similar issues. For instance, Denizer et al. (2013) in their paper on factors driving project success of World Bank investments faced the exact problem of lacking a good instrument which, as they explained would be difficult for them to justify classification of some variables as instruments that influence project outcomes only through their effects on other potentially endogenous variables with no direct effects on their outcomes. For this reason, they have decided to quantify the magnitude of the likely biases on their OLS estimates due to these unobserved, and potentially confounding, effects. For this, they used Bayesian methods to formally specify a range of reasonable prior beliefs about the importance of these confounding variables, and then explored quantitatively how much these priors influence posterior inferences about the slope coefficients of interest. Unfortunately, this method cannot be applied here due to the binary nature of my outcome equation.

The method which is chosen for this chapter is the approach based on Lewbel's (2012) idea for instrumental variables estimation using heteroscedasticity-based instruments. His approach aims to identify structural parameters in regression models with endogenous regressors in the

absence of traditional identifying information, i.e. a good external instrument. As explained by Lewbel (2012) the identification is achieved by having regressors hats that are uncorrelated with the product of heteroskedastic errors, which is the feature of many models where error correlations are due to unobserved common factor. Lewbel's model can be applied when no external instruments are available as it is the case in this chapter, or, alternatively, used to supplement external instruments to improve the efficiency of the IV estimator.

More formally, in its simplest version, the Lewbel's model allows for construction of generated instruments from the auxiliary equations' residuals, multiplied by each of the included exogenous variables in mean-centered form: $Z_j = \left(X_j - \bar{X}\right) * \in$, where $\in$ is the vector of residuals from the 'first-stage regression' of each endogenous regressor on all exogenous regressors, including a constant vector.

Identification in Lewbel's model is achieved by restricting correlations of errors with X. This relies upon higher moment, and is likely to be less reliable than identification based on coefficient zero restrictions. However, in the absence of plausible identifying restrictions for 'project size', this approach is the only reasonable strategy to use in this chapter.

2.4. Empirical results

I now move to the presentation of the results based on the empirical analyses outlined above. I firstly present the selection bias results which are then followed by the results from the main regression specifications. I then discuss the results of the moderated mediation analysis. I end this section with the results of the robustness checks.

2.4.1. Selection bias results

The selection bias results are outlined first (see Table 10). Based on the four tested regression specifications of the Heckman method. I find no strong evidence to reject the null hypothesis of independence of selection and outcome equations. Hence, it is safe to proceed with the modelling of the outcome equation with no controls for selection bias which is reassuring considering the importance of such controls as I explained earlier in this chapter. In terms of specifics, the reported rho statistics are not significant in any of the applicable regression specifications (i.e. numbered 1 and 2 in Table 10).[9] Similarly, the inverse Mills ratio is not significant under two-stage Heckman regression specification under number 3 in Table 10. The fourth regression specification which includes additional country-level controls provides an extra robustness check by varying the controls in the specification in comparison to the other methods and further re-confirms the results of no selection bias.

[9] Rho statistics are negative under all of the tested methods. This indicates that unobservables are negatively correlated with one another. However, since these results are missing statistical significance, this means that there is no robust indication of project selection at work in the regression specifications 1 and 2.

Table 10: Heckman sample selection modelling –results from the four regression specifications.

	1. Heckprobit (without country-level controls)			2. Heckprobit (with country-level controls)			3. Two-stage Heckman (with country-level controls)				4. Heckprob with CMP module		
	Outcome equation		Selection equation	Outcome equation		Selection equation	First stage (selection equation)		Second stage (outcome equation)		Outcome equation		Selection equation
	Raw	Margins*	Raw	Raw	Margins*	Raw	Raw	Margins	Raw	Margins	Raw	Margins	Raw
Project size (ln)	0.062	0.021	0.083**	0.0939**	0.035***	0.036	0.043	0.014	0.0948*	0.0336*	0.115*	0.038	0.043
	(0.050)	(0.016)	(0.037)	(0.039)	0.011	(0.034)	(0.035)	(0.012)	(0.037)	(0.014)	(0.062)	0.023	(0.030)
Effectiveness delay (srt)	-0.013	-0.005	n/a	0.007	0.002	n/a	n/a	n/a	0.007	0.003	0.040	0.013	n/a
	(0.054)	0.020	-	(0.062)	0.022	-	-	-	(0.063)	(0.022)	(0.051)	0.018	-
Preparation time (srt)	0.043	0.016	n/a	0.015	0.005	n/a	n/a	n/a	0.015	0.005	-0.009	-0.003	n/a
	(0.068)	0.025	-	(0.063)	0.023	-	-	-	(0.063)	(0.022)	(0.064)	0.021	-
Framework (1=yes)	0.121	0.045	n/a	0.202	0.072	n/a	n/a	n/a	0.205	0.073	0.238	0.080	n/a
	(0.127)	0.046	-	(0.146)	0.052	-	-	-	(0.151)	(0.052)	(0.163)	0.058	-
Technical assistance (1=Yes)	0.356	0.099	1.573***	0.232	0.146	1.527***	1.543***	0.508***	0.256	0.091	0.281	0.094	1.546***
	(0.613)	0.066	(0.141)	(0.741)	0.108	(0.137)	(0.134)	(0.045)	(0.770)	(0.274)	(0.532)	0.194	(0.186)
Co-fin w/t others (1=Yes)	0.008	0.003	n/a	-0.077	-0.027	n/a	n/a	n/a	-0.078	-0.028	-0.056	-0.019	n/a
	(0.115)	0.043	-	(0.126)	0.046	-	-	-	(0.130)	(0.046)	(0.152)	0.051	-
Equity instrument (1=Yes)	-0.243	-0.082	-0.467***	-0.158	-0.079	-0.49***	-0.50***	-0.16***	-0.170	-0.061	-0.181	-0.062	-0.497***
	(0.210)	0.053	(0.066)	(0.339)	0.058	(0.065)	(0.061)	(0.021)	(0.332)	(0.122)	(0.293)	0.111	(0.092)
Client's PD	-0.152	-0.060*	0.199***	-0.148	-0.045	0.198***	0.198***	0.065***	-0.146	-0.052	-0.062	-0.021	0.199***
	(0.153)	0.035	(0.032)	(0.154)	0.033	(0.035)	(0.036)	(0.011)	(0.168)	(0.059)	(0.117)	0.037	(0.026)
Client as state (1=Yes)	-0.289*	(0.101)	-0.311**	-0.302*	-0.119	-0.259*	-0.267	-0.088	-0.307	-0.109	-2.439	-0.087	-0.213
	(0.156)	0.070	(0.124)	(0.171)	0.081	(0.141)	(0.138)	(0.046)	(0.162)	(0.057)	(1.666)	0.115	(0.603)
Expired dummy (1=Yes)	n/a	n/a	-7.428***	n/a	n/a	-7.46***	-7.424***	n/a	n/a	n/a	n/a	n/a	-5.424*

	1. Heckprobit (without country-level controls)			2. Heckprobit (with country-level controls)			3. Two-stage Heckman (with country-level controls)				4. Heckprob with CMP module		
	Outcome equation		Selection equation	Outcome equation		Selection equation	First stage (selection equation)		Second stage (outcome equation)		Outcome equation		Selection equation
	Raw	Margins*	Raw	Raw	Margins*	Raw	Raw	Margins	Raw	Margins	Raw	Margins	Raw
	-	-	(0.205)	-	-	(0.186)	(0.198)	-	-	-	-	-	(0.268)
/athrho)		n/a	0.093		n/a	-0.190	n/a	n/a	n/a	n/a	n/a	n/a	-0.211
		-	(0.781)		-	(1.064)	-	-	-	-	-	-	(0.667)
rho		n/a	0.092		n/a	-0.187	n/a	n/a	n/a	n/a	n/a	n/a	-0.208
		-	(0.774)		-	(1.027)	-	-	-	-	-	-	0.359
Inverse Mills	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.156	-0.055	n/a	n/a	-0.638
Ratio	-	-	-	-	-	-	-	-	(1.081)	(0.381)	-	-	-
Clusters	Concept year x Project ID			Concept year x Project ID			Concept year x Project ID		Concept year x Project ID		[not allowed]		
VCE	Robust			Robust			Robust		Robust		Robust		
Observations	2,611			2,213			1,494		1,093		1,494		
Pseudo R2	n/a			n/a			0.1433		0.0678		n/a		
Wald chi2	0.62			0.03			1778.05		14223.23		n/a		
LR chi2	n/a			n/a			n/a		n/a		346.71		
Prob > chi2	0.4306			0.8586			0.000		0.000		0.000		
Log pseudolikelihood	-1406.807			-1223.24			-863.897		-368.273		-1217.05		

Notes: This table reports regression results from the four methods used to tackle the selection bias in this chapter. Regression specifications 1 and 2 use heckprobit technique which fits maximum-likelihood probit models with sample selection. Outcome equation refers to the analysed sample of 1,573 signed and completed projects. Selection equation refers to the sample of 2,034 projects which were rejected or cancelled. The allocation variable used in these models is coded as 0 or 1, indicating an observation not selected (i.e. selection equation) and 1 indicating a selected observation (i.e. outcome equation). Margins are calculated on the probability of success conditional on selection [Pr(achieved=1|outcome=1), predict(pcond)]. Both heckprobit regression specifications report robust standard errors as specified with the vce(robust) option. This results with computation of the Wald test which is reported at the end of the outputs instead of a likelihood-ratio test. The exclusion restriction used in the selection equation is 'expired' project dummy variable. The difference between the first and second regression specification is the fact the latter uses a range of country-level controls.

The third regression specification applies two-stage Heckman procedure with the same range of county-level controls as per the second regression specification. Here, the regressions are fitted with selection using Heckman's two-step consistent estimator. The first stage results show the first-step probit estimates of the selection equation. Average marginal effects are obtained and displayed in a separate column. The second stage results show the second-step probit estimates of the outcome equation. It also includes the inverse Mills ratio calculated after fitting the first stage of this model. Average marginal effects are obtained and displayed in a separate column.

The fourth regression specification expands on the second specification with additional county-level controls as well as interaction terms to further test the results. The user-defined Stata routine CMP described in Rodman (2009) is used due to issues with model convergence as explained earlier. Similarly, margins are calculated on the probability of success conditional on selection [Pr(achieved=1|outcome=1), predict(pcond)]. Robust standard errors are reported as specified with the vce(robust) option. This results with computation of the Wald test which is reported at the end of the outputs instead of a likelihood-ratio test. The exclusion restriction used in the selection equation is 'expired' project dummy variable which is consistent across all regression specifications.

Robust standard errors are clustered by concept review year – project ID in all regression specifications (except the fourth specification where clustering is not allowed) and are shown in parentheses. The display of the following variables is omitted: sector and regional dummies (all models), country-level controls (all models except the first specification) interaction terms (only the fourth specification), constant (all specifications). ***(**)(*) denote significance at the 1 (5) (10) percent level.

Source: Author's calculations (2018).

2.4.2. Regression results

As the analysis finds no evidence for selection bias, the main focus is placed on probit modelling of the outcome equation (see Table 11). A variety of specifications is reported to indicate the robustness of the findings. First, the first regression specification is reported which has been selected based on a range of diagnostic checks carried out earlier and explained in the previous section of this chapter. This is the regression specification without interaction terms and the summary of its coefficients are plotted under Figure 8.

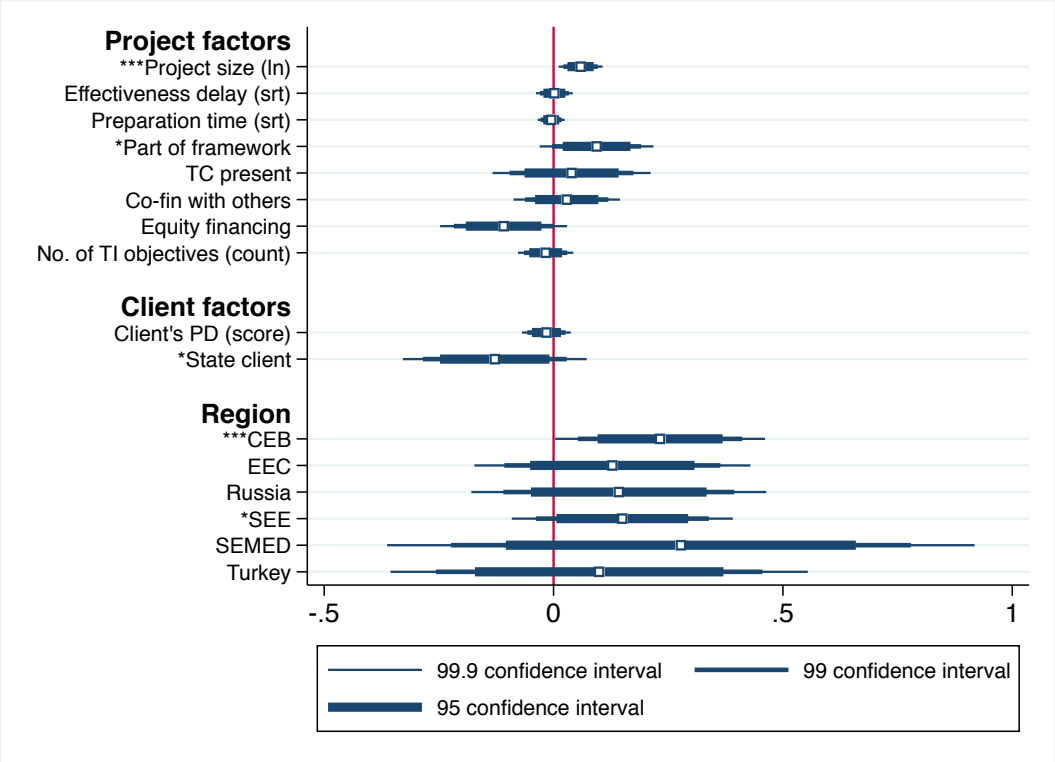
Table 11: Main regression results.

	Regression specification 1		Regression specification 2		Regression specification 3	
	Raw	Margins	Raw	Margins	Raw	(Δ) Spec. 1
Project size (ln)	0.174***	0.0589***	0.208***	0.0637***	0.042	-
	(0.044)	(0.015)	(0.047)	(0.015)	(0.047)	-
Effectiveness delay	-0.005	-0.002	-0.026	-0.004	-0.001	*-0.005*
(srt)	(0.036)	(0.012)	(0.037)	(0.012)	(0.012)	*(0.025)*
Preparation time	-0.015	-0.005	-0.014	-0.005	-0.006	*-0.009*
(srt)	(0.027)	(0.009)	(0.027)	(0.009)	(0.008)	*(0.019)*
Framework (1=yes)	0.278*	0.0938*	0.300**	0.101**	0.085	*0.193*
	(0.112)	(0.038)	(0.112)	(0.038)	(0.062)	*(0.050)*
Technical	0.116	0.039	2.120	0.022	0.039	*0.077*
assistance (1=Yes)	(0.155)	(0.052)	(1.437)	(0.048)	(0.048)	*(0.107)*
Co-fin w/t others	0.085	0.029	0.051	0.017	0.030	*0.055*
(1=Yes)	(0.104)	(0.035)	(0.104)	(0.035)	(0.037)	*(0.067)*
Equity instrument	-0.312**	-0.109**	-0.327**	-0.114**	-0.114*	*-0.198*
(1=Yes)	(0.119)	(0.042)	(0.119)	(0.042)	(0.052)	*(0.067)*
Number of TI	-0.051	-0.017	-0.048	-0.016	-0.017	*-0.034*
objectives	(0.054)	(0.018)	(0.054)	(0.018)	(0.018)	*(0.036)*
Client's PD (at	-0.0461	-0.0156	-0.0455	-0.0153	-0.0176	*-0.029*
signing)	(0.048)	(0.016)	(0.047)	(0.016)	(0.020)	*(0.028)*
Client as state	-0.380*	-0.128*	-0.796**	-0.179*	-0.128	*-0.252*
(1=Yes)	(0.182)	(0.061)	(0.299)	(0.072)	(0.074)	*(0.109)*
Regions:	0.670**	0.232***	0.657**	0.226**	0.24**	*0.431*
CEB	(0.223)	(0.070)	(0.224)	(0.070)	-0.0831	*(0.140)*
EEC	0.355	0.128	0.355	0.128	0.123	*0.232*
	(0.253)	(0.091)	(0.254)	(0.091)	-0.0802	*(0.173)*
Russia	0.395	0.142	0.386	0.138	0.144	*0.251*
	(0.272)	(0.098)	(0.272)	(0.097)	-0.0808	*(0.191)*
SEE	0.418*	0.150*	0.408*	0.146*	0.151*	*0.267*
	(0.201)	(0.073)	(0.204)	(0.074)	-0.0756	*(0.125)*
SEMED	0.824	0.278	0.776	0.262	0.313	*0.511*
	(0.690)	(0.195)	(0.699)	(0.201)	-0.198	*(0.492)*
Turkey	0.274	0.099	0.223	0.081	0.102	*0.172*
	(0.387)	(0.138)	(0.384)	(0.138)	-0.153	*(0.234)*
Size x TC dummy	n/a	n/a	(0.126)	-	n/a	*n/a*
	-	-	(0.086)		-	-
Effectiveness x	n/a	n/a	0.164*	-	n/a	*n/a*
client as a state	-	-	(0.072)		-	-
Clusters (no.)	Sector x Sign yr. (65)		Sector x Sign yr. (65)		-	
Sector FE	Yes		Yes		Yes	
Year FE	Yes		Yes		Yes	

	Regression specification 1		Regression specification 2		Regression specification 3	
	Raw	Margins	Raw	Margins	Raw	(Δ) Spec. 1
VCE	robust		robust		n/a	
Observations	1,125		1,125		1,126	
Pseudo R2	0.09		0.09		n/a	
Centered R2	n/a	n/a	n/a	n/a	0.10	
Uncentered R2	n/a	n/a	n/a	n/a	0.68	
Root MSE	n/a	n/a	n/a	n/a	0.45	
Wald chi2 (df)	481.6 (39)		446.8 (41)		n/a	
Prob > chi2 or F	0.0 (chi2)		0.0 (chi2)		0.0 (F)	
Log pseudolikelihood	-667.998		-664.886		n/a	

Notes: This table reports the results from the regression specifications based probit methodology and investigating factors driving probability of project success. The dependent variable is binary success (0,1) in all specifications. The table reports marginal effects from probit regression for regression specifications 1 and 2, but from the third regression specification. Robust standard errors are clustered by sector-signing year in all models (except the third specification where clustering is not allowed) and are shown in parentheses. Similarly, sector and signing year fixed effects are applied in all regression specifications except the third specification. The display of the following variables is omitted: sector dummies, country-level controls, constant. The'y2 hat', i.e. fitted value of 'project size', which applies in the third regression specification is reported under the 'project size (ln)' line. ***(**)(*) denote significance at the 1 (5) (10) percent level.
Source: Author's calculations (2018).

Figure 8: Average marginal effects based on the first regression specification from Table 11.



Notes: This chart plots the coefficients from the first regression specification (see details in Table 11). The dependent variable is the probability of project success which is plotted on the x-axis. The following coefficients are omitted from graphical display: sectors, country-level controls, constant, signing years dummies. Confidence

intervals are plotted as per legend description. Statistical significance is indicated at the beginning of the variable name as follows: *p<0.05, **p<0.01, ***p<0.001.
Source: Author's calculations (2018).

As can be noted from Figure 8, only two project-related factors produce significant results, namely 'project size' and 'framework' dummy. From the client-related factors, client's state ownership stands out as the only significant result, albeit with relatively wide standard errors. Two regional dummies display significant results, namely CEB and SEE.

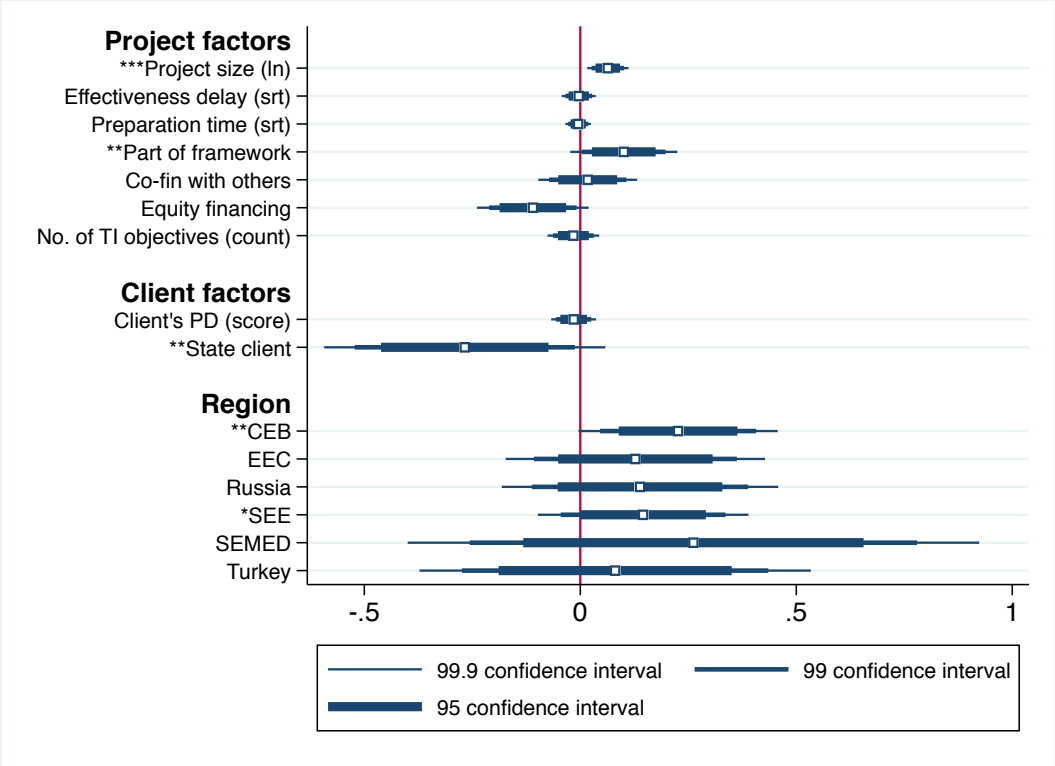
As explained earlier, a special attention is dedicated to indirect effects. A series of models is tested in which the core variables, in particular, 'project size', are interacted with other explanatory variables. Based on the test results, the only significant coefficients within 95% confidence interval are: (i). 'project size' vs. TC dummy, and (ii). 'effectiveness delay' vs. client's ownership.

As confirmed through the diagnostic checks, adding the interaction terms has slightly improved the robustness of the first regression specification. Namely, as can be seen from Figure 9 as well as in the Table 11, client as state dummy has gained in significance. 'Project size' has recorded a slightly stronger magnitude, similarly to framework dummy as well as few regional dummies. Sectoral dummies, on the other hand, as well as co-financing and TC dummies all have slightly reduced their respective magnitudes.

The third and final regression specification reported in Table 11 addresses the issue of potential endogenous bias. Specifically, standard IV method could not be used to assess the treatment of 'project size' which is the core potential endogenous variables, as explained earlier, due to lack of valid instruments for 'project size'. Lewbel's (2012) method which uses heteroscedasticity to identify endogenous regressor is applied with the Stata application for probit modelling.[10]

[10] The modelling base is the first regression specification as ivreg2 cannot handle interaction terms. Also, ivreg2 only works if the endogenous variable is continuous which works well with tested 'project size' variable.

Figure 9: Average marginal effects based on the second regression specification from Table 11.



Notes: This chart plots the coefficients from the second regression specification (see Table 11). The dependent variable is the probability of project success which is plotted on the x-axis. The following coefficients are omitted from graphical display: sectors, country-level controls, constant, signing years dummies, TC dummy (due to large standard errors), interaction terms. Confidence intervals are plotted as per legend description. Statistical significance is indicated at the beginning of the variable name as follows: *p<0.05, **p<0.01, ***p<0.001.
Source: Author's calculations (2018).

In terms of specifics behind the third regression specification, the bootstrapping is reduced to 45 replications in order to allow the regression to converge. The vce clustering option, which has been applied in all regression specifications, is not allowed here. Similarly, no interaction terms are allowed due to model set-up requirements. The'y2 hat', i.e. fitted value of 'project size', produce positive, but not statistically significant, coefficient as can be seen from Table 11. There is no change in the majority of the coefficients magnitude, signs as well as significance levels as noted in the last column in Table 11. 'Framework dummy' and 'client as State' are the only two reported coefficients which record significance losses but retain their magnitude and positive signs.

It is important to note that the identifications under the third regression specification are based on higher moments, and, thus, as explained by Lewbel and College (2010), are likely to give noisier, less reliable estimates than identification based on standard exclusion restrictions. Still,

it is a useful application as there is no robust instruments to use for 'project size' as I explained earlier.

Overall, majority of the studied regression specifications confirm the initial factor predictions through the reported significant results albeit with few exceptions. Namely, 'project size' delivers significantly positive rather than negative coefficient in all regression specifications except the third specification where its fitted value loses its significance, which could confirm the suspected endogenous character of this variable. 'Being part of a framework' is found, as expected, to be a factor which increases the likelihood of project success (as confirmed in all specifications except the third one). Client's characteristics matter for project success, i.e. client as state is one factor which may reduce the chances of a project's transition success. Surprisingly, the client's PD does not produce significant results, although its sign is in line with the expectation of its negative influence on project success. Two regional dummies, namely CEB and SEE, maintain its positive significant coefficient across all models. The estimated indirect effects of 'project size' vs. TC dummy and 'client as state' dummy vs. 'effectiveness delay' are modest under the second regression specification but only at the lowest level of statistical significance. This calls for deeper analysis through indirect effects which comes next.

2.4.3. Moderated mediation analysis

Lastly, a more in-depth assessment of all of the potential indirect effects at work in the analysed probit regression specifications is carried out through the moderated mediation modelling. The goal of such analysis is to investigate alternative casual mechanisms by examining the roles of intermediate variables that lie in the casual paths between the explanatory variables and project success probability.

A broad combination of potential mediating variables and treatment variables is assessed together with respective sensitivity analyses. Table 12 presents only the significant results from this testing. 'Project size' displays some indication of mediating properties for four treatment variables. 'Effectiveness delay' is found to be partially mediated by 'equity financing instrument' as well as 'client's ownership' which confirms the earlier findings delivered through the interaction terms. Lastly, co-financing with other MDBs seems to be mediated through equity financing instrument.

Table 12: Results from moderated mediation analyses**.**

Treatment variable (type)	Mediating variable (type)	Average Direct Effect	Average mediation [95% CI]	Total Effect mediated (%)
framework (binary)	project size (continuous)	0.05	.01 [.001 to .02]	16.6%
technical assistance* (binary)	project size (continuous)	0.01	-.02 [-.03 to -.005]	22.3%
co-fin with other MDBs (binary)	project size (continuous)	0.05	.01 [.001 to .02]	15.6%
equity instrument (binary)	project size (continuous)	0.09	.02 [.01 to .04]	21.9%
effectiveness delay* (continuous)	client as a state (binary)	-0.002	.003 [.001 to .006]	19.4%
co-fin with other MDBs (binary)	client as a state (binary)	0.05	-.006 [-.02 to -.0002]	-11.6%
effectiveness delay (continuous)	equity instrument (binary)	0.01	.004 [.0001 to .01]	24.2%

Notes: this table summarises the results from casual mediation analyses (Medeff). Only significant and valid results are displayed, i.e. results with no zero in the confidence interval for average mediation as well as passed sensitivity tests (medsens). The definitions of treatment and mediating variables, average direct effects, average mediation and total effect are all provided in the previous section which outline the empirical set-up. A sign of '*' against treatment variable name indicates the underlying specifications which displayed significant results with the interaction terms between treatment and mediating variables under the second regression specification. Average mediation results are provided together with the 95% confidence intervals. Total effect mediated is expressed in percentage terms.
Source: Author's calculations (2018).

Specifically, 22% of the total effects of technical co-operation dummy on project success is mediated through project size. Similarly, 19% of total effect of effectiveness delay on project success is mediated through client's ownership. In addition to this, 'framework' dummy displays some moderated mediation effects which should be considered in addition to the results from the first and third regression specifications. 17% of the reported total effect of the framework dummy is mediated through project size. None of the other moderated mediation channels can be reported on as their respective treatment variable's coefficients were not statistically significant under the first and third regression specifications.

2.4.4. Additional robustness checks

A range of further sensitivity checks is carried out in order to check the validity of the reported results. The first test is to re-run all regression specifications without outliers. Outliers are selected as the projects being outside the outer fence (as identified by the inter-quartile range multiplied by three) and they are removed from the sample. It is found that some of the results, particularly from the third regression specification, do not continue to hold, but this could potentially be justified by the fact that Lewbel's method used in this regression has a tendency to produce less reliable estimates as explained earlier.

In addition to the outliers testing, the core variables from the first and third regression specifications are adjusted to further test the results. Specifically, 'project size' is derived as deflated using a U.S. GDP deflator as at project's year of signing. Also, client's PD as well as country-level controls are taken as at project's completion year. Following these checks, some of the reported coefficient on client's PD has gained in significance, but none of the previously reported variables have lost it which is reassuring. Finally, to provide extra robustness check, the country-level controls are enriched with e.g. addition of a proxy for banking sector efficiency (net interest margins) or stock market capitalisation ratios - the inclusion of which do not substantially change the reported results.

To further validate my results, I construct ordered probit set-up in which I re-defined the two binary dependent variable used in the main regressions more gradually. Namely, I defined the probability of movement from one level of success to another on a 1-3 rating scale:
the following binary variable (1,0) which are used to derive the probability of project success in the probit models:

- 'Success achieved' (1) is assigned with the rating '3'. These projects preserve or outperform their original transition scores at the completion stage, i.e. ETI ≤ PTI.
- 'Success not achieved' (0) is re-defined into two separate rating categories based on the degree of their failure (i.e. ETI > PTI). Projects which underperform on their original transition scores fully are assigned with the rating score '1'. Projects which underperform on their original transition scores partially based on their failure on some, but not all, underlying transition benchmarks are assigned with the rating score of '2'.

I re-run all three regression specifications with the ordered dependent variable and find that the results stay broadly in line with my findings.

Additional testing of the moderated mediation models is carried out with the help of sensitivity analyses for moderated mediation (i.e. medsens) which re-confirm the validity of the reported findings albeit at the lower end of the threshold of statistical significance which indicates the need to treat the moderated mediation results with some caution.

2.5. Discussion and further research areas

The empirical analysis delivers few valuable findings which could shade a light on the nature of factors contributing towards investment projects non-financial success in transition delivery. The results are discussed here from the perspective of project success factors. They are then linked to the broader context of the non-financial priority objectives of EBRD (i.e.transition) as well as the overall mandate of the bank which also cares about the financial sustainability of its projects and this may influence the degree to which certain success factors contribute towards transition delivery.

2.5.1. Project design and structure

The size of a project delivers some puzzling results. On one hand, project size positively influences the probability of project success under a range of regression specifications which goes against the evidence from existing literature in the field of MDBs. The variable also continues to provide robust results when interacted with other variables. For instance, it mediates 22% of positive technical co-operation effect on project success. On the other hand, however, it displays some signs of endogeneity and, thus, need to be treated with some caution. Further analysis on this topic could benefit in exploring a good instrument to control for the endogenous nature of project size which failed to be found in this chapter due to data availability.

One project factor displays consistent and robust results, namely project 'being part of a framework' seems to increase the chances of project success which confirms the initial predictions. The sub-operation under existing frameworks are likely to require less resources due to, for instance, an established relation with the client as well as know-how acquired from

the previous framework's activities. My results also indicate that 17% of framework's overall effect on success is mediated through project size.

It is worth noting that the range of explored project-related factors has been constrained due to data limitations. For instance, no consistent HR-level data on operation leaders in charge of the projects has been available at the time of this research. Such data could provide fruitful lines of enquires due to a significant role project manager seems to play in project success as found by other scholars. Potential factors could include the years of experience of the project manager, the average success probability of the previous projects the given project manager worked on and so on. I have continued researching this topic independently as well as through a fruitful co-operation on this topic with colleagues from World Bank, IFC, Asian Development Bank, among the others. This research area has become one of my top areas of expertise at EBRD. My further research on my database is currently ongoing. It already feeds into the bank's new country strategies, new investment project selection and design as well as knowledge sharing and institutional learning.

2.5.2. Client's characteristics

Client's ownership structure seems to play a role in driving project success. Projects with a state client have, on average, fewer chances to succeed. It also impacts certain project-related factors in their ways of influencing project success. For instance, 20% of effectiveness delay is dependable on client's ownership structure.

From a broader perspective, it is fair to argue that the characteristics of project success factors are likely to be a reflection of the transition progress in the EBRD's CoOs. The client's ownership structure is likely to be of a greater importance in early transition countries, such as Tajikistan, than in countries like Poland which is approaching its graduation phase in its transition advancement.

This links to a broader topic of the nature of transition impact which is conditioned by time and context. Transition is a dynamic process and the impact of a project will depend on its timing[11]. A project may come too early (i.e. the economy is not ready to pick up the stimulus) or too late

[11] All of the reported regression specifications controlled for the impact of timing through signing years' dummies.

(i.e. the project's impact is marginal). Similarly, market structure conditions transition impact.[12] Where there are few competitors, a project's impact on competition may be particularly significant. On the other hand, a high degree of concentration can slacken the project entity's own commitment and incentive to compete. One of the findings confirmed this, namely projects located in the most transition-advanced region, CEB, are more likely to achieve full transition success. Still, country-level assessment of project success factors is beyond the scope of this chapter and it could be taken forward as the next line of enquiry which I am currently exploring as an extension of the research presented int this chapter.

2.5.3. 'Transition' versus other project performance measurers

This chapter focuses on the defining project success in terms of its transition-related delivery. However, although transition is the most important project performance measure at EBRD, it is only one of the three main project eligibility and performance measurers at EBRD, the other two being sound banking and additionality. Having a multiple range of such principles is expected to create certain trade-offs between them, as well as some complementarities. These are likely to be rooted in the project design and structure characteristics, and, thus in turn, impact the project success as analysed in this chapter.

For instance, one may expect that the application of sound banking principles has a positive transition impact in a project. The sound banking principle implies that in structuring and pricing its projects, the EBRD tries to ensure that each project is financially sustainable which is likely to go hand-in-hand with the transition-related objectives. There are, however, cases where the project would satisfy sound banking principles, but would, nevertheless, have a negative transition impact (e.g. where the former arose in large part from an unregulated or protected monopoly position that was expected to persist). Further research, which I am currently exploring, could explore cases where transition and sound banking deliveries are complementary to each other and vice versa. This would serve as a valuable extension of this chapter. Moreover, a wider range of factors could be explored which have not been applicable in this chapter due to the restricted focus on transition-relation delivery.

[12] All of the reported regression specifications controlled for the impact of market conditions through, for instance, a proxy for the level of banking sector development in a country as displayed earlier.

From the broader perspective, trade-off between financial and non-financial impact can potentially become new business strategy's directions in many organisations in today's world as explained by Alberti and Garrido (2017). The term 'hybrid organisation' has been gaining a high interest internationally as more organisations blur the boundary between for-profit (i.e. financial) and non-profit (i.e. non-financial) worlds in their business models. Hybrid organisations break the traditional customer-beneficiary dichotomy by providing products and services that produce social value (Battilana et al., 2012) and their increasing number creates a demand for a new stream of research into the project success factors which are driving their multi-dimensional success delivery. An increase in awareness of impact investing further contributes to this. For these reasons, EBRD could provide an ideal case study for such analyses due its unique mandate.

2.6. Conclusion

Understanding the critical factors that influence project non-financial success enhances the ability of donors and EBRD's bankers to ensure the desired performance outcomes. In addition, it helps them forecast the future status of the project, diagnose the problematic areas, and prioritize their attention and scare resources to ensure successful completion of the investment projects. The aim of this chapter was to show which factors contribute towards success of EBRD projects in relation to their non-financial transition delivery. The chapter contributes to the advancing thinking of transition impact. It is the first of its kind to examine success factors of all EBRD projects as one of the MDBs and, thus, complementing some of the research which fills the gap in the literature which so far has been heavily focused on the studies of World Bank's investment projects. From the EBRD perspective, the chapter helps in understanding better how and why certain factors may impact project selection going forward, although it does not provide 'one size fits all' solution. Based on the sample of almost 1,600 projects completed between 2003 and 2016, three core results stand out. Firstly, the probability of transition success is more likely with larger size projects, although the robustness of this finding is questionable due to the potentially endogenous nature of this variable. Secondly, projects being part of a framework is more likely to be successful and it is mediated through project size with approximately 17% of its total effect being conditional. Lastly, results show that clients' characteristics matter; projects ran with state clients are less likely to be successful, this variable is also found to mediate the impact of 'effectiveness delay' on probability of success. The chapter's scope was constrained by multiple data limitation at the time of the research. I

am currently looking into a future research in this field could focus on the topic of a broader impact of potential trade-offs, or complementarities, between non-financial (i.e. transition-related) and financial returns on the project success factors which could serve as an important contribution to the newly emerging field of project management as well as corporate strategies for hybrid organisations like EBRD. I co-operate with other MDBs on a joined proposal to expand on my findings by cross-institutional joined analysis into factors behind non-financial project performance.

3

The impact of government interventions on bank performance

Abstract

The global economy has witnessed many events where banks' performance went out of hands. Till recently governments could freely bailout failing banks during turbulent times, but they have become increasingly cautious to do so due to questionable effectiveness of such interventions. This topic has, once again, become urgent with the unfolding of the next financial crisis triggered by Covid-19 pandemic. In this chapter, I use an extended version of a novel database consisting of banks from 39 countries which received government support between 1990 and 2017. I compare their performance with their non-intervened peers. I focus on three cases of the government intervention: (i). nationalisation, (ii). government-assisted merger and (iii). 'bad-bank'. My findings contribute to the latest empirical literature which is far from conclusive by identifying no clear winner among the studied interventions with gains as well as potential losses under each of the interventions. I argue that a 'one-size-fits-all' intervention approach is suboptimal. My findings suggest that governments should implement their interventions on a case-by-case basis and to do so after a careful ex-ante assessment of their their current priority objectives towards banks and the economy as a whole.

3.1. Introduction

In the nineteenth and early twentieth century governments around the world either largely stood aside or adopted minimalistic policy responses to the systemic banking crises (Calomiris, 1997). This has changed during the last decade, particularly after 2007-8 financial crisis. The most recent years have witnessed governments adopting increasingly extensive and costly bailout interventions. These interventions are highly unpopular with the general public because of the fiscal burden they impose on the taxpayers. They can also contribute to the moral hazard with respect to future crises through the perception that they create rents for bankers (e.g. Gropp et al., 2014; Dam and Koetter, 2012; Gropp et al., 2014). However, when distressed banks are not sufficiently restored, the contagion effects might result in a severe disruption in the wider context of the banking sector, economy and eventually financial stability of the entire system as documented by many scholars (Gai et al., 2011).

The last financial crisis of 2007-2008 has called for the need of creating orderly resolution frameworks for restoring failing banks in the event of the next financial shock which is just unfolding as triggered by the Covid-19 pandemic. Although banks have a set of measures in their hands which they can use to restructure their activities, they often refer to their governments for a help.[13] Spin-offs, recapitalizations or selling some parts of the business are suggested internal intervention scenarios under the current frameworks (e.g. Living Wills, FSB, 2014). However, in the centre of debate are external intervention mechanisms aimed at mitigating the systemic effect with the help of taxpayers money so-called bailouts. Their scale and scope is often much larger than the internal interventions and, thus, require deeper analysis. For this reason, I will focus on the bailouts in this chapter.

Specifically, I analyse how different government interventions affect the performance of a distressed bank as well as their banking peers. In theory, the effective intervention should allow a distressed bank to restore its financial performance and, at the same time, to mitigate the systemic effect for other banks in the economy. However, in practice, the real effects are less obvious. For example, some interventions may trigger negative externalities which could increase further the risk in the banking system and endanger financial stability (Hueser et al., 2018). This, in turn, may negatively impact the performance of the non-intervened banks. To the best of my knowledge, my research approach conducted in this chapter is unique as it is the first study which assesses the impact of different government interventions on bank performance on a cross-country scale and across a long period of time.

The empirical studies on the effectiveness of government interventions is varied and inconsistent. Some point to the harmful effects of the interventions on the future bank behaviour, e.g. Berger et al. (2010) on a decline in bank liquidity; Duchin and Sosyura (2014) on higher risk. Others, often by the same authors, find some positive evidence of government interventions on troubled banks, e.g. Li (2013) on higher lending; Berger et al. (2010) on increase in capital; Hackenes and Schnabel (2010) on lower risk; Giannetti and Simonov (2013)

13 Under specific circumstances the bank recovery and resolution directive (BRRD) allows for bailouts. It states that in the events of extraordinary systemic stress, governments may provide public support instead of imposing losses in full on private creditors. This measures would nonetheless only become available after the bank's shareholders and creditors bear equivalent to 8% of the bank's liabilities and would be subject to the applicable rules associated with the state aid (BBRD, 2014).

on higher lending. I review these studies in more details in the next section of this chapter. Overall, there is no study in the current literature which covers a wide range of countries, from both developed and developing economies, and, at the same time, analyses multiple intervention mechanisms simultaneously and over a substantially long period of time. This defines my contribution to the existing literature.

From the methodological perspective, I use a novel bank-level database to empirically assess the impact of different government interventions across 39 countries on almost 1,000 banks, of which 215 received some form of government support during the episodes of the systemic banking crises between 1990 and 2017. In terms of the measure of bank performance of interest, I analyse the effectiveness of different interventions in regards to multiple indicators of bank's performance, namely bank's future lending activities, their capital and reserves-to-NPL positions in comparison to the non-intervened banks. I use several difference-in-difference (DID) empirical approaches including fixed effects panel regressions to carry out my analyses.

My findings indicate that the optimal intervention design requires a delicate balance due to the fact that I find no clear winner among the studied interventions. For instance, I find that mergers and 'bad bank' approaches deliver some favourable results for the intervened banks, e.g. an increase in capital, but this comes at the cost of slower lending growth. Thus, a 'one-size-fits-all' intervention approach is suboptimal. Instead, governments should implement their interventions on a case-by-case basis and, through that approach, reflect their specific priority objectives towards the recovery of their troubled banks. This is a fragile task considering the likely consequences caused by the increase in public debt due to the high cost of banking bailouts.

The chapter is organized as follows. Section 3.2. describes the related literature. In Section 3.3, I carry out the empirical analysis based on the data from 39 countries and present the results. I also carry out multiple robustness checks of my results in this section. Section 3.4. concludes and outlines the limitations of my chapter. It also outlines areas for further research on this topic which are already under way.

3.2. Review of the related literature

3.2.1. Systemic banking crises – systemic risk, contagion and moral hazard

Before I proceed to the specific literature on the government interventions, it is important to outline the wider conceptual context in which these interventions occur. Namely, this chapter analyses government interventions during the episodes of systemic banking crises. Acharya (2009) defines a banking crisis as systemic if many banks fail together, or if one bank's failure propagates as a contagion causing many banks to fail. Claessens et al. (2005) explains that in a systemic crisis, a large number of defaults occurs which contributes to a difficulty in repaying contracts on time by banks as well as corporations. As a result, NPLs increase sharply and all or most of the aggregate banking system capital is exhausted. Thus, I place a special attention on NPLs of the studied banks in my empirical analyses.

I follow the definition of systemic crisis adopted by Laeven and Valencia (2013, 2018). This is because I rely on their database for the country classification I use later in this chapter. They define banking crisis as an event with significant signs of financial distress in the banking system, i.e. defined as bank runs, losses in the banking system, and bank liquidations. They consider losses as 'severe' when either:

- a country's banking system exhibits significant losses resulting in a share of NPLs above 20% of total loans or bank closures of at least 20% of banking system assets;

or

- fiscal restructuring costs of the banking sector are sufficiently high, exceeding 5% of GDP.

They also condition their definition of the systemic banking crisis on a 'significant' banking policy interventions taking place in the banking system which goes in alignments with my research agenda in this chapter. They define policy intervention as 'significant' if at least three out of the following six measures have been used in a given country: (1). deposit freezes and/or bank holidays; (2). significant bank nationalisations; (3). bank restructuring fiscal costs (at least 3% of GDP); (4). extensive liquidity support (at least 5% of deposit and liabilities to non-residents); (5). significant guarantees put in place; and (6). significant asset purchases (at least 5% of GDP).

Systemic banking crisis and the need for government interventions to save the troubled banks are often explained in the context of systemic risk. Shoenmaker and Siegmann (2014) defines systemic risk as an event that triggers a loss of confidence in a substantial portion of the financial system that is serious enough to have significant adverse effects on the real economy. A systemic risk can develop either because of macroeconomic shock or because of contagion between banks. In terms of the latter, the failure of a bank may negatively impact the whole banking industry and this is what governments aim to avoid. This is because troubled banks may default on their interbank liabilities and impact other banks in the economy which eventually may lead to financial instability. The macroeconomic environment is important in setting the conditions for this domino effect to occur, since a lower yield on loans, due to high loan losses, depletes banks capital and it reduces the buffers each bank has to cope with risks. Banks might have correlated exposures and an adverse economic shock may result directly in simultaneous, multiple bank defaults. This adds to the pressure on governments to intervene in the banking sector.

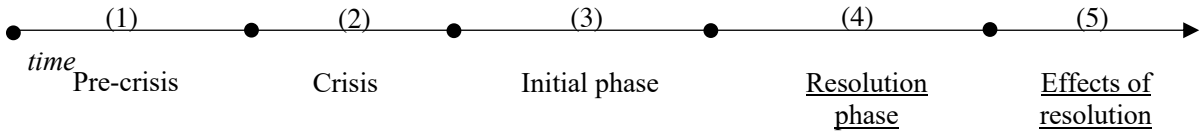
Many scholars defined systemic risk in the context of correlations. Rampini (1999), for instance, defines systemic risk as a default correlation. In his model, a substantial correlation of default arises to enable risk-sharing when an aggregate shock is low. Acharya (2009) defines systemic risk as the join failure risk arising from the correlation of returns on asset side of bank balance sheets. Namely, they argue that banks find it optimal to increase the probability of surviving together, as well as failing together, by choosing asset portfolios with greater correlation of returns. They explain that the preference for high correlation arises a joint consequence of limited liability of the banks' equity holders and the nature of the externalities which further calls for the government interventions in the event of bank's failure.

Specifically, systemic risk pushes many governments to intervene into their banking sector through bailouts in order to cut off the potential channel of contagion from the distressed banks to other banks in the economy. The concept of contagion can have multiple definitions. Elsinger et al. (2006) define contagion as a low probability high impact event which dominates the far tail of the loss distribution. Allen and Gale (2000), on the other hand, define contagion as an amplification of spillover effects. They explain that the persistence in spillovers, following a negative incident, evolves to contagion. Similarly, Dornbush, Park, and Claessens (2000) refer to 'a fundamentals-based contagion' which explains why spillovers naturally flow from banks' financial linkages. Lastly, Longstaff (2010: 438) defines financial contagion as

‘an episode in which there is significant increase in cross market linkages after a shock occurs in one market.’

The focus of this chapter is on the post-resolution phase of the systemic crisis, in particular on the effects of government intervention on banks’ future behaviour (i.e. Stage 5 in Figure 10). The determinants of crisis are taken as given. (i.e. Stage 1). Prior to the crisis, the increased fragility occurs which is often accompanied by negative shocks within the economy. The initial phase of the crisis consists of the immediate reactions during the containment phase of the crisis (i.e. Stage 3). During this phase the focus is on restoring the confidence in the financial system and minimizing the contagion effects of the crisis. I focus on the last two phases of the systemic crisis in this chapter, namely the government intervention stage (i.e. Stage 4) and the period after the intervention during which its effectiveness can be analysed (i.e. Stage 5). I control empirically for the time period prior to the interventions in my regression analyses.

Figure 10: A simplified conceptual timeline of a systemic banking crisis.



Source: Author (2019).

Lastly, government interventions in banking sector during systemic crisis are associated with the problem of moral hazard. The widespread belief that interventions into troubled banks create moral hazard dates back to Bagehot (1873). More recently, Avgouleas and Goodhart (2014) argued that bank bailouts lead to moral hazard and undermine market discipline. In general terms, the term ‘moral hazard’ refers to the situation where in the provision of insurance leads to the insurant taking action that increase the likelihood of an adverse outcome (Dreher, 2004).

Jensen and Meckling (1976) suggest that there are two kinds of moral hazard problems which lead bank managers to take more risky lending than the optimal level. One is managerial rent-seeking, which takes place when managers pursue their private benefits by investing in ‘pet projects’ or through insufficient monitoring of loans. The other moral hazard problem arises

from a conflict of interest between shareholders and creditors. Shareholders may want to make risky loans but eventually shift the risk to the depositors. For these reasons, the positive impact of government interventions into banks in reducing the externalities associated with contagion may vanish completely due to the exacerbation of the moral hazard stemming from limited liability.

Empirical research investigating moral hazard faces a range of limitations. For instance, it is challenging to quantify moral hazard. This is because the excessive risk-taking behaviour of creditors and debtors cannot be directly observed and measured (Li et al., 2015). Also, it is difficult to separate the effects of the intervention from other macroeconomic factors (Lee and Shin, 2008).

3.2.2. Government interventions into troubled banks – their typology and effectiveness

I now move to the literature on the government bailouts which are at the core of this chapter. There is no doubt that managing systemic banking crises is a fraught business for contemporary governments. Delivering prompt, effective banking interventions that protect households wealth and that spread the fiscal burden reasonably fairly across different groups is seen as an ideal, but almost impossible, solution to the problem of troubled banks by many governments across the globe. On the top of this, even successful interventions are far more costly than they used to be the case in the past. This all adds to the difficulty in picking the 'right' intervention.

In this chapter I test the effect of three government interventions aimed at restoring the failing banks. The first intervention is nationalisation of the distressed bank. This intervention is often perceived as the 'last resort' option. Here, the government recapitalises the failing financial institution in exchange for its ownership. The fact that the government owns a stake in these financial institutions does not necessarily have a direct distortionary impact, as long as the recapitalized banks' are managed on commercial basis. The second analysed intervention is a government-assisted merger. Here, the government helps a troubled bank to find a partner willing to acquire the distressed institution. It can also consist of capital injection by the government to the merged bank. Sheng (1996) claims that this form of intervention is used when government has limited resources to handle the closure of the troubled bank. The third intervention is a 'bad bank' approach. It often takes the form of a transfer of NPLs from distressed institutions' balance sheets into a fund created for this purpose. The role of such

fund, called asset management company (AMC), is to clean up the banks' balance sheets and to restore their profitability. The fund then attempts to maximise the recovery rates of bad debt through active restructuring.

A running theme behind all of these interventions is the balance sheet's recapitalisation of the failing bank. It is very likely that undercapitalised banks are likely to be subject to the debt overhang problem (Myers, 1977). Thus, an efficient recapitalisation programme should be designed in a way that reduces the debt overhang problem, while limiting the moral hazard it creates for banks (Philippon and Schnabl, 2013). Walther and White (2017) explain that bank's shareholders need to be given incentive to manage the banks' choices in desirable way. As a result, a deterioration in bank capital creates a deadweight loss, because it erodes shareholders' 'skin in the game' and weakens their incentives. This friction could motivate timely government intervention that recapitalise failing banks which need assistance and improves incentives in the banking sector.

As a general rule, any type of government intervention needs to be tailored to the characteristics of a systemic banking crisis the given country is facing, as these will have a strong impact on the effectiveness of these interventions. Claessens et al. (2005) explains that recapitalisations of banks under any of the government interventions is defaulted to be ineffective in countries where the bankruptcy system is not functioning or where many ownership links exist between banks and corporations and the supervisory authority has little credibility in enforcing prudential regulations. Thus, it is crucial to control for the quality of the country's institutional environment in my empirical analysis which comes in the next section.

3.2.3. Literature contribution

The research I carry out in this chapter contributes to two main strays of literature.

Firstly, I contribute to the literature on the effectiveness of government interventions on banks' recovery. My contribution comes from the coverage of almost 40 countries which is rare in the literature as well as from my approach of studying a wide range of bank-level government interventions simultaneously. The latest empirical studies provide a rather mixed evidence on the question of intervention measures which are most effective in restoring the health in the banking sector. From the theoretical perspective, prior to the intervention, high NPLs often

affect bank owners' decisions in lending. Bank owners may face a situation akin to the classical debt overhang problem of Myers (1977) and they may miss out on profitable lending opportunities.

I now provide few examples of these studies. Segura and Suarez (2019), for instance, find through their empirical analysis that the financial strength of the healthier bank reduces the incentives of the intervened (i.e. through merger) bank relative to the stand-alone distressed bank based on their observations of their undertakings of new lending. Li (2013) investigates the effect of intervention in the form of equity injections under the Troubled Asset Relief Program (TARP) in the USA and finds that they increase loan supply. Conversely, Duchin and Sosyura (2014), who look at mortgage loan applications, find that after receiving TARP funds banks originat riskier loans, but there seems to be no effect on the amount of their lending. Giannetti and Simonov (2013) provide insight into both issues by analysing government interventions into Japanese banks. They find that properly recapitalised bank increase lending to creditworthy borrowers, whereas those that received small recapitalisation, such that they were still in breach of regulatory capital requirements after being recapitalised, only extend more loans to zombie firms. Similarly, Homar (2016) find that European banks that received a sufficiently large recapitalisation increase their lending, attract more deposits and clean up their balance sheets. In contrast, they also found that banks that received a small recapitalisation relative to their capital shortfall they reduced lending and shrank assets. Finally, recently, Beck et al. (2018) document that though the bail-ins lead to the reduced credit supply after the shock, however the affected firms quickly establish new bank relationships, and thus in total, they did not suffer any credit contraction, as compared to other firms.

Moreover, Berger et al. (2010) find that government intervention leads to decline in liquidity creation in the long term. They also find that government intervention in the form of capital injection improves the capital position of the intervened banks. Klingebiel (2000) finds that AMCs (i.e. 'bad bank' approach) are ineffective in fixing the failing banks due to lack of expertise, regulatory frameworks relating to the targeted institutions as well as the risk associated with the political involvements in the restructuring processes.

Veronsi and Zingales (2010) explain why a government intervention can have negative effects on banks. First, the government can impose restrictions on banks decision (for example, on executive compensations or lending requirements) that reduce banks' profits. Second, the

government can introduce political criteria into the lending decisions, reducing bank's profitability (Sapienza, 2004). Finally, the government intervention can delay or block the natural transfers of assets to the more efficient managers, reducing the overall profitability of the banking industry. The first and second effects are more likely to be present in banks where government ownership becomes larger, while the third one is likely to manifest itself in the price of the better run banks, which will be prevented to take advantage of the acquisition opportunities. Hoshi and Kashyap (2010) claim that strong transparency and disclosure mechanisms, effective supervisory authorities, and limited government interference in the debt restructuring processes are all necessary factors to deliver an effective outcome of any government intervention in the banking sector. I take account of these factors in my empirical analysis.

As part of the conditions behind the government interventions, banks are often asked to increase their domestic lending. For instance, French banks which received government support during the last financial crisis of 2007-2008 pledged to increase lending domestically by three to four per cent, and the Dutch bank ING announced that it would lend 25 billion euros to Dutch businesses and households as the outcome of the received government assistance (World Bank, 2009). Similarly, the U.S. TARP specifically stated that one of its objectives was to increase domestic lending. This leads to the 'home bias' as exhibited by many scholars in the related literature (e.g. Cerutti and Claessens 2014, Cerutti et al. 2014, De Haas and Van Horen 2012, Giannetti and Laeven 2012, Presbetero et al. 2014, Forbes et al. 2016). These scholars argue that such 'home bias' would be exacerbated if the bank received a large government intervention, because of the natural preference of a regulator or government towards domestic lending. Furthermore, this effect would be even more pronounced in a crisis, especially when there is a credit crunch as banks face competing demands from regulators and funding constraints (Cerutti and Claessens 2014).

Secondly, my research also broadly contributes to the literature on systemic risk in the banking sector. Specifically, my contribution comes from the analysis of government interventions on both intervened and non-intervened banks which could provide some value added on the potential sector-wide contagion impact of government interventions among the banks in the economy. The importance of financial stability and systemic risk concepts was highlighted by the financial crisis of 2007-2008. Thus, from an academic perspective, the source of systemic risk has become an important topic. On one hand, a large number of researchers has

concentrated on identifying sources of systemic risk (e.g. Brunnermeier, 2009; Georg 2013; Hellwig, 2009; Breckenfelder and Schwaab, 2017; Kirschenmann et al., 2017). On the other hand, the recent regulatory frameworks from many countries and regions are on the look for mechanisms which could allow them to mitigate the systemic risk in the most effective way.

The academic literature on bank interventions has been mostly focused on assessing the intervention mechanisms from a bank or country perspective rather than from a multi-country, systemic context. I am partially contributing to this literature gap by bringing a cross-country and cross-bank assessment of government interventions, but I do not model it in the systemic risk context. Even recent studies, which assess the recent changes in the resolution frameworks, such as bail-ins mechanisms, mostly consider the individual context in the given country for a group of banks. There are only a few papers which test the effect of bank interventions on a multi-country and the systemic risk context. Beck et al. (2019), for instance, analyse how cross-country differences in intervention frameworks affect the systemic risk in case of financial crisis. The authors have created the country resolution index based on the FSA proposals and test which of intervention framework becomes the most effective in case of systemic or bank-specific shock. Hueser et al. (2019) analyse how bail-in may trigger the contagion effect to other banks in the network using the agent-based model. They do not find significant results claiming that this is due to limited cross-holding of securities in the banking network.

3.3. Empirical analysis

I begin this section with the description of the data I use in my empirical analyses. This includes the data's sources, bank selection method, descriptive statistics by country as well as some key bank characteristics. This is then followed by the outline of the methodology. Finally, I present the results and end this section with the robustness checks.

3.3.1. Data and descriptive statistics

I focus my analysis on a cross-section of banks from countries that experienced systemic banking crisis between 1990 and 2017. I rely on Laeven and Valencia's (2013, 2018) mapping of the systemic banking crises episodes as well as on their country-level categorisation of government interventions. Authors of this database identified 151 systemic banking crises episodes from around the world during 1970-2017. They covered both developed and

developing countries. Their database includes information on crisis dates, country-level policy responses to resolving banking crises, as well as fiscal and output costs of crises. However, all of this information is collected and provided at country level which leads to a major drawback for any potential bank-level research. This is where one of my contributions comes in. I merge this country-level data with an extended version of the bank-level database of Hryckiewicz (2014) which consists of the actual bank names which were intervened by their governments. I select three interventions for my analysis, namely nationalisation, government-assist merger and 'bad bank' approach. I also look into recapitalisation which often occurs through these interventions.

My bank-level data is sourced from S&P Global Market Intelligence and Bureau van Dijk/BankFocus databases. They contain bank financials required for my analysis. I restrict the lower end of the time series at 1992 due to limited coverage of bank financials prior to that year available in those databases for my sample. I source country-level data from multiple and well-known public sources as listed in Table 13.

Table 13: Variables – definitions, sources and regression usage.

Type	Variable	Definition	Proxy	Source
Bank-level variable	Loans/Total Assets	The ratio of net loans to Total Assets indicates how much of the total assets of the company are tied up in loans. It is used as proxy for measuring liquidity. The higher the ratio, the more illiquid the bank is.	bank's liquidity	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Loan growth	Year-on-year loan growth expressed as a percentage.	bank's activity level	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Loan Loss Reserves / NPLs	Total value of reserves on risk loans over non-performing loans (%). A loan loss reserves are the expenses set aside as an allowance for uncollected loans and loan payments. This provision is used to cover a number of factors associated with potential loan losses.	bank's risk level	S&P Global Market Intelligence, BankFocus/ BankScope

Type	Variable	Definition	Proxy	Source
Bank-level variable	ROAE	Return on average equity is a measure of the return on shareholder funds (%). It refers to the performance of a company over a financial year. This ratio is an adjusted version of the return of equity that measures the profitability of a company.	bank's profitability	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Liquid Assets / Total Deposits & Borrowings	The ratio of the value of liquid assets (easily converted to cash) to total deposits and borrowings. Liquid assets include cash and due from banks, trading securities and at fair value through income, loans and advances to banks, reverse repos and cash collaterals. Deposits and borrowings include total customer deposits (current, savings and term) and short term borrowing (money market instruments, CDs and other deposits).	bank's liquidity	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Total Assets	Total assets (in mln USD) expressed in logarithmic form. TA is defined as the assets owned by the entity that has economic value whose benefits can be derived in the future.	bank's market power, diversification, bank's size	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Total capital ratio	The ratio measures the amount of a bank's capital in relation to the amount of risk it is taking. It is a measure of a bank's capital. It is expressed as a percentage of a bank's risk-weighted credit exposures. The enforcement of regulated levels of this ratio is intended to protect depositors and promote financial stability.	bank's capital	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Total equity / total assets	The ratio measures the amount of protection afforded by the bank by the equity they invested in.	bank's capital	S&P Global Market Intelligence, BankFocus/ BankScope

Type	Variable	Definition	Proxy	Source
Bank-level variable	Loan Loss Reserves / Gross Loans	Total value of reserves on risk loans over total loans (%). It indicates the ability of a bank to absorb losses from non-performing loans. It helps to determine the quality of loans.	bank's risk level	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	Net Interest Margin	The difference between the interest income generated by banks and the amount of interest paid out to their lenders, relative to the amount of their assets (%)	bank's profitability	S&P Global Market Intelligence, BankFocus/ BankScope
Bank-level variable	General intervention dummy	Dummy equals to 1 if a bank has received any of the following government interventions: nationalisation, merger, 'bad' bank. Dummy equals to 0 for all the other banks.	government intervention	National central banks
Bank-level variable	Nationalisation dummy	Dummy equals to 1 if a bank was subject to a public financial support in exchange for ownership. Dummy equals to 0 for all the other banks.	government intervention	National central banks
Bank-level variable	Government-assisted merger dummy	Dummy equals to 1 if a bank has been taken over by another bank with help of a government. Dummy equals to 0 for all the other banks.	government intervention	National central banks
Bank-level variable	'Bad' bank dummy	Dummy equals to 1 if a bank was subject to a restructuring process in the form of a separate entity to transfer to its toxic assets. Dummy equals to 0 for all the other banks.	government intervention	National central banks
Industry-level variable	Concentration ratio	The assets of three largest banks as a share of assets of all banks in the economy (%)	market competition	World Bank Financial Structure Database (July 2018)
Industry-level variable	Bank deposits to GDP	Demand, time and saving deposits in deposit money banks as a share of GDP (%)	size of the banking sector	World Bank Financial Structure Database (July 2018)
Country-level variable	GDP growth rate	Annual percentage growth of rate of GDP at market prices based on constant local currency (annual)	-	World Bank Development Indicators (2019)

Type	Variable	Definition	Proxy	Source
Country-level variable	Inflation	Annual percentage change in consumer price index (annual), in logarithms	-	IMF (2019)
Country-level variable	Current account balance	The sum of net exports of goods and services, net primary income, and net secondary income expressed as a ratio of GDP (%)	-	IMF (2019)
Country-level variable	Currency crisis	Dummy =1 indicating the currency crisis occurring in the same year as systemic banking crisis	-	Laeven and Valencia (2018)
Country-level variable	Business extent of disclosure index	Disclosure index measures the extent to which investors are protected through disclosure of ownership and financial information. The index ranges from 0 to 10, with higher values indicating more disclosure.	-	World Bank, Doing Business project (2019)
Country-level variable	Legal origin	Classification of legal origin following La Porta et al. (1999): French, German, Scandinavian, British, Socialist	-	La Porta et al. (1999)
Country-level variable	Developing country	Dummy = 1 indicating if a country is a developing country	-	World Bank (2019)

Source: Author (2019).

My initial sample consisted of 215 intervened banks and 5,064 non-intervened banks from 39 countries. I carried out the process of peer selection on the non-intervened banks which followed a similar approach to that employed in Hryckiewicz (2014). This is done in order to balance the characteristics of the intervened banks and non-intervened banks using the technique of matching. Its logic mirrors the well-known approach of propensity score matching. The general idea behind this is to combine banks which received government interventions in one period with nearly identical banks which did not receive such support from the government. This is done in order to compare the changes in the bank performance's parameters between these two groups of banks over time in the later regression analysis.

Table 14 includes the country detail behind each stage of the peer selection process. I began with the selection based on the overlap of the lending activities, i.e. loan-to-total asset ratio of the non-intervened banks falling within the range of loan-to-total asset ratio of the intervened

banks as at the intervention year. This stage of selection delivered 703 peer banks. Next, I applied the same approach but this time based on the total assets figures which resulted in the selection of 880 peer banks. Following the approach of other micro banking studies, I then applied a number of screens to exclude implausible and unreliable observations. This involved a clean-up process of the selected as well as non-selected peer banks to ensure the final selection is well matched with the intervened bank characteristics. For instance, I looked only for the banks which are deposit takers which characterises the studied intervened banks. Deposit taking can only be undertaken by institutions licensed to do so, and that are appropriately regulated and supervised. I then excluded bank observations with (i) negative or missing values for total assets, (ii) negative total loans, (iii) loan-to-asset ratio larger than one, or (iv) capital-to-asset ratio larger than one. The outcome delivered 757 peer banks.

For the sake of my regression analysis, I reduced the time series for all of the selected banks to cover the first six years after and before the year in which the intervention occurred. This resulted in the final pull of 708 peer banks. This was motivated by the desire to focus the regressions on the assessment of the intervention impact on banks within a reliable and consistent time period across all studied countries which was necessary in order to apply difference-in-difference (DID) regression set-up which I explain in the next section of this chapter.

Table 15 summarises the country distribution of my final sample which consists of 215 intervened and 708 non-intervened banks. Majority of the sample belongs to developed countries, i.e. 79%. Most frequently found intervention in the developed countries is nationalisation, closely followed by a ‘bad bank’ approach. In developing countries, a ‘bad bank’ approach is most frequent. A government assisted merger is the most rare type of the studied intervention in both country groups. In a vast majority of the developing countries, the systemic banking crisis is accompanied by a currency crisis. This is quite uncommon in the developed economies. I control for currency crises in my regressions.

Table 14: Country level summaries behind each stage of the peer selection.

Country	No. of intervened banks	No. of non-intervened banks	1. Loans/ TA selection	No. of peers from Loans/TA select.	Ex-post Stage 1 Peer Sample	2. TA selection	No. of peers from TA select.		Stage 1+2 peers total	Ex-post Stage 1+2 Peer Sample	3. Clean-up step			Ex-post Stage 3 Peer Sample
							Total	*of which: new*			Kept	Replace/ delete	[pull]	
Argentina	4	13	Y	0	0	Y	5	5	5	5	2	3	14	13
Austria	4	27	Y	17	17	Y	22	5	22	22	19	3	3	19
Belgium	3	11	Y	2	2	Y	1	0	2	2	2	n/a	11	11
Bulgaria	2	9	N	n/a	0	Y	1	1	1	1	1	n/a	9	9
Colombia	6	14	Y	2	2	Y	2	2	4	4	2	2	14	14
Croatia	6	19	Y	0	0	Y	2	2	2	2	0	2	21	19
Czech Rep.	1	12	N	n/a	12	N	n/a	0	n/a	12	n/a	n/a	12	12
Denmark	3	40	Y	24	24	Y	9	2	26	26	17	9	9	17
Ecuador	3	3	Y	n/a	3	Y	n/a	n/a	n/a	3	n/a	n/a	3	3
Estonia	2	4	N	n/a	4	Y	0	0	n/a	4	n/a	n/a	4	4
Finland	1	1	N	n/a	1	N	n/a	n/a	n/a	1	n/a	n/a	1	1
France	5	101	Y	27	27	Y	78	51	78	78	60	18	18	60
Germany	9	87	Y	31	30	Y	75	44	75	74	39	36	36	39
Greece	4	5	Y	0	5	Y	0	0	0	5	n/a	n/a	5	5
Iceland	2	2	Y	0	2	Y	n/a	n/a	n/a	2	n/a	n/a	2	2
Indonesia	10	22	Y	0	0	Y	4	4	4	4	0	4	26	22
Ireland	4	15	Y	2	2	Y	7	7	9	9	5	4	4	5
Jamaica	3	5	Y	2	2	Y	4	2	4	4	3	1	3	5
Japan	11	18	Y	0	18	Y	0	0	0	18	n/a	n/a	18	18
Lithuania	3	6	Y	0	0	Y	1	1	1	1	1	0	5	6
Malaysia	5	28	Y	0	0	Y	13	13	13	13	1	12	39	28
Mexico	4	19	Y	0	0	Y	2	2	2	2	1	1	19	19
Netherlands	4	16	Y	3	3	Y	10	7	10	10	9	1	1	9
Nicaragua	1	2	N	n/a	2	N	n/a	n/a	n/a	2	n/a	n/a	2	2
Norway	5	13	N	n/a	13	N	n/a	n/a	n/a	13	n/a	n/a	13	13
Russia	2	4	N	n/a	4	Y	0	0	n/a	4	n/a	n/a	4	4
Slovenia	5	1	Y	n/a	1	Y	n/a	n/a	n/a	1	n/a	n/a	1	1
South Korea	6	16	Y	0	0	Y	11	11	11	11	7	4	4	7
Spain	12	51	Y	35	35	Y	39	6	41	41	14	27	27	14
Sweden	2	9	N	n/a	9	N	n/a	n/a	n/a	9	n/a	n/a	10	10
Switzerland	2	36	Y	2	2	N	n/a	n/a	n/a	2	1	1	36	36
Thailand	5	4	Y	0	0	Y	2	2	2	2	2	0	2	4
Turkey	8	23	Y	0	0	Y	6	6	6	6	6	0	18	24
Ukraine	2	2	Y	n/a	2	Y	n/a	n/a	n/a	2	n/a	n/a	2	2
UK	11	50	Y	24	24	Y	26	3	27	27	22	5	5	22
Uruguay	2	6	N	n/a	6	Y	0	0	n/a	6	n/a	n/a	6	6
USA	6	4360	Y	446	446	Y	1	1	447	447	267	180	180	267
Venezuela	2	5	N	n/a	5	Y	1	1	n/a	5	1	0	4	5
Total	170	5,064		617	703			177	792	880	482	313	588	757

Source: Author' calculations (2019).

Table 15: Descriptive statistics at the country level.

Country	Year of the systemic crisis	Currency crisis (Yes =1, No = 0)	Total no. of non-intervened banks	Total no. of intervened banks[14] under studied cases	No. of nation. cases [1]	No. of assisted merger cases [2]	No. of the 'Bad bank' cases [3]	No. of recapital. banks [in any 1-3]
Developed countries								
Austria	2008	0	19	8	2	0	2	6
Belgium	2008	0	11	4	3	1	0	1
Bulgaria	1996	1	11	2	2	0	2	0
Croatia	1998	0	15	6	4	4	4	0
Czech Rep.	1996	0	14	1	0	1	0	0
Denmark	2008	0	17	6	2	6	2	0
Estonia	1992	1	4	4	0	4	4	0
Finland	1991	0	1	1	1	0	1	0
France	2008	0	60	6	5	0	0	2
Germany	2008	0	40	14	3	0	5	10
Greece	2008	0	5	4	0	0	0	12
Iceland	2008	1	2	2	2	0	1	0
Ireland	2008	0	5	4	4	0	2	3
Japan	1997	0	6	11	2	8	9	0
Lithuania	1995	0	6	4	2	1	2	2
Netherlands	2008	0	9	4	4	0	0	1
Norway	1991	0	10	5	2	0	4	0
Slovenia	2008	0	1	5	0	0	3	9
Spain	2008	0	14	12	3	10	8	20
Sweden	1991	1	6	2	1	2	2	0
Switzerland	2008	0	36	2	2	0	0	0
UK	2007	0	22	14	9	3	3	4
USA	2007	0	267	6	6	0	4	0
Sub-total	-	4	581	152	59	40	58	70
Developing countries								
Argentina	2002	1	12	4	2	1	3	0
Colombia	1998	0	14	6	2	5	2	0
Ecuador	1998	1	3	3	0	0	3	0
Indonesia	1997	1	17	10	10	1	8	0
Jamaica	1996	1	5	3	3	3	1	0
Malaysia	1997	1	24	5	1	4	2	0
Mexico	1994	1	16	4	1	3	2	0
Nicaragua	2000	0	2	1	0	0	1	0
Russia	1998	1	1	2	0	1	1	0
South Korea	1997	1	7	6	2	4	2	0
Thailand	1997	1	3	5	4	1	4	0
Turkey	2000	1	17	8	1	6	5	0
Ukraine	1998	1	2	2	0	0	2	0
Uruguay	2002	1	1	2	2	0	1	0
Venezuela	1994	1	3	2	2	0	2	0
Sub-total	-	13	127	63	30	29	39	0
Total	-	17	708	215	89	69	97	70

Note: Data on systemic banking crises in individual countries and implemented intervention policies on a country-level comes from Laeven and Valencia (2018); data on intervened banks in individual countries and their type of government intervention comes from the extended database of Hryckiewicz (2014). It is constructed based on the information from the central banks' reports and surveys conducted among the central banks.
Source: Author' calculations (2019).

In developed countries, nationalisation is most often accompanied by 'bad bank' approach. Similarly, mergers are most frequently associated with a 'bad bank' approach. In developing

[14] The number refers to a single count of bank names that received government intervention(s).

countries, both nationalisation and merger occur frequently with a 'bad bank' approach. I control for the cases of multiple interventions in a single bank in my analysis. Due to data limitation, I am not able to identify under which of the three interventions bank recapitalisation occurred. I argue that this is a common approach under each of the three interventions.

I select a wide range of bank-, industry- and country-variables to assess the impact of government interventions on banks in my sample. Table 13 lists these variables used in my empirical analysis together with their definitions and sources. I explore four dependent variables to assess the impact of the interventions on banks' performance in terms of their future lending, asset quality/NPLs and capital positions. Namely, I use loan ratio and loan growth as proxies for bank lending. Loan ratio can also reflect liquidity risk since loans are less liquid and riskier but have a higher expected returns than other assets in banks portfolio. Next, I proxy bank's risk position with the ratio of loan loss reserves-to-NPLs. Lastly, I proxy bank's capital position with total capital ratio and I test alternatives, e.g. total equity to total assets ratio, under the robustness checks in section 3.3.4.

Bank lending is expected to increase prior to government intervention. Keeton (1999) shows that faster loan growth leads to higher loan losses. When banks increase their supply of loans, they reduce their interest rates charged on loans and lower their credit standard as documented by Keeton (1999). Such reduction in credit standards increases the chances of loan defaults by borrowers. The effect of interventions on bank's capital can be ambiguous. On one hand, managers in the bank with low capital bases have a moral hazard incentive to engage in risky lending practices along with poor credit scoring and monitoring borrowers (Keeton and Morris, 1987). On the other hand, however, managers in banks that are highly capitalised may resort to a liberal credit policy under the notion 'too big to fail' (Rajan, 1994). The ratio of loan loss reserves-to-NPLs reflects credit quality of banks and the overall attitude of the bank to risk control (Ghosh, 2015). The theoretical underpinning of this is the 'moral hazard' hypothesis. Keeton and Moris (1987), for instance, argue that banks with poor credit quality have moral hazard incentives by increasing the riskiness of their loan portfolio which in turn results in higher NPLs.

I capture a range of bank-level explanatory variables in my regression specifications. Specifically, I look into bank's profitability (ROAE), liquidity (ratio of liquid assets to total deposits and borrowings), bank's size (total asset ratio). Table 16 shows the descriptive

statistics for the bank-level variables used in my analysis. The statistics are subdivided for non-intervened and intervened banks as well as for the period before and after the government interventions. By splitting the data along these two dimensions, I can report the difference between intervened and non-intervened banks (column 3) and the difference between the period before and after the intervention (row 3). The bottom right part of the table (column 3, row 3) shows the DID results, which indicates how intervened banks differ from non-intervened banks after the government intervention *relative* to their difference prior to the intervention. Because selection of the banks for the intervention is an endogenous choice made by the government, it is important to control for inherent differences between intervened and non-intervened banks.

For instance, Column 3 in Table 16 shows that the intervened banks were more capitalised than the non-intervened banks on average prior to the intervention. Interestingly, the intervened banks had a higher loan growth than non-intervened banks prior to the intervention, but slow downed their loan growth after the intervention. This does not necessarily imply that the government interventions were harmful. Without government interventions, these banks may have had even slower loan growth in the later period due to ongoing losses on their balance sheets caused by their unresolved NPL legacies from the crisis era.

Table 16: Descriptive statistics of the main bank characteristics.

	Non-intervened banks (1)		Intervened banks (2)		Intervened – non-intervened banks (3)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
(1) Before government intervention (six years prior to the intervention)						
Reserves	210.189	200.005	72.250	89.848	-137.939***	7.257
Total capital	17.327	16.661	11.344	6.156	-5.983***	0.497
Loan ratio	57.847	14.971	59.478	16.677	1.631**	0.936
Loan growth	1.737	15.161	1.690	11.827	-0.047*	0.779
ROAE	10.047	23.838	8.334	80.813	-1.714*	3.675
TA (ln)	7.4135	2.377	10.0318	2.634	2.618***	0.121
Liquidity	37.520	23.119	35.069	24.046	-2.450**	1.285
(2) After government intervention (six years post the intervention)						
Reserves	95.852	111.541	75.158	63.099	-20.694***	3.079
Total capital	16.618	10.286	11.313	18.976	-5.305***	0.808
Loan ratio	59.819	15.858	55.222	18.161	-4.597***	0.796

	Non-intervened banks (1)		Intervened banks (2)		Intervened – non-intervened banks (3)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
Loan growth	0.820	11.927	33.306	563.672	32.485**	23.842
ROAE	5.721	39.464	-2.374	114.354	-8.095**	3.872
TA (ln)	8.106	2.442	10.175	2.780	2.068***	0.099
Liquidity	35.965	24.635	33.440	27.461	-2.524**	1.070
(3) After – before						
Reserves	-114.3***	5.435	2.909***	5.710	117.246***	4.790
Total capital	-0.709***	0.405	-0.031***	0.858	0.678***	0.375
Loan ratio	1.972***	0.442	-4.257***	1.146	-6.229***	0.415
Loan growth	-0.917***	0.423	31.616***	23.850	32.533***	3.787
ROAE	-4.327***	0.818	-10.708***	5.275	-6.381***	1.191
TA (ln)	0.693***	0.062	0.143***	0.143	-0.550***	0.061
Liquidity	-1.556***	0.666	-1.629***	1.534	-0.074***	0.612
No. of banks	708		215			
No. of observations	7,429		2,397			

Notes: this table shows the mean and standard deviation of bank characteristics used in my analysis. Each statistic is differentiated by the period before and after the government intervention and whether the bank was intervened by the government. Differences are then calculated across both dimensions. Differences-in-differences are shown in the bottom right corner.

* Standard deviations are shown in the respective column, with significance at 10%

** Standard deviations are shown in the respective column, with significance at 5%

*** Standard deviations are shown in the respective column, with significance at 1%.

Source: Author's calculations (2019).

I include industry- and country- level controls in my regression specifications, e.g. banking industry concentration ratio, proxies for country's macroeconomic conditions, corporate governance proxies such as the business extent of disclosure index and country legal origin classification from La Porta et al. (1999). The definitions and sources are listed in Table 13 and their summary statistics are presented below in Table 17.

Table 17: Summary statistics for the industry- and country-level variables.

Variable name	n	Mean	Median	Minimum	Maximum	Standard deviation
Concentration ratio	4,911	56.043	56.588	24.740	100	18.752
GDP growth rate	5,180	1.727	1.842	-13.126	25.117	3.338
Inflation (ln)	4,395	.750	.670	-4.791	6.964	1.072
Currency crisis (Yes=1; Otherwise=0)	5,182	.185	0	0	1	.388

Variable name	n	Mean	Median	Minimum	Maximum	Standard deviation
Developing country (Yes=1; Otherwise=0)	5,182	.1777	0	0	1	.382
Financial crisis '08 (Yes=1; Otherwise=0)	5,182	.214	0	0	1	.410
US (Yes=1; otherwise=0)	5,182	.316	0	0	1	.465
Business extent of disclosure index	3,403	6.963	7.4	1	10	1.668
Credit boom index (Yes=1, Otherwise=0)	5,182	.187	0	0	1	.391

Notes: This table shows the summary statistics for the industry- and country-level variables used in the empirical analysis on the impact of government interventions on banks performance. All variable definitions and data sources are provided in Table 13.
Source: Author's calculation (2019).

3.3.2. Methodology

I use three related approaches to analyse the effect of government intervention on bank performance. In my first approach, I use a basic DID analysis to examine the change in the average bank behaviour parameters for the intervened banks compared to the non-intervened banks. My second approach uses the bank-level data to empirically assess if the government interventions affect bank behaviour controlling for other factors via fixed effects regression specifications with DID estimators. This conventional difference-difference regression technique is based on some strong assumptions which are tested separately under my third complementary approach based on semiparametric difference-difference (SDID) estimator.

Specifically, I carry out a panel data regression analysis on the characteristics of bank's behaviour to control more closely for other factors which can influence the effectiveness of government interventions in my sample. The main hypothesis I want to test is whether the bank's behaviour by the intervened banks changed after the intervention while controlling for other bank-, industry- and country-level characteristics (i.e. H1). This is the hypothesis that the government intervention will affect a bank's incentives and, thus, their behaviour (i.e. lending, reserves and capital). To test this, I estimate the following fixed effects DID equation:

$$Bank\ behaviour_{i,t} = \beta_0 + \beta_1 bank\ controls_{i,t} + \beta_2 industry\ controls_{i,t} + \beta_3 country\ controls_{i,t} + \beta_4 (T_g\ x\ P_t) + \alpha \mathrm{bank_i} + \alpha \mathrm{time}_t + \varepsilon_{i,t} \quad \text{(Eq. 1)}$$

where $Bank\ behaviour$ is the outcome of interest (i.e. loan loss reserves to NPLs ratio, total capital, loan ratio, loan growth), i indicates a bank and t indicates time. g refers to the grouping of banks into two groups - treatment (intervened), control (non-intervened) - observed in two time periods before and after the intervention, ($t = 1, 2$). The treatment ('intervention') variable is the product of these two dummy variables, $D_{gt} = T_g \ x \ P_t$, and it is it the crucial aspect of my analysis. The control variables include other bank characteristics that are related to a particular measure of bank behaviour as well as industry- and country- controls.

Under the second approach, I test multiple forms of fixed effects in my regression specifications and decide to include time dummies (αtime_t) to control for any aggregate effects of the banking crises in each year since the intervention. I also explored the impact of adding bank fixed effects which I include in order to control for any bank heterogeneity that is constant over time and which may be correlated with the given measure of bank behaviour. The inclusion of the bank fixed effects ($\alpha \text{bank}_\text{i}$) and time fixed effects (αtime_t) produces a DID estimates of the effect of the government intervention on the bank behaviour, controlling for the pre-existing differences across banks in my sample. The coefficient β_4 measures how much the given bank behaviour by the intervened bank changes relative to non-intervened banks after the intervention. I explore it in depth below.

I also want to investigate whether certain government interventions are more effective than others and this constitutes my second hypothesis (i.e. H2). I look into the effects of the studied interventions on bank's performance by assessing the effectiveness of the interventions in regards to bank's lending, capital, reserves to NPL ratios and loan growth. I apply the same approach as under the baseline specification with the general intervention (eq. 1). Namely, I include specific intervention dummies in my regressions in the same way I included the general intervention dummy in my main regression.

Lastly, under my third complementary approach, I test the strong assumption on which my DID regressions are based under the second approach. Namely, as explained by Abadie (2005), the conventional DID estimator I used under my second approach is based on the assumption that in the absence of the treatment (i.e. government intervention), the average outcomes for treated banks and controls (i.e. non-treated banks) would have followed similar paths over time. This is a very strong assumption which needs to be tested separately as it is likely to be implausible, i.e. the pre-intervention bank characteristics that are thought to be associated with

the dynamics of the chosen bank performance variables are likely to be unbalanced between intervened and non-intervened banks. The bank selection into treatment can also depend on covariates which determine also the treatment (i.e. intervention) outcome. In these circumstances, conditional exogeneity is not plausible.

In order to test this issue, I follow the approach advocated by Abadie (2005) in which he used a two-step strategy to estimate the average effect of the treatment (ATE) (i.e. government intervention) for the treated (i.e. intervened banks). This approach originated from the identification procedure introduced by Heckman et al. (1997). The estimator proceeds in three steps. First, it computes the change of outcome variables in question over time for bank. Next, the model estimates the probability of each bank being treated (i.e. intervened). To do this, the approach applies weights to each observation. Last, the model compares weighted change over time across treated (i.e. intervened) and non-treated (i.e. non-intervened) banks.

More formally, the applied version of the model by Abadie (2005) aims to estimate the casual effect of the government intervention on the given dependent variables of bank performance (y) at some time t. Each bank in the sample has two potential outcomes: (y_{1t}, y_{0t}). y_{1t} is the value of y if the bank receives the government intervention by time t. y_{0t} is the value of y had the bank not received the government support at time t. d_t is equal to 1 when a bank is intervened by time t and 0 otherwise. At baseline b no bank is treated (i.e. intervened). Lastly, $x_b$is a vector of covariates measured at baseline. The average treatment effect on the treated (ATET) (i.e. intervened) banks is as follows:

$$ATET \equiv \mathbb{E}\,(y_{1_t} - y_{0t} |\, d_t = 1) \qquad \text{Eq. (2)}$$

The key assumptions behind this equations are as follows:

$$\mathbb{E}\,(y_{0_t} - y_{0b} |\, d_t = 1, x_b) = \mathbb{E}\,(y_{0_t} - y_{0b} |\, d_t = 0, x_b) \qquad \text{Eq. (3)}$$

$$\mathrm{P}\,(d_t = 1) > 0 \; and \; \pi\,(x_b) < 1 \qquad \text{Eq. (4)}$$

The semiparametric DID estimator is the sample analogue of:

$$\mathbb{E}\left(\frac{y_t - y_b}{\mathrm{P}\,(d_t = 1)} \times \frac{d - \pi\,(x_b)}{1 - \pi\,(x_b)}\right) \qquad \text{Eq. (5)}$$

Abadie (2005) suggests to approximate the propensity score and $\pi\,(x_b)$ semiparametrically using a polynomial series of the predictors. Thereafter, the predicted values are plugged into the sample analogue of (eq. 5). As he explained, even though the approximation improves for

higher polynomial order, the estimation becomes less precise. The approximation of $\pi\ (x_b)$ produced by the linear probability can be written as follows:

$$\hat{\pi}\ (x_b)\ =\ \widehat{\gamma_0}\ +\ \widehat{\gamma_1}\ x\ x_1 + \sum_{i\ =\ 1}^{k} \widehat{\gamma_{2i}}\ x\ x_2^i \qquad \text{Eq. (6)}$$

Unfortunately, the method by Abadie (2005) does not allow to use sampling weights which are critical in my regression analysis as I explain next. This reduces the comparability and validity of the findings from my third approach which was intended to serve as an extension to the results based on the conventional DID which followed my second, and core, approach. Still, this continues to be the most reliable empirical approach I could use to tackle the strong DID assumption.

Sampling weights and other methods

Although my bank-level data covers almost 40 countries, the U.S. banks dominate my sample. This gives the US-based banks a total share of 29% of all banks in my sample. Thus, to ensure I draw an unbiased and representative conclusions, I reduce the contribution of the US banks to 5.5% by assigning a weight to each observation in all of my regression specifications under the second approach with the conventional DID estimator. Unfortunately, Abadie (2005)'s model I incorporate under the third approach does not allow weights.

Following Hryckiewicz and Kozlowski's (2018) approach, each weight equals the ratio of the natural logarithm of the total number of banks in a given country divided by the sum of natural logarithms of all banks in each country. I test various weights during the robustness checks. The full country details of the applied weights are listed in Table 18.

I also use robust standard errors in my regressions and cluster them at bank level in order to obtain unbiased standard errors free from the risk of heteroscedasticity. Fixed effects are selected in favour of random effects under my second approach. This is based on tests of overidentification. The test is implemented with the use of the artificial regression approach described by Arellano (1993) and Wooldridge (2002). I could not use the well-known Hausman test due to the necessity to apply robust clustered standard errors in our regression specifications. Specifically, I run all regressions with the conventional DID estimator with 'vce (robust)' option to deal with suspected heteroskedasticity and within panel autocorrelation in

the idiosyncratic error term. The choice of fixed effect model is also motivated by the desire to control for any potential omitted variable bias which could influence my results.

Table 18: The country breakdown of the weights applied in the all regression specifications with conventional DID estimator.

Country	No. of banks	Pre-weighted share	Logarithm conversion	Post-weighted share
Argentina	17	1.8%	2.83	2.8%
Austria	27	2.9%	3.30	3.2%
Belgium	15	1.6%	2.71	2.7%
Bulgaria	11	1.2%	2.40	2.4%
Colombia	19	2.0%	2.94	2.9%
Croatia	21	2.2%	3.04	3.0%
Czech Republic	13	1.4%	2.56	2.5%
Denmark	23	2.4%	3.14	3.1%
Ecuador	6	0.6%	1.79	1.8%
Estonia	7	0.7%	1.95	1.9%
Finland	2	0.2%	0.69	0.7%
France	66	7.0%	4.19	4.1%
Germany	54	5.8%	3.99	3.9%
Greece	17	1.8%	2.83	2.8%
Iceland	4	0.4%	1.39	1.4%
Indonesia	32	3.4%	3.47	3.4%
Ireland	12	1.3%	2.48	2.4%
Jamaica	8	0.9%	2.08	2.0%
Japan	17	1.8%	2.83	2.8%
Lithuania	10	1.1%	2.30	2.3%
Malaysia	30	3.2%	3.40	3.4%
Mexico	19	2.0%	2.94	2.9%
Netherlands	13	1.4%	2.56	2.5%
Nicaragua	3	0.3%	1.10	1.1%
Norway	15	1.6%	2.71	2.7%
Russia	6	0.6%	1.79	1.8%
Slovenia	10	1.1%	2.30	2.3%
South Korea	13	1.4%	2.56	2.5%
Spain	36	3.8%	3.58	3.5%
Sweden	8	0.9%	2.08	2.0%
Switzerland	38	4.0%	3.64	3.6%
Thailand	9	1.0%	2.20	2.2%
Turkey	32	3.4%	3.47	3.4%
Ukraine	4	0.4%	1.39	1.4%
United Kingdom	36	3.8%	3.58	3.5%
Uruguay	8	0.9%	2.08	2.0%
USA	273	29.1%	5.61	5.5%
Venezuela	5	0.5%	1.61	1.6%
Total	939	100.0%	101.53	100.0%

Source: Author's calculations (2019).

Lastly, in order to control for non-linear effects and to reduce the influence of outliers, one of the dependent variables, i.e. loan loss reserves-to-NPLs, is transformed to its logarithmic form and truncated at the 1st and 99th percentiles following Chirrozza and Milani (2010)'s approach. This is because of some extreme observations at both tails of variable distribution which need

to be addressed. Although this chapter is looking into the banks' performance during the periods of financial crises, and, thus, keeping those outliers could have been desirable, I follow the view that some of these outliers may be caused by one-off events, or some data errors. I do, however, look into the results with all observations under the loan loss reserves-to-NPLs ratio under the robustness checks and I find no difference in the results.

3.3.3. Results

Table 19 provides the average parameters for studied bank performance in the full sample after government interventions. I stratify banks into three NPL ratio categories here - high, medium, and low - in order to compare the changes in bank performance after government interventions among these groups. As shown in column 3 of Table 19, the average reserves decreased in high and medium banks after the intervention over that of non-intervened banks with similar levels of NPLs. In contrast, among low NPL banks, the average reserves for intervened banks sharply increased by 25.3 relative to non-intervened banks. In all cases, total capital of intervened banks declined after the intervention in comparison to the non-intervened banks. This is the first evidence that the government intervention may have a negative impact on banks' capital position. Similarly, in all cases, and particularly under the low NPLs sub-sample, government intervention slowed down the loan ratio of intervened banks in comparison to non-intervened banks. Oddly, the interventions are also appearing to increase loan growth of intervened banks in all cases except for banks with low NPL. This could be explained by intervened banks continuing their risky lending due to reduced market discipline. Igan et al. (2011), for instance, found that aggressive lenders in the banking sector between 2000 and 2007 received the largest government bailouts and continued to increase their risk levels in the post-crisis environment. These mixed results require closer analysis under my second approach which comes next.

Table 19: Average changes in the studied parameters of bank performance after government interventions (t1-t6).

	Non-intervened banks (1)		Intervened banks (2)		Intervened – non-intervened banks (3)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
After government intervention (t1-t6)						
Full sample:						
Reserves	95.852	111.541	75.15836	63.09868	-20.694***	3.079
Total capital	16.618	10.285	11.31296	18.97573	-5.305***	0.808
Loan ratio	59.819	15.858	55.22208	18.16133	-4.597***	0.796

	Non-intervened banks (1)		Intervened banks (2)		Intervened – non-intervened banks (3)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
Loan growth	0.820	11.92685	33.30551	563.6716	32.485**	23.842
Sub-samples: High NPL banks						
Reserves	66.702	53.928	54.906	31.851	-11.796***	2.121
Total capital	16.852	12.682	12.161	21.069	-4.691***	1.104
Loan ratio	63.968	18.060	57.126	16.933	-6.843***	0.879
Loan growth	1.148	14.201	38.789	608.147	37.641**	27.760
Medium NPL banks						
Reserves	127.069	142.427	116.896	91.273	-10.173*	7.386
Total capital	16.895	7.081	10.879	10.169	-6.016***	0.917
Loan ratio	55.516	11.774	45.402	19.780	-10.114***	2.531
Loan growth	0.589	9.046	4.587	18.877	3.998**	2.512
Low NPL banks						
Reserves	51.806	34.134	77.095	50.479	25.289***	5.749
Total capital	11.791	9.026	6.090	18.087	-5.701**	2.561
Loan ratio	56.678	12.266	40.514	23.860	-16.164**	5.096
Loan growth	-2.705	8.340	-11.921	21.941	-9.216**	4.837

Notes: this table shows changes in the bank behaviour by intervened and non-intervened banks. The amounts shown are the average change in given variable during the period following the government interventions (i.e. first six years after the intervention year). The banks are stratified into three sub-samples based on their NPL ratio as at the time of the intervention: high (NPL ratio ≥ 63.8), moderate (10 ≥ NPL ratio < 63.8) and low (NPL ratio < 10).

* Standard deviations are shown in the respective column, with significance at 10%

** Standard deviations are shown in the respective column, with significance at 5%

*** Standard deviations are shown in the respective column, with significance at 1%.

Source: Author's calculations (2019).

I now turn to my second, and core, approach by focusing on the regression results using a conventional DID estimator. Table 20 shows the full regression results for each of my four parameters of bank performance to test both of the hypotheses , i.e. for general intervention as well as specific intervention measurers. My key variable of interest is the coefficient of the interaction term (i.e. DID estimator) which shows the impact of government intervention on the bank performance in the post-intervention period. All of the regressions deliver satisfactory results in terms of statistical significance with the exception of loan growth models which are based on a poorer coverage of banks. I now can proceed to analysing these results of the interaction terms in detail which require additional calculations.

Table 20: Main regression results.

Model specification	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank
Reserves/ NPL (ln)	-	-	-	-	0.28	0.294	0.300	0.259	1.300**	1.284**	1.271**	1.303**	0.0227	0.0238	0.0363	0.0472
					-0.279	(0.278)	(0.279)	(0.284)	-0.601	(0.602)	(0.603)	(0.609)	-1.312	(1.326)	(1.331)	(1.342)
Loan ratio	0.0147**	0.0145**	0.0144**	0.0145**	-0.098***	-0.10***	-0.099***	-0.099***	-	-	-	-	0.90***	0.90***	0.90***	0.90***
	-0.0064	(0.00640)	(0.00642)	(0.00638)	-0.0289	(0.0293)	(0.0287)	(0.0294)					-0.116	(0.115)	(0.116)	(0.115)
Total capital ratio	0.00547	0.00573	0.00584	0.00497	-	-	-	-	-0.17***	-0.17***	-0.17***	-0.17***	0.500**	0.500**	0.498**	0.501**
	-0.00568	(0.00566)	(0.00569)	(0.00567)					-0.0627	(0.0638)	(0.0627)	(0.0640)	-0.219	(0.221)	(0.221)	(0.222)
ROAE	-0.0011***	-0.0011***	-0.0012***	-0.001***	-0.000721	-0.00088	-0.000278	-0.000489	0.0166**	0.0167**	0.0158**	0.0166**	0.019**	0.019**	0.020**	0.019**
	-0.000306	(0.000320)	(0.000353)	(0.000303)	-0.0033	(0.0034)	(0.00322)	(0.00351)	-0.00723	(0.0075)	(0.0069)	(0.0077)	-0.0095	(0.0094)	(0.0097)	(0.0095)
TA (ln)	-0.242**	-0.253**	-0.260**	-0.244**	-2.010***	-2.09***	-2.038***	-2.092***	0.598	0.745	0.610	0.724	-2.182	-2.151	-2.065	-2.201
	-0.109	(0.109)	(0.111)	(0.107)	-0.57	(0.581)	(0.585)	(0.572)	-1.713	(1.675)	(1.715)	(1.691)	-3.561	(3.486)	(3.540)	(3.419)
Liquidity	0.00477	0.00466	0.00453	0.00406	-0.00469	-0.00558	-0.00452	-0.00683	-0.42***	-0.42***	-0.42***	-0.42***	-0.0403	-0.0398	-0.0380	-0.0397
	-0.00459	(0.00454)	(0.00455)	(0.00449)	-0.0158	(0.0158)	(0.0155)	(0.0156)	-0.0477	(0.0478)	(0.0480)	(0.0482)	-0.0596	(0.0594)	(0.0598)	(0.0596)
Concentration ratio	0.0113*	0.0113*	0.0107*	0.0124**	0.0357	0.0354	0.0415	0.0379	0.0742	0.0754	0.0636	0.0737	-0.0943	-0.0940	-0.0814	-0.0962
	-0.00601	(0.00602)	(0.00619)	(0.00602)	-0.0369	(0.0369)	(0.0392)	(0.0370)	-0.0649	(0.0649)	(0.0586)	(0.0654)	-0.119	(0.120)	(0.121)	(0.120)
GDP growth	0.0400***	0.0422***	0.0426***	0.0377***	0.0394	0.0550	0.0548	0.0496	0.0947	0.0653	0.0740	0.0730	-0.03	-0.0370	-0.0337	-0.0227
	-0.00871	(0.00883)	(0.00895)	(0.00907)	-0.0485	(0.0493)	(0.0510)	(0.0524)	-0.101	(0.101)	(0.0987)	(0.0999)	-0.21	(0.201)	(0.187)	(0.187)
Inflation (ln)	-0.0439*	-0.0440**	-0.0438**	-0.0419*	-0.112	-0.112	-0.114	-0.109	0.175	0.178	0.180	0.175	-0.504	-0.502	-0.509	-0.507
	-0.0226	(0.0224)	(0.0223)	(0.0222)	-0.173	(0.173)	(0.172)	(0.173)	-0.195	(0.197)	(0.198)	(0.198)	-0.615	(0.615)	(0.618)	(0.615)
Disclosure index	0.0389	0.0407	0.0399	-0.00618	-0.231	-0.213	-0.217	-0.319	-1.049**	-1.057**	-1.071**	-1.013**	1.718	1.748	1.726	1.784
	-0.0511	(0.0529)	(0.0525)	(0.0497)	-0.354	(0.355)	(0.352)	(0.384)	-0.417	(0.427)	(0.425)	(0.453)	-1.117	(1.132)	(1.119)	(1.186)
Interaction term (1.treat# 1.post)	**0.0959****	**0.0103****	**-0.173***	**0.982*****	**0.781****	**0.213****	**1.795***	**2.091***	**-1.111****	**0.229****	**-3.255***	**-1.131***	**0.0963***	**0.663***	**3.509***	**-1.379***
	-0.107	**(0.110)**	**(0.277)**	**(0.161)**	**-0.611**	**(0.639)**	**(2.717)**	**(1.421)**	**-0.981**	**(1.051)**	**(7.201)**	**(1.639)**	**-2.715**	**(3.002)**	**(5.428)**	**(3.099)**
Constant	3.528**	3.591***	3.705***	3.896***	34.01***	34.46***	33.44***	35.32***	60.78***	60.03***	62.10***	59.76***	-22.15	-22.51	-24.36	-22.42
	-1.369	(1.371)	(1.413)	(1.372)	-6.087	(6.269)	(6.496)	(6.208)	-18.62	(18.27)	(18.48)	(18.55)	-36.74	(36.59)	(37.82)	(35.75)
Observations	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,550	1,550	1,550	1,550
R-squared	0.141	0.139	0.140	0.153	0.334	0.333	0.334	0.334	0.483	0.481	0.482	0.481	0.186	0.186	0.186	0.186
No. of banks	418	418	418	418	418	418	418	418	418	418	418	418	415	415	415	415
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Notes: this table shows the results of my fixed effect regression specifications on bank, industry and country characteristics. The dependent variables are i). loan loss reserves to NPLs ratio, ii). total capital, iii). loan ratio, and iv). loan growth. The respective columns illustrates the change in the 'treatment' variable via the interaction term which captures the impact on government intervention on bank's performance after the government intervention. Interventions include: nationalisation, government-assisted merger and 'bad' bank approach. All observations are weighted as follows: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. All regressions include bank and time fixed-effects. Year dummies are included in all specifications, but are not displayed. Robust standard errors at the bank level are reported in brackets and are follows:

* Robust standard errors are shown in brackets, with significance at 10%

** Robust standard errors are shown in brackets, with significance at 5%

*** Robust standard errors are shown in brackets, with significance at 1%.

Source: Author's calculations (2019).

Specifically, these interaction terms represent the treatment effect which is estimated by the coefficient of '1.treat#1.post' in each of the respective regression outputs in Table 20. In order to deliver the expected change in the expected values of each of my studied outcome variables in the post-intervention period in respect to this variable, I run the average marginal effects for each of these regressions. The summary is presented in Table 21 together with the coefficient of each of the interaction terms.

Bank's reserves as a share of NPLs increases in all post-intervention scenarios except the merger case where the average decrease of the ratio by 0.81 is found. All of the effects are significant and with relatively narrow confidence intervals. There is a very small difference between the positive increase in the ratio for the intervened and non-intervened banks under the nationalisation scenario. In contrast, the effect of intervention in the form of 'bad-bank' leads to much higher increase in reserves ratio for intervened banks (1.85) than it is the case for banks with no intervention (0.86). Similar observations can be noted in the sub-sample of banks with the high level of NPLs at the time of the intervention (Table 23 based on regressions displayed in Table 22).[15] The only substantial difference comes from the nationalisation case where there is no difference in the average effects between the intervened and non-intervened banks. Overall, however, nationalisation seems to be the only intervention which delivers positive results for all analysed banks in both full and sub-sample regressions.

Table 21: Average marginal effects for the intervention interaction terms used in the main regressions as presented in Table 20.

Depend. variable	Model specification	Coeff. of 1.POST treatment	Bank group	Delta method				95% Confidence interval		
				dy/dx	Std. Err.	z	P>|z|	lower	upper	width
Reserves/ NPLs	general	0.0959**	Control	0.91	0.27	3.37	0.00	0.4	1.4	1.1
			Treat	1.01	0.26	3.93	0.00	0.5	1.5	1.0
	nation.	0.0103**	Control	0.98	0.26	3.8	0.00	0.5	1.5	1.0
			Treat	0.99	0.26	3.74	0.00	0.5	1.5	1.0
	merger	-0.173*	Control	0.99	0.26	3.85	0.00	0.5	1.5	1.0
			Treat	0.81	0.38	2.15	0.03	0.1	1.6	1.5
	'bad bank'	0.982***	Control	0.86	0.31	2.82	0.01	0.3	1.5	1.2
			Treat	1.85	0.36	5.1	0.00	1.1	2.6	1.4
Total capital ratio	general	0.781**	Control	4.23	0.99	4.27	0.00	2.3	6.2	3.9
			Treat	5.01	1.04	4.83	0.00	3.0	7.0	4.1
	nation.	0.213**	Control	4.70	1.00	4.69	0.00	2.7	6.7	3.9
			Treat	4.91	1.10	4.45	0.00	2.7	7.1	4.3
	merger	1.795*	Control	4.73	0.98	4.83	0.00	2.8	6.6	3.8
			Treat	6.52	2.97	2.2	0.03	0.7	12.3	11.6

[15] I test the results on the sub-sample of banks with the high level of ex-ante NPLs (i.e. NPL ratio ≥ 63.8 as at the intervention year) which tend to characterise the banks which required government help. I could not deliver the sub-sample results for banks with the medium and low level of NPLs due to insufficient number of observations under the intervened banks to deliver significant and robust results.

Depend. variable	Model specification	Coeff. of 1.POST treatment	Bank group	Delta method				95% Confidence interval		
				dy/dx	Std. Err.	z	P>|z|	lower	upper	width
	'bad bank'	2.091*	Control	4.56	0.87	5.22	0.00	2.8	6.3	3.4
			Treat	6.65	1.79	3.72	0.00	3.1	10.2	7.0
Loan ratio	general	-1.111**	Control	8.40	2.83	2.97	0.00	2.8	14.0	11.1
			Treat	7.29	2.85	2.56	0.01	1.7	12.9	11.2
	nation.	0.229**	Control	7.56	2.84	2.66	0.01	2.0	13.1	11.1
			Treat	7.79	2.92	2.67	0.01	2.1	13.5	11.4
	merger	-3.255*	Control	7.73	2.85	2.71	0.01	2.1	13.3	11.2
			Treat	4.47	7.68	0.58	0.56	-10.6	19.5	30.1
	'bad bank'	-1.131*	Control	7.77	2.87	2.7	0.01	2.1	13.4	11.3
			Treat	6.64	3.16	2.1	0.04	0.4	12.8	12.4
Loan growth	general	0.0963*	Control	-21.34	6.18	-3.45	0.00	-33.5	-9.2	24.2
			Treat	-21.24	5.68	-3.74	0.00	-32.4	-10.1	22.3
	nation.	0.663*	Control	-21.53	6.05	-3.56	0.00	-33.4	-9.7	23.7
			Treat	-20.86	5.72	-3.65	0.00	-32.1	-9.7	22.4
	merger	3.509*	Control	-21.27	5.75	-3.7	0.00	-32.5	-10.0	22.6
			Treat	-17.76	7.59	-2.34	0.02	-32.6	-2.9	29.7
	'bad bank'	-1.379*	Control	-21.32	5.78	-3.69	0.00	-32.6	-10.0	22.7
			Treat	-22.70	7.45	-3.05	0.00	-37.3	-8.1	29.2

Notes: this table shows the average marginal effects for each of the interaction terms used in the regressions presented in Table 20. They show the expected change in expected values of each of the four outcome variables in the post intervention period for both intervened (treatment) and non-intervened (control) banks. They are derived from the main fixed effect regression specifications where all observations are weighted as follows: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. All regressions include bank and time fixed-effects. Robust standard errors at the bank level against the coefficients of the interaction terms are follows:
* Robust standard errors with significance at 10%; ** Robust standard errors with significance at 5%
*** Robust standard errors with significance at 1%. Source: Author's calculations (2019).

The average marginal effects do not differ much among the gains in total capital ratios for the intervened banks. A positive increase in the ratio occurs under all of the intervention scenarios with the most substantial gains for the intervened banks under the bad-bank approach (6.65) and merger (6.52) in comparison to non-intervened banks, ceteris paribus. The same observations apply to the sub-sample of banks with high NPLs as reported in Tables 22 and 23.

The regressions with lending proxies produce mixed results and they are also less reliable with much wider confidence intervals for their average marginal effects and lower statistical significance than under other measurers of bank behaviour. This applies to the results from both regressions with the full sample as well as the high NPL sub-sample. One should, thus, interpret these results with caution. Oddly, loan ratio declines in all scenario cases except nationalisation where both intervened and non-intervened banks deliver higher loan ratio. The results from the loan growth regressions point towards bad-bank scenario as the most harmful under which both intervened and non-intervened banks lose out. However, the width of the confidence intervals under both full sample as well as high NPL sub-sample results indicates limited reliability of these findings.

Table 22: Regression results for the sub-sample of banks with high NPLs.

Model specification	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	b. bank
Reserves/NPL (ln)	-	-	-	-	0.310	0.325	0.333	0.284	1.501**	1.484**	1.467**	1.520**	-0.186	-0.186	-0.169	-0.136
					(0.330)	(0.328)	(0.330)	(0.337)	(0.720)	(0.722)	(0.725)	(0.733)	(1.544)	(1.561)	(1.566)	(1.586)
Loan ratio	0.0152**	0.0150**	0.0148**	0.0150**	-0.01***	-0.10***	-0.01***	-0.10***	-	-	-	-	0.86***	0.86***	0.86***	0.86***
	(0.00696)	(0.00696)	(0.00699)	(0.00694)	(0.0291)	(0.0296)	(0.0288)	(0.0298)					(0.132)	(0.131)	(0.132)	(0.131)
Total capital ratio	0.00585	0.00614	0.00630	0.00527	-	-	-	-	-0.18***	-0.19***	-0.19***	-0.19***	0.56**	0.56**	0.56**	0.56**
	(0.00644)	(0.00640)	(0.00645)	(0.00643)					(0.0643)	(0.0658)	(0.0643)	(0.0661)	(0.265)	(0.267)	(0.267)	(0.268)
ROAE	-0.001***	-0.001***	-0.001***	-0.001***	-0.00079	-0.00095	-0.0002	-0.0006	0.0168**	0.0169**	0.0160**	0.0167**	0.0207**	0.0204**	0.0217**	0.0203**
	(0.00031)	(0.00033)	(0.00036)	(0.00031)	(0.00334)	(0.00349)	(0.00323)	(0.00355)	(0.00727)	(0.00752)	(0.00699)	(0.00764)	(0.0097)	(0.0096)	(0.001)	(0.0097)
TA (ln)	-0.272**	-0.283**	-0.290**	-0.273**	-1.830***	-1.918***	-1.851***	-1.923***	0.629	0.796	0.655	0.774	-2.147	-2.093	-2.004	-2.160
	(0.117)	(0.117)	(0.120)	(0.114)	(0.577)	(0.590)	(0.596)	(0.581)	(1.859)	(1.813)	(1.858)	(1.830)	(3.648)	(3.575)	(3.637)	(3.486)
Liquidity	0.00469	0.00458	0.00444	0.00401	-0.00438	-0.00535	-0.00414	-0.00650	-0.412***	-0.411***	-0.413***	-0.410***	-0.0308	-0.0301	-0.0283	-0.0296
	(0.00481)	(0.00476)	(0.00478)	(0.00472)	(0.0160)	(0.0159)	(0.0156)	(0.0158)	(0.0509)	(0.0510)	(0.0512)	(0.0515)	(0.0624)	(0.0621)	(0.0626)	(0.0625)
Concentration	0.0111*	0.0110*	0.0103*	0.0121**	0.0421	0.0417	0.0487	0.0441	0.0680	0.0694	0.0577	0.0668	-0.0883	-0.0878	-0.0748	-0.0916
ratio	(0.00604)	(0.00605)	(0.00624)	(0.00604)	(0.0370)	(0.0369)	(0.0394)	(0.0370)	(0.0665)	(0.0665)	(0.0600)	(0.0670)	(0.119)	(0.120)	(0.121)	(0.120)
GDP growth	0.0425***	0.0446***	0.0450***	0.0399***	0.0491	0.0652	0.0646	0.0605	0.128	0.0960	0.105	0.106	-0.0331	-0.0442	-0.0395	-0.0237
	(0.00851)	(0.00866)	(0.00883)	(0.00898)	(0.0497)	(0.0505)	(0.0519)	(0.0534)	(0.0969)	(0.0969)	(0.0952)	(0.0963)	(0.211)	(0.201)	(0.186)	(0.184)
Inflation (ln)	-0.0568**	-0.0570**	-0.0568**	-0.0541**	-0.173	-0.173	-0.176	-0.170	0.121	0.124	0.126	0.119	-0.708	-0.704	-0.711	-0.712
	(0.0243)	(0.0240)	(0.0239)	(0.0239)	(0.181)	(0.181)	(0.180)	(0.181)	(0.201)	(0.204)	(0.204)	(0.205)	(0.623)	(0.622)	(0.626)	(0.623)
Disclosure index	0.0389	0.0401	0.0393	-0.00755	-0.217	-0.198	-0.201	-0.304	-0.996**	-1.004**	-1.021**	-0.925*	2.045*	2.081*	2.056*	2.164*
	(0.0529)	(0.0544)	(0.0540)	(0.0513)	(0.373)	(0.375)	(0.371)	(0.405)	(0.444)	(0.455)	(0.454)	(0.476)	(1.133)	(1.150)	(1.137)	(1.204)
Interaction term (1.treat1#1.post)	**0.0854****	**0.00171****	**-0.190***	**0.971*****	**0.788****	**0.225****	**1.988***	**1.987****	**-1.195***	**0.205***	**-3.128***	**-1.821****	**0.0129***	**0.805***	**3.617***	**-2.470***
	(0.106)	**(0.110)**	**(0.268)**	**(0.163)**	**(0.613)**	**(0.639)**	**(2.728)**	**(1.440)**	**(0.978)**	**(1.055)**	**(7.161)**	**(1.697)**	**(2.691)**	**(2.982)**	**(5.221)**	**(3.069)**
Constant	4.143**	4.236**	4.385**	4.530***	33.81***	34.50***	33.08***	35.43***	62.89***	61.66***	64.19***	61.10***	-19.84	-20.52	-22.73	-20.42
	(1.631)	(1.633)	(1.694)	(1.617)	(7.061)	(7.290)	(7.601)	(7.202)	(22.89)	(22.41)	(22.71)	(22.79)	(43.62)	(43.29)	(44.81)	(42.15)
Observations	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,138	1,120	1,120	1,120	1,120
R-squared	0.164	0.162	0.163	0.179	0.373	0.371	0.372	0.372	0.478	0.476	0.478	0.477	0.174	0.174	0.174	0.174
No. of banks	192	192	192	192	192	192	192	192	192	192	192	192	190	190	190	190
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Notes: this table shows the results of my main fixed effect regression specifications on bank, industry and country characteristics for the sub-sample of banks with high NPLs (i.e. NPL ratio ≥ 63.8). The dependent variables are i). loan loss reserves to NPLs ratio, ii). total capital, iii). loan ratio, and iv). loan growth. The respective columns illustrates the change in the 'treatment' variable via the interaction term which captures the impact on government intervention on bank's behaviour after the government intervention. Interventions include: nationalisation, government-assisted merger and 'bad' bank approach. All observations are weighted as follows: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. All regressions include bank and time fixed-effects. Year dummies are included in all specifications, but are not displayed. Robust standard errors at the bank level are reported in brackets and are follows:

* Robust standard errors are shown in brackets, with significance at 10%

** Robust standard errors are shown in brackets, with significance at 5%

*** Robust standard errors are shown in brackets, with significance at 1%.

Source: Author's calculations (2019).

Table 23: Average marginal effects for the intervention interaction terms used in the regressions for high NPL sub-sample as presented in Table 22.

Dependent variable	Model specification	Coeff. of 1.POST treatment	Bank group	Delta method dy/dx	Std. Err.	z	P>|z|	95% Confidence interval lower	upper	width
Reserves/ NPLs	general	0.0854**	Control	0.59	0.16	3.63	0.00	0.3	0.9	0.6
			Treat	0.67	0.14	4.75	0.00	0.4	0.9	0.6
	nation.	0.0017**	Control	0.64	0.14	4.41	0.00	0.4	0.9	0.6
			Treat	0.64	0.16	4.11	0.00	0.3	0.9	0.6
	merger	-0.190*	Control	0.64	0.14	4.60	0.00	0.4	0.9	0.5
			Treat	0.45	0.29	1.55	0.12	-0.1	1.0	1.1
	'bad bank'	0.971***	Control	0.52	0.21	2.43	0.02	0.1	0.9	0.8
			Treat	1.49	0.24	6.14	0.00	1.0	2.0	0.9
Total capital ratio	general	0.788**	Control	5.95	0.96	6.20	0.00	4.1	7.8	3.8
			Treat	6.73	0.98	6.90	0.00	4.8	8.6	3.8
	nation.	0.225**	Control	6.35	0.96	6.59	0.00	4.5	8.2	3.8
			Treat	6.58	1.03	6.38	0.00	4.6	8.6	4.0
	merger	1.988*	Control	6.40	0.92	6.93	0.00	4.6	8.2	3.6
			Treat	8.39	2.86	2.93	0.00	2.8	14.0	11.2
	'bad bank'	1.987**	Control	6.19	0.75	8.24	0.00	4.7	7.7	2.9
			Treat	8.18	1.79	4.57	0.00	4.7	11.7	7.0
Loan ratio	general	-1.195*	Control	6.75	2.62	2.57	0.01	1.6	11.9	10.3
			Treat	5.56	2.63	2.12	0.03	0.4	10.7	10.3
	nation.	0.205*	Control	6.00	2.58	2.32	0.02	0.9	11.1	10.1
			Treat	6.21	2.70	2.30	0.02	0.9	11.5	10.6
	merger	-3.128*	Control	6.07	2.58	2.35	0.02	1.0	11.1	10.1
			Treat	2.94	7.68	0.38	0.70	-12.1	18.0	30.1
	'bad bank'	-1.821**	Control	6.27	2.75	2.28	0.02	0.9	11.7	10.8
			Treat	4.45	2.98	1.49	0.14	-1.4	10.3	11.7
Loan growth	general	0.0129*	Control	-21.74	7.42	-2.93	0.00	-36.3	-7.2	29.1
			Treat	-21.72	6.73	-3.23	0.00	-34.9	-8.5	26.4
	nation.	0.805*	Control	-22.07	7.20	-3.07	0.00	-36.2	-8.0	28.2
			Treat	-21.27	6.72	-3.16	0.00	-34.4	-8.1	26.4
	merger	3.617*	Control	-21.78	6.85	-3.18	0.00	-35.2	-8.4	26.9
			Treat	-18.16	8.20	-2.21	0.03	-34.2	-2.1	32.1
	'bad bank'	-2.470*	Control	-21.75	6.85	-3.18	0.00	-35.2	-8.3	26.8
			Treat	-24.22	8.35	-2.90	0.00	-40.6	-7.9	32.7

Notes: this table shows the average marginal effects for each of the interaction terms used in the sub-sample regressions presented in Table 22. They show the expected change in expected values of each of the four outcome variables in the post intervention period for both intervened (treatment) and non-intervened (control) banks. They are derived from the main fixed effect regression specifications where all observations are weighted as following: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. The sub-sample is derived from banks with high NPL ratio (i.e. NPL ratio ≥ 63.8 as at the intervention year). All regressions include bank and time fixed-effects. Year and bank dummies are included in all specifications, but are not displayed. Robust standard errors at the bank level against the coefficients of the interaction terms are follows: * Robust standard errors with significance at 10%; ** Robust standard errors with significance at 5%; *** Robust standard errors with significance at 1%. Source: Author's calculations (2019).

Overall, I find some evidence to support my first hypothesis with the use of my second approach which relies on the conventional DID estimator. Namely, the results indicate that the bank's behaviour of the intervened banks changes after the intervention controlling for other bank-, industry- and country-factors in comparison to non-intervened banks. My findings also confirm that the choice of intervention type matters for bank's future performance. There is a higher likelihood of greater gains to bank's performance with mergers and 'bad bank' approaches than with nationalisation, for instance, but nationalisation is the only intervention which delivers positive, albeit weak, results across all measurers of bank performance I have investigated in this chapter. There are certain trade-offs one should consider when deciding which method to use in order to tackle the issue of trouble banks. For instance, government assisted merger can help in restoring bank's capital, but, at the same time, it may lead to the decline of reserves ratio and, to some extent, its lending patterns. Nationalisation, on the other hand, brings limited, but consistent, positive efficiency gains in comparison to no-intervention scenario. The choice of the intervention policy is strongly linked to the preferences of the government which may have different targets and goals for its banking sector. There is no 'one-size-fits-all' intervention method to address the problem of troubled banks.

Lastly, I follow the third complementary approach in which I use the SDID estimator in order to test my findings from the second approach which are based on a set of strong assumptions which may be implausible if government selection for intervention is correlated with the characteristics that affect the dynamics of my bank performance's outcome variables. As explained earlier, the constrain of not being able to use sampling weights under this approach limits the validity of the findings in direct comparison to my main results under the second approach. Specifically, I use the Stata's absdid command to compute the SDID estimator of the government intervention effect for failing banks. Since I am not able to use the sampling weights to control for the dominance of the US-banks in my sample, I run the regressions for the sub-samples of non-US banks separately in order to see results which are not biased by the sampling distribution. Tables 24 and 25 present these results, respectively.

In both tables, the 'number of banks' indicates the number of observations used for the estimations that satisfy the condition that their respective estimated propensity score is bigger than 0 and smaller than 1. To avoid any loss of information, I also re-run the regressions with the sle option which forces the use of a logistic specification rather than linear in order to

estimate the propensity score following the approach by Hirano et al. (2003). This ensures that the estimated propensity score is always greater than 0 and less than 1. I report the results in the respective columns, i.e. under the headings indicating linear polynomial model (LPM) and logic specification model (SLE) for each of the four dependent variables I analyse. The model specifications in terms of the variables which are included as the explanatory variables follow exactly the same set-up as under the regressions from the second approach.

Similarly, I also consider that the effect of government intervention varies with the bank characteristics. In my main regressions I could control for that with use of bank fixed effects. This is not possible here. Thus, I test how the effect of government intervention varies with certain bank controls, namely, the banks' size and diversification (i.e. TA), its profitability (i.e. ROAE) and its liquidity (i.e. Liquid Assets / Total Deposits & Borrowings).

The results based on the full sample as presented in Table 24 are mixed and inconsistent. As explained earlier, this is likely to be caused by the bias caused by the dominance of US banks in the sample which could not be controlled for with the applied method. Thus, I turn to the results based on the sub-sample of banks which exclude all non-US banks as these are likely to be more reliable (Table 25). As can be noted, 'bad bank' approach delivers most positive and consistent SDID estimator which is in line with the earlier findings. The SDID estimator does however vary with the type of approximation used and also delivers results on the lower end of statistical significance. The results on loan growth are rarely significant across all specifications. Similar constraints were found under the main regressions with the conventional DID estimator. Overall, the results based on the sub-sample of non-US banks broadly confirm the earlier findings with a stronger positive impact of government interventions under 'bad bank' approach and no evidence of any positive impact of nationalisation on bank performance. Still, there is a high variation in the results across the different specifications which adds to caution in interpreting this additional results in direct comparison to the main results under the second approach.

Table 24: Effects of government intervention on the measurers of bank performance using SDID estimator – full sample.

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
general																
Constant	-0.217	-11.1***	-0.063	3.360	-1.88**	-53.24***	-0.847	5.152	-7.53***	-116.2***	-10.114	42.464	-1.039	-15.53**	0.638	-24.753
	0.143	1.621	0.283	2.812	0.820	8.890	1.349	12.768	2.720	30.402	11.287	95.190	0.946	6.812	1.910	17.434
ROAE		-0.013**		-0.001		-0.043		0.017		-0.244***		-0.129*		0.026		-0.029
		0.006		0.009		0.027		0.051		0.066		0.077		0.043		0.082
TA (ln)		1.003***		-0.342		4.89***		-0.626		8.843**		-6.668		1.235*		1.955
		0.163		0.234		0.972		1.120		3.417		7.445		0.630		1.507
Liquidity		-0.020		0.016*		-0.125		0.039		0.056		0.535**		0.005		0.010
		0.014		0.009		0.089		0.052		0.325		0.224		0.045		0.057
No. of banks	842	842	1,108	1,108	846	846	1,108	1,108	851	851	1,186	1,186	836	836	1,183	1,183
nationalization																
Constant	-0.539***	-15.8***	0.295	-8.790	-1.88**	-61.54***	1.949	-21.440	-9.87***	-154.9***	0.200	-34.304	0.207	-1.748	0.821	6.580
	0.125	1.470	0.307	5.453	0.608	7.074	1.447	26.761	1.641	20.787	4.048	75.828	0.995	6.266	1.399	14.161
ROAE		0.000		0.006		0.019		0.034		-0.020		-0.022		0.001		-0.051
		0.005		0.009		0.023		0.037		0.042		0.041		0.028		0.070
TA (ln)		1.298***		0.676		5.122***		1.578		11.144***		1.436		0.101		-0.434
		0.117		0.424		0.576		2.025		1.693		5.787		0.550		1.168
Liquidity		-0.008		0.004		-0.04*		0.045		0.187**		0.255**		0.013		-0.003
		0.006		0.010		0.023		0.034		0.079		0.102		0.038		0.057
No. of banks	793	793	1,096	1,096	794	794	1,096	1,096	795	795	1,174	1,174	787	787	1,168	1,168
merger																
Constant	-1.128	-2.229	-0.911	3.112	-4.47**	-29.112*	-3.398	-57.622	-16.95**	-80.144	-10.530	-51.575	1.189	-43.720	-1.892	-81.521
	0.717	6.450	6.529	56.630	2.160	16.494	36.665	350.031	8.522	93.069	85.734	727.093	5.892	36.617	4.470	58.887
ROAE		0.009		0.019		0.008		-0.029		0.085		0.257		-0.073		-0.041
		0.024		0.095		0.045		0.125		0.282		1.416		0.154		0.069
TA (ln)		0.399		0.065		2.718**		3.537		9.565		10.934		2.263		4.727
		0.405		3.698		1.257		26.402		6.743		47.331		2.007		7.317
Liquidity		-0.081		-0.116		-0.152		0.394		-1.119		-2.296		0.442		0.854
		0.064		0.447		0.248		0.510		0.739		5.445		0.362		1.555
No. of banks	661	661	248	248	636	636	248	248	686	686	326	326	662	662	321	321
bad bank																
Constant	-0.783**	-6.28***	1.396**	-2.636	-2.424	-18.28***	2.301	-28.338	-10.07**	-45.352**	15.127**	14.611	-2.421	2.068	-5.53**	-4.791
	0.319	1.318	0.678	3.470	1.692	5.649	4.449	22.840	4.562	20.320	6.524	23.817	1.677	6.764	2.420	14.917
ROAE		-0.008**		-0.012		-0.018		-0.043		-0.059		-0.002		0.011		0.050
		0.004		0.008		0.022		0.044		0.054		0.075		0.016		0.042
TA (ln)		0.603***		0.120		1.932***		1.654		3.571**		-1.134		-0.644		-1.570

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
		0.103		0.307		0.450		1.534		1.581		1.987		0.712		2.144
Liquidity		-0.020		0.055		-0.099		0.258		-0.058		0.304		0.053		0.415
		0.013		0.038		0.065		0.204		0.168		0.255		0.059		0.404
No. of banks	679	679	524	524	682	682	524	524	702	702	602	602	673	673	601	601

Notes: Models (1) and (3) report estimates of the average effect of government intervention for intervened banks. Models (2) and (4) show how the effect of government intervention varies with bank's size, profitability and liquidity level. The ATT reported in (1) and (2) are estimated using a linear polynomial function to approximate the propensity score. The ATT reported in (3) and (4) are estimated using a logit specification to estimate the propensity score. All regressions include the following control variables: banking sector concentration ratio, GDP growth, inflation, business disclosure country index, time and country dummies. Standards errors are in parentheses. Significance levels are denoted as follows: * $p<0.10$, ** $p<0.05$, and *** $p<0.01$.
Source: Author's calculations (2019).

Table 25: Effects of government intervention on the measurers of bank performance using SDID estimator – sub-sample of non-USA banks.

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
general																
Constant	0.076	-4.33**	0.053	3.286	-0.871	-28.9***	-0.628	0.475	-7.43**	-68.850	-8.365	22.228	-0.32	-21.2**	1.021	-25.154*
	0.142	1.881	0.272	2.837	0.768	10.398	1.288	13.914	3.880	46.896	11.179	119.681	1.03	10.056	1.823	15.136
ROAE		-0.007		0.000		-0.020		0.013		-0.24***		-0.139		0.003		-0.019
		0.007		0.008		0.034		0.044		0.074		0.086		0.058		0.066
TA (ln)		0.337**		-0.301		2.409***		-0.091		3.764		-4.560		1.623*		1.965
		0.153		0.232		0.852		1.165		3.493		8.777		0.835		1.304
Liquidity		0.005		0.009		-0.024		0.005		0.264***		0.442***		0.027		0.029
		0.005		0.008		0.033		0.049		0.090		0.154		0.038		0.061
No. of banks	604	604	674	674	604	604	674	674	607	607	752	752	602	602	749	749
nationalization																
Constant	-0.3**	-13.0**	0.193	-8.250	-1.3**	-53.1***	1.437	-23.892	-9.87**	-133.6**	-1.635	-42.241	0.55	-2.655	1.456	6.135
	0.121	1.842	0.317	5.218	0.640	10.086	1.695	30.761	1.628	27.493	5.046	94.483	1.03	8.112	1.479	14.591
ROAE		0.000		0.006		0.018		0.037		-0.034		-0.029		0.003		-0.050
		0.005		0.009		0.026		0.038		0.045		0.037		0.029		0.070
TA (ln)		0.99***		0.627		4.069***		1.771		8.456***		1.917		0.197		-0.378
		0.143		0.395		0.791		2.314		2.223		7.145		0.692		1.211
Liquidity		0.005		0.005		0.015		0.039		0.308***		0.253***		0.013		0.001
		0.005		0.007		0.022		0.030		0.065		0.094		0.041		0.060
No. of banks	558	558	662	662	555	555	662	662	555	555	740	740	551	551	734	734
merger																
Constant	-1.017	0.030	-0.911	3.112	-3.88*	-21.797	-3.34	-57.62	-15.64*	-72.620	-10.530	-51.575	1.82	-56.348	-1.892	-81.521
	0.718	8.267	6.529	56.630	2.128	21.437	36.66	350.03	9.142	111.302	85.734	727.093	5.62	51.462	4.470	58.887
ROAE		0.009		0.019		0.008		-0.029		0.088		0.257		-0.072		-0.041
		0.023		0.095		0.044		0.125		0.294		1.416		0.149		0.069
TA (ln)		0.213		0.065		2.111		3.537		8.996		10.934		3.310		4.727
		0.551		3.698		1.647		26.402		7.942		47.331		3.283		7.317
Liquidity		-0.082		-0.116		-0.157		0.394		-1.137		-2.296		0.450		0.854
		0.062		0.447		0.245		0.510		0.691		5.445		0.337		1.555
No. of banks	461	461	248	248	450	450	248	248	455	455	326	326	458	458	321	321
bad bank																
Constant	-0.163	8.361**	no. con.	no. con.	0.050	43.87***	1.962	-51.47	-3.450	118.62**	no. con.	no. con.	-2.16	6.523	no. con.	no. con.
	0.431	2.858			2.056	12.910	4.189	52.229	4.296	51.318			2.840	15.201		
ROAE		-0.002				0.006		-0.021		-0.001				0.008		
		0.005				0.028		0.034		0.079				0.021		

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TA (ln)		-0.64**				-3.47***		3.712		-11.07**				-1.072		
		0.285				1.328		3.749		5.159				1.423		
Liquidity		-0.05***				-0.21***		0.521		-0.305**				0.045		
		0.015				0.078		0.617		0.148				0.067		
No. of banks	480	480			476	476	90	90	487	487			458	458		

Notes: Models (1) and (3) report estimates of the average effect of government intervention for intervened banks. Models (2) and (4) show how the effect of government intervention varies with bank's size, profitability and liquidity level. The ATT reported in (1) and (2) are estimated using a linear polynomial function to approximate the propensity score. The ATT reported in (3) and (4) are estimated using a logit specification to estimate the propensity score. All regressions include the following control variables: banking sector concentration ratio, GDP growth, inflation, business disclosure country index, time and country dummies. Standards errors are in parentheses. Significance levels are denoted as follows: * p<0.10, ** p<0.05, and *** p<0.01.
Source: Author's calculations (2019).

3.3.4. Robustness checks

I perform several robustness check to validate my main empirical results based on the second empirical approach I rely on to draw conclusions. Firstly, I re-run the regressions under the second approach using alternative peer selection sample as explained in the methodology section. The results do not differ significantly from my original findings. Similarly, I run the regressions with additional fixed effects, namely country fixed effects and report no substantial changes in my main findings. I show these regressions in Table 26. I also run the regressions for the sub-sample of European countries (Table 27) and I find no significant difference from the reported results based on the analysis of the interaction terms (Table 28) with the exception of nationalisation case. The reserves/NPL ratio seems to deliver a slightly better results in the non-intervened banks in comparison to the intervened banks which did not differ in their performance in the full sample. Similarly, the difference in the total capital ratio between intervened and non-intervened banks is slightly wider under the European banks' sub-sample than it was the case in the full sample.

I also carry out additional checks on the core regressions such as reducing the number of variables, reducing the time series of our data by two years from six to four years prior/after the intervention, dropping certain controls as well as exchanging the variables used in the regressions with alternative proxies (e.g. replacing ROAE with ROAA or net interest margin, replacing loan loss reserves/NPLs with reserves/gross loans). I find no significant change in the main results based on the conventional DID estimator as an outcome of these checks.

Table 26: Robustness checks – main regression results with country fixed effects.

Model specification	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank
Reserves/NPL	-	-	-	-	-0.0105	-0.00862	-0.0111	-0.0126	0.779*	0.774*	0.793*	0.773*	0.516	0.515	0.487	0.513
(ln)					(0.328)	(0.328)	(0.328)	(0.328)	(0.710)	(0.714)	(0.715)	(0.718)	(1.665)	(1.675)	(1.674)	(1.674)
Loan ratio	0.00740*	0.00733*	0.00752*	0.00732*	-0.10***	-0.10***	-0.10***	-0.10***	-	-	-	-	0.90***	0.91***	0.91***	0.90***
	(0.00670)	(0.00671)	(0.00672)	(0.00675)	(0.0338)	(0.0337)	(0.0338)	(0.0337)					(0.136)	(0.135)	(0.134)	(0.134)
Total capital ratio	-0.00017	-0.00014	-0.00018	-0.00020	-	-	-	-	-0.170**	-0.172**	-0.171**	-0.172**	0.525**	0.525**	0.524**	0.524**
	(0.00526)	(0.00524)	(0.00525)	(0.00525)					(0.0701)	(0.0705)	(0.0704)	(0.0706)	(0.238)	(0.240)	(0.239)	(0.239)
ROAE	-0.00059*	-0.00059*	-0.00047*	-0.0006*	-0.00439	-0.00445	-0.00426	-0.00451	0.02***	0.02***	0.02***	0.02***	0.04***	0.03***	0.03***	0.03***
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0039)	(0.00392)	(0.0040)	(0.0039)	(0.0067)	(0.0069)	(0.0065)	(0.0069)	(0.007)	(0.008)	(0.007)	(0.0068)
TA (ln)	-0.157	-0.162	-0.153	-0.161	-2.39***	-2.44***	-2.42***	-2.42***	0.545	0.662	0.593	0.702	-1.435	-1.292	-1.254	-1.384
	(0.115)	(0.116)	(0.120)	(0.118)	(0.744)	(0.747)	(0.746)	(0.736)	(1.756)	(1.726)	(1.767)	(1.730)	(4.124)	(4.076)	(3.976)	(3.919)
Liquidity	0.00431	0.00425	0.00437	0.00425	-0.00390	-0.00470	-0.00439	-0.00466	-0.42***	-0.42***	-0.42***	-0.41***	-0.0416	-0.0394	-0.0388	-0.0410
	(0.00317)	(0.00316)	(0.00319)	(0.00321)	(0.0206)	(0.0204)	(0.0203)	(0.0202)	(0.0498)	(0.0499)	(0.0503)	(0.0502)	(0.063)	(0.062)	(0.0617)	(0.0615)
Concentration	-0.0230**	-0.0233**	-0.0225**	-0.0234**	-0.132	-0.136	-0.134	-0.137	-0.0768	-0.0682	-0.0757	-0.0662	-1.077*	-1.066*	-1.059*	-1.073*
ratio	(0.00976)	(0.01000)	(0.00944)	(0.00997)	(0.0911)	(0.0964)	(0.0964)	(0.0959)	(0.124)	(0.123)	(0.119)	(0.123)	(0.617)	(0.611)	(0.624)	(0.622)
GDP growth	0.00874	0.0101	0.00929	0.0101	0.0472	0.0647	0.0602	0.0647	-0.0714	-0.102	-0.110	-0.117	0.339	0.282	0.312	0.326
	(0.0115)	(0.0118)	(0.0127)	(0.0129)	(0.0753)	(0.0769)	(0.0840)	(0.0827)	(0.0902)	(0.0938)	(0.0831)	(0.0843)	(0.295)	(0.313)	(0.318)	(0.317)
Inflation (ln)	-0.00985	-0.0119	-0.00638	-0.0136	-0.977***	-1.003***	-0.988***	-1.032***	0.576	0.609	0.572	0.629	-1.581	-1.479	-1.461	-1.574
	(0.0487)	(0.0480)	(0.0498)	(0.0494)	(0.350)	(0.348)	(0.364)	(0.366)	(0.596)	(0.610)	(0.601)	(0.602)	(1.598)	(1.572)	(1.661)	(1.636)
Disclosure index	0.257***	0.260***	0.256***	0.261***	-0.110	-0.0681	-0.0843	-0.0512	-1.983	-2.042	-2.040	-2.083	2.970	2.805	2.868	2.943
	(0.0873)	(0.0899)	(0.0863)	(0.0882)	(0.772)	(0.776)	(0.778)	(0.786)	(1.409)	(1.439)	(1.396)	(1.432)	(2.679)	(2.640)	(2.759)	(2.746)
Interaction term	**0.0287****	**0.00600***	**-0.276***	**0.147***	**0.340****	**0.0972***	**0.466***	**2.477***	**-1.128****	**0.463**	**-3.669***	**-0.781***	**0.349***	**1.218**	**5.180***	**-1.109***
(1.treat1#1.post)	**(0.0907)**	**(0.0974)**	**(0.263)**	**(0.0995)**	**(0.741)**	**(0.764)**	**(2.546)**	**(2.299)**	**(0.968)**	**(1.128)**	**(4.643)**	**(1.520)**	**(3.541)**	**(4.003)**	**(3.373)**	**(2.503)**
Constant	3.732**	3.288**	3.605**	3.747**	43.44***	43.92***	54.29***	54.49***	54.67***	53.65***	55.18***	86.91***	44.98	61.37	50.88	50.22
	(1.681)	(1.382)	(1.730)	(1.702)	(8.727)	(8.795)	(9.854)	(9.676)	(20.47)	(20.25)	(20.58)	(23.44)	(58.46)	(55.47)	(55.18)	(55.13)
Observations	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,550	1,550	1,550	1,550
R-squared	0.390	0.390	0.391	0.390	0.425	0.425	0.425	0.426	0.563	0.562	0.563	0.562	0.244	0.244	0.244	0.244
No. of banks	418	418	418	418	418	418	418	418	418	418	418	418	415	415	415	415
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: this table shows the results of my main fixed effect regression specifications on bank, industry and country characteristics with additional fixed effects to test the robustness of the findings. The dependent variables are i). loan loss reserves to NPLs ratio, ii). total capital, iii). loan ratio, and iv). loan growth. The respective columns illustrates the change in the 'treatment' variable via the interaction term which captures the impact on government intervention on bank's behaviour after the government intervention. Interventions include: nationalisation, government-assisted merger and 'bad' bank approach. All observations are weighted as follows: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. All regressions include bank, time and country fixed-effects. Year dummies are included in all specifications, but are not displayed. Robust standard errors at the bank level are reported in brackets and are follows:

* Robust standard errors are shown in brackets, with significance at 10%

** Robust standard errors are shown in brackets, with significance at 5%

*** Robust standard errors are shown in brackets, with significance at 1%.

Source: Author's calculations (2019).

Table 27: Robustness checks - baseline regression results with the sub-sample of European countries.

Model specification	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank
Reserves/ NPL (ln)	-	-	-	-	0.294	0.315	0.323	0.264	1.58**	1.56**	1.55**	1.60**	-0.549	-0.539	-0.535	-0.508
					(0.322)	(0.321)	(0.323)	(0.329)	(0.714)	(0.713)	(0.715)	(0.726)	(1.464)	(1.490)	(1.491)	(1.506)
Loan ratio	0.0162**	0.0160**	0.0159**	0.0160**	-0.1***	-0.1***	-0.1***	-0.1***	-	-	-	-	0.9***	0.87***	0.88***	0.87***
	(0.0069)	(0.0068)	(0.0068)	(0.0068)	(0.031)	(0.031)	(0.031)	(0.031)					(0.120)	(0.119)	(0.119)	(0.119)
Total capital ratio	0.00579	0.00620	0.00636	0.00508	-	-	-	-	-0.15**	-0.16**	-0.16**	-0.16**	0.59**	0.587**	0.586**	0.589**
	(0.0065)	(0.0064)	(0.0065)	(0.0064)					(0.066)	(0.068)	(0.066)	(0.068)	(0.268)	(0.270)	(0.270)	(0.271)
ROAE	-0.01***	-0.02***	-0.02***	-0.01***	-0.0004	-0.0007	-0.0006	-0.0002	0.016**	0.016**	0.016**	0.016**	0.02**	0.019**	0.020**	0.019**
	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.007)	(0.007)	(0.007)	(0.007)	(0.009)	(0.009)	(0.01)	(0.009)
TA (ln)	-0.295**	-0.308***	-0.315***	-0.295***	-1.78***	-1.86***	-1.79***	-1.87***	0.907	1.055	0.975	1.023	-3.562	-3.499	-3.479	-3.576
	(0.114)	(0.116)	(0.119)	(0.109)	(0.506)	(0.518)	(0.528)	(0.511)	(1.822)	(1.765)	(1.791)	(1.791)	(3.494)	(3.454)	(3.497)	(3.361)
Liquidity	0.00447	0.00433	0.00421	0.00358	0.00411	0.00345	0.00442	0.00177	-0.4***	-0.4***	-0.3***	-0.4***	-0.0104	-0.009	-0.009	-0.009
	(0.00577)	(0.00569)	(0.00570)	(0.00564)	(0.0167)	(0.0167)	(0.0163)	(0.0165)	(0.0491)	(0.0489)	(0.0490)	(0.0496)	(0.0626)	(0.0623)	(0.0628)	(0.0629)
Concentration ratio	0.0121*	0.0120*	0.0111*	0.0133**	0.0363	0.0354	0.0427	0.0383	0.0684	0.0703	0.0651	0.0673	-0.0602	-0.0599	-0.0519	-0.0629
	(0.00625)	(0.00625)	(0.00638)	(0.00623)	(0.0376)	(0.0375)	(0.0400)	(0.0376)	(0.0680)	(0.0677)	(0.0601)	(0.0685)	(0.121)	(0.122)	(0.123)	(0.122)
GDP growth	0.0408***	0.0436***	0.0434***	0.0381***	0.0517	0.0677	0.0693	0.0642	0.0493	0.0179	0.0247	0.0298	-0.0662	-0.0782	-0.0676	-0.0586
	(0.00915)	(0.00898)	(0.00902)	(0.00935)	(0.0488)	(0.0493)	(0.0504)	(0.0521)	(0.102)	(0.102)	(0.101)	(0.102)	(0.222)	(0.211)	(0.197)	(0.197)
Inflation (ln)	-0.0516*	-0.0525*	-0.0522*	-0.0490*	-0.217	-0.220	-0.222	-0.218	0.230	0.239	0.237	0.233	-0.379	-0.374	-0.380	-0.384
	(0.0296)	(0.0292)	(0.0292)	(0.0289)	(0.194)	(0.194)	(0.193)	(0.194)	(0.222)	(0.226)	(0.226)	(0.227)	(0.621)	(0.620)	(0.622)	(0.621)
Disclosure index	0.0514	0.0517	0.0526	0.00611	-0.0388	-0.00705	-0.0148	-0.114	-0.769*	-0.777*	-0.798*	-0.711	1.424	1.471	1.432	1.501
	(0.0547)	(0.0569)	(0.0563)	(0.0552)	(0.378)	(0.377)	(0.374)	(0.412)	(0.430)	(0.439)	(0.439)	(0.461)	(1.084)	(1.092)	(1.083)	(1.159)
Interaction term (1.treat1#1.post)	**0.0982****	**-0.0403***	**-0.231***	**0.913*****	**0.883***	**0.346****	**1.931***	**1.828***	**-1.157***	**0.387****	**-1.285***	**-1.622***	**0.0728***	**1.077***	**2.130***	**-1.498***
	(0.118)	**(0.118)**	**(0.254)**	**(0.171)**	**(0.606)**	**(0.623)**	**(2.527)**	**(1.464)**	**(1.024)**	**(1.141)**	**(7.431)**	**(1.630)**	**(2.631)**	**(2.994)**	**(5.172)**	**(2.841)**
Constant	3.867**	3.986**	4.136**	4.187***	31.53***	32.04***	30.72***	32.94***	56.92**	55.81**	57.18***	55.53**	-4.025	-4.847	-5.739	-4.317
	(1.588)	(1.606)	(1.665)	(1.561)	(6.153)	(6.380)	(6.714)	(6.356)	(22.60)	(21.94)	(21.93)	(22.37)	(39.26)	(39.32)	(40.62)	(38.15)
Observations	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,115	1,115	1,115	1,115
R-squared	0.168	0.167	0.168	0.187	0.368	0.366	0.367	0.367	0.490	0.489	0.489	0.489	0.187	0.187	0.187	0.187
No. of banks	188	188	188	188	188	188	188	188	188	188	188	188	186	186	186	186
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Notes: this table shows the results of my main fixed effect regression specifications on bank, industry and country characteristics for the sub-sample of banks from European countries. The dependent variables are i). loan loss reserves to NPLs ratio, ii). total capital, iii). loan ratio, and iv). loan growth. The respective columns illustrates the change in the 'treatment' variable via the interaction term which captures the impact on government intervention on bank's performance after the government intervention. Interventions include: nationalisation, government-assisted merger and 'bad' bank approach. All regressions include bank and time fixed-effects. Year dummies are included in all specifications, but are not displayed. Robust standard errors at the bank level are reported in brackets and are follows:

* Robust standard errors are shown in brackets, with significance at 10%

** Robust standard errors are shown in brackets, with significance at 5%

*** Robust standard errors are shown in brackets, with significance at 1%.

Source: Author's calculations (2019).

Table 28: Robustness checks – average marginal effects for the interaction terms used in the baseline regression results with the sub-sample of European countries as presented in Table 27.

Dependent variable	Model specification	Coeff. of 1.POST treatment	Bank group	Delta method				95% Confidence interval		
				dy/dx	Std. Err.	z	P>|z|	lower	upper	width
Reserves/ NPLs	general	0.0982**	Control	0.87	0.28	3.11	0.00	0.3	1.4	1.1
			Treat	0.96	0.26	3.72	0.00	0.5	1.5	1.0
	nation.	-0.0403*	Control	0.93	0.27	3.52	0.00	0.4	1.5	1.0
			Treat	0.89	0.27	3.34	0.00	0.4	1.4	1.0
	merger	-0.231*	Control	0.92	0.26	3.53	0.00	0.4	1.4	1.0
			Treat	0.69	0.36	1.93	0.05	0.0	1.4	1.4
	bad bank	0.913***	Control	0.83	0.30	2.76	0.01	0.2	1.4	1.2
			Treat	1.74	0.37	4.72	0.00	1.0	2.5	1.4
Total capital ratio	general	0.883*	Control	5.53	0.89	6.24	0.00	3.8	7.3	3.5
			Treat	6.41	0.94	6.8	0.00	4.6	8.3	3.7
	nation.	0.346**	Control	5.91	0.91	6.51	0.00	4.1	7.7	3.6
			Treat	6.25	0.98	6.37	0.00	4.3	8.2	3.8
	merger	1.931*	Control	5.99	0.88	6.8	0.00	4.3	7.7	3.5
			Treat	7.92	2.66	2.98	0.00	2.7	13.1	10.4
	bad bank	1.828*	Control	5.87	0.76	7.75	0.00	4.4	7.4	3.0
			Treat	7.70	1.83	4.22	0.00	4.1	11.3	7.2
Loan ratio	general	-1.157*	Control	7.67	2.57	2.98	0.00	2.6	12.7	10.1
			Treat	6.51	2.69	2.42	0.02	1.2	11.8	10.5
	nation.	0.387**	Control	6.93	2.59	2.67	0.01	1.8	12.0	10.2
			Treat	7.32	2.74	2.67	0.01	1.9	12.7	10.7
	merger	-1.285*	Control	7.07	2.60	2.72	0.01	2.0	12.2	10.2
			Treat	5.79	7.85	0.74	0.46	-9.6	21.2	30.8
	bad bank	-1.622*	Control	7.18	2.65	2.71	0.01	2.0	12.4	10.4
			Treat	5.56	2.98	1.87	0.06	-0.3	11.4	11.7
Loan growth	general	0.0728*	Control	-20.7	6.05	-3.43	0.00	-32.6	-8.9	23.7
			Treat	-20.6	5.58	-3.71	0.00	-31.6	-9.7	21.9
	nation.	1.077*	Control	-21.1	5.98	-3.53	0.00	-32.8	-9.4	23.4
			Treat	-20.0	5.58	-3.59	0.00	-31.0	-9.1	21.9
	merger	2.130*	Control	-20.7	5.66	-3.66	0.00	-31.8	-9.6	22.2
			Treat	-18.6	7.47	-2.49	0.01	-33.2	-3.9	29.3
	bad bank	-1.498*	Control	-20.8	5.69	-3.65	0.00	-31.9	-9.6	22.3
			Treat	-22.3	7.31	-3.04	0.00	-36.6	-7.9	28.7

Notes: this table shows the average marginal effects for each of the interaction terms used in the regressions presented in Table 27. They show the expected change in expected values of each of the four outcome variables in the post intervention period for both intervened (treatment) and non-intervened (control) banks. They are derived from the main fixed effect regression specifications that include bank and time fixed-effects. Robust standard errors at the bank level against the coefficients of the interaction terms are follows: * Robust standard errors with significance at 10%; ** Robust standard errors with significance at 5%; *** Robust standard errors with significance at 1%. Source: Author's calculations (2019).

Next, I re-run the regressions under my second approach with the dynamic two-step GMM panel estimator (i.e. system-GMM) as introduced by Blundell and Bond (1998) and Windeijer's (2005) finite sample correction in order to further test and challenge my findings. As explained by Chiorazzo and Milani (2011), system-GMM ensures efficiency and consistency provided that residuals do not show serial correlation of order two and the instruments are appropriate. In presence of heteroscedasticity and serial correlation, the system-GMM uses a consistent estimate of the weighting matrix, taking the residuals from the one-step estimate (Davidson and MacKinnon, 2004). The one disadvantage of the first difference transformation is that it magnifies gaps in unbalanced panels (Baum, 2013). This motivates an alternative transformation: the forward orthogonal deviations (FOD) transformation proposed

by Arellano and Bover (1995). FOD transformation is computable for all periods except the last period, even in the presence of gaps in the panel in all of my regressions.

In terms of variables mappings, the lagged bank-level variables were modelled as predetermined and, thus, needed to be instrumented GMM-style. The endogenous variable was the lagged dependent variable under each of my regression specifications I ran with the conventional DID estimator. The country- and industry-level variables were assigned to be strictly exogenous. This implies, as explained by Roodman (2006), that they can be instrumented by itself as an "IV-style" instrument. The time dummies were treated as strictly exogenous and they were included in the instrument sets, but not displayed in the regression tables under Table 29.

Instrumenting with the second and higher order lags was launched, although, as explained by Kleibergen and Mavroeidis (2009), there is a trade-off between the validity of the instruments (i.e. robustness to serial correlation) and the strength of the instruments (i.e. decreasing correlation with larger distance in time) with using deeper lags. I used the approach developed by Retana et al. (2015) in which they advise to base the starting point on the maximum number of lags, and then gradually reduce the number of lags until they fail to satisfy their respective specification tests. The best results were reached with the lags from second to fourth for both regressions with (i). reserves/NPL ratio and (ii). total capital ratio as dependent variables. The lags from sixth to ninth were used for regressions with (ii). loan ratio and, lastly, the lags from second to seventh were used in regressions with (iv). loan growth.

Roodman (2009) explains that the Hansen test is able to detect invalidity of the system GMM instruments. He argues that a perfect Hansen statistic of 1.000 and also Hansen test p-value below 0.1 should be taken with caution and. He also notes that higher values, such as 0.25, are potential signs of trouble. Majority of the specifications in Table 29 pass the Hansen-J statistic test for over-identifying restrictions (OIR), which indicates that the instrument set are likely to be valid. The F-test for the overall significance of the regression and the Arellano-Bond (AB) tests for serial correlation are also reported and broadly support the model specification.[16]

[16] If the model is well specified one can expect to reject the null of not autocorrelation of the first order (A-B AR1), and to not reject the hypothesis of no autocorrelation of the second order (A-B AR2). In other words, if a significant autocorrelation of the second order (A-B AR2) statistic is encountered, the second lags of endogenous variables will not be appropriate instruments for their current values.

Table 29: Robustness checks – main regression specifications under system-GMM with forward orthogonalization.

Model specification	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank	general	nation.	merger	bad bank
Reserves/NPL (lagged)	0.558***	0.599***	0.677***	0.588***	-0.902	-0.692	-0.705	-0.921	-1.719	-2.068	-0.821	-1.941	3.196**	2.548	2.411	2.609*
	[5.193]	[5.179]	[5.604]	[5.081]	[-1.307]	[-0.971]	[-0.894]	[-1.416]	[-0.724]	[-0.887]	[-0.305]	[-0.926]	[2.279]	[1.554]	[1.384]	[1.839]
Loan ratio (lagged)	-0.00507	-0.012	-0.0155	-0.0132*	0.0816	0.08	0.0838	0.0562	0.877***	0.857***	0.963***	0.894***	-0.0863	-0.045	-0.0531	0.008
	[-0.738]	[-1.293]	[-1.492]	[-1.693]	[1.259]	[0.934]	[0.999]	[0.768]	[5.063]	[4.494]	[4.790]	[5.270]	[-0.503]	[-0.22]	[-0.230]	[0.0373]
Total capital ratio (lagged)	-0.055***	-0.052***	-0.041**	-0.056***	0.702***	0.734***	0.743***	0.697***	-0.0597	-0.0363	0.107	-0.0572	0.445	0.45	0.515	0.373
	[-3.496]	[-3.313]	[-2.310]	[-3.376]	[3.890]	[4.230]	[4.071]	[4.336]	[-0.183]	[-0.104]	[0.272]	[-0.176]	[1.491]	[1.481]	[1.561]	[1.373]
ROAE (lagged)	-0.000859	-0.000526	-0.00031	-0.000217	-0.016**	-0.0144*	-0.012**	-0.012**	-0.0248	-0.0341	-0.00895	-0.0194	0.0133	0.0142	0.0128	0.00296
	[-1.175]	[-1.319]	[-0.649]	[-0.462]	[-2.303]	[-1.827]	[-1.995]	[-2.064]	[-0.812]	[-1.085]	[-0.207]	[-0.965]	[1.491]	[0.124]	[0.579]	[0.234]
TA (lagged)	-0.099***	-0.0661**	-0.0213	-0.0617**	-0.434*	-0.49	-0.376	-0.411	-1.075	-1.144*	-0.578	-1.064*	0.348	-0.452	-0.469	-0.796
	[-2.950]	[-2.096]	[-0.793]	[-2.262]	[-1.694]	[-1.245]	[-1.015]	[-1.285]	[-1.449]	[-1.660]	[-0.638]	[-1.665]	[0.449]	[-0.46]	[-0.420]	[-0.901]
Liquidity (lagged)	-0.00082	-0.0032	-0.00336	-0.0035	0.103*	0.083	0.104*	0.0919*	0.168	0.164	0.152	0.162	0.0629	0.066	0.0165	0.0736
	[-0.200]	[-0.591]	[-0.601]	[-0.784]	[1.671]	[0.124]	[1.686]	[1.694]	[1.601]	[1.560]	[1.419]	[1.531]	[0.550]	[0.601]	[0.137]	[0.634]
Loan growth (lagged)	-	-	-	-	-	-	-	-	-	-	-	-	-0.0673	-0.064	-0.0513	-0.105
													[-0.994]	[-0.86]	[-0.644]	[-1.233]
GDP growth	0.0229***	0.0126	0.00796	0.0145*	0.0183	0.0214	0.0226	-0.0162	-0.0178	-0.037	0.0429	-0.0032	0.0585	0.0355	0.0574	0.178
	[2.883]	[1.605]	[0.741]	[1.771]	[0.232]	[0.272]	[0.271]	[-0.192]	[-0.0791]	[-0.158]	[0.187]	[-0.0147]	[0.281]	[0.154]	[0.250]	[0.762]
Inflation (ln)	-0.08***	-0.0656**	-0.0435	-0.0667**	0.0874	0.0836	0.154	0.0648	0.963**	0.883*	0.952*	0.893*	0.966*	0.747	0.497	0.777
	[-2.861]	[-2.381]	[-1.306]	[-2.487]	[0.353]	[0.329]	[0.600]	[0.247]	[2.054]	[1.802]	[1.941]	[1.866]	[1.712]	[1.407]	[0.724]	[1.312]
Disclosure index	0.00988	0.00632	-0.00339	0.00808	0.122	0.165	0.117	0.168	0.252	0.364	0.0189	0.274	0.186	0.458	0.437	0.397
	[0.789]	[0.511]	[-0.318]	[0.725]	[1.217]	[1.570]	[0.974]	[1.412]	[0.761]	[0.985]	[0.0491]	[0.891]	[0.608]	[1.648]	[1.093]	[1.366]
Concentration ratio	0.00133	-0.000494	-0.00382	-0.000835	0.0303	0.0423	0.0302	0.0364	0.0652	0.072	0.0172	0.0661	0.0096	0.0813	0.0745	0.0983
	[0.398]	[-0.212]	[-1.531]	[-0.324]	[1.304]	[1.394]	[0.917]	[1.212]	[1.082]	[1.203]	[0.235]	[1.131]	[0.132]	[1.207]	[0.761]	[1.307]
Interaction term (1.treat# 1.post)	**0.00629**	**0.0527**	**0.656**	**0.236**	**1.1**	**-0.0029**	**14.62*****	**3.827****	**-2.799**	**0.375**	**-22.6*****	**-7.996****	**-6.177***	**-0.523**	**1.287**	**-14.1*****
	[0.0786]	**[0.500]**	**[1.294]**	**[1.125]**	**[1.049]**	**[-0.004]**	**[4.324]**	**[2.323]**	**[-1.572]**	**[0.226]**	**[-3.101]**	**[-2.432]**	**[-1.871]**	**[-0.19]**	**[0.0266]**	**[-3.163]**
Constant	4.234***	3.002***	2.721***	4.274***	1.81*	2.11*	1.01*	3.21	11.29	8.32*	12.1**	11.89**	-14.59	30.69	3.704	-50.21
	[1.823]	[2.902]	[2.993]	[3.683]	[0.244]	[0.124]	[0.982]	[0.289]	[0.572]	[0.124]	[0.124]	[0.124]	[-0.826]	[0.573]	[0.0236]	[-0.605]
Observations	1,377	1,377	1,377	1,377	1,370	1,370	1,370	1,370	1,402	1,402	1,402	1,402	1,383	1,383	1,383	1,383
No. of banks	400	400	400	400	404	404	404	404	413	413	413	413	409	409	409	409
No. of instruments	50	48	48	49	50	48	48	49	51	51	51	51	80	78	77	78
Lag limits	(2, 4)	(2, 4)	(2, 4)	(2, 4)	(2, 4)	(2, 4)	(2, 4)	(2, 4)	(6, 9)	(6, 9)	(6, 9)	(6, 9)	(2, 7)	(2, 7)	(2, 7)	(2, 7)
Forward orthog.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hansen test p-value	0.192	0.105	0.058	0.200	0.086	0.023	0.064	0.080	0.190	0.223	0.143	0.210	0.027	0.025	0.012	0.087
A-B AR(1) test p-value	0.001	0.002	0.003	0.001	0.004	0.003	0.005	0.003	0.004	0.005	0.010	0.002	0.002	0.002	0.002	0.003
A-B AR(2) test p-value	0.085	0.055	0.065	0.076	0.531	0.571	0.585	0.584	0.389	0.390	0.339	0.397	0.391	0.365	0.425	0.330

Notes: this table shows the results of my main regression specifications on bank, industry and country characteristics under system-GMM with forward orthogonalization . The dependent variables are i). loan loss reserves to NPLs ratio, ii). total capital, iii). loan ratio, and iv). loan growth. The respective columns illustrates the change in the 'treatment' variable via the interaction term which captures the impact on government intervention on bank's behaviour after the government intervention. Interventions include: nationalisation, government-assisted merger and 'bad' bank approach. All observations are weighted as follows: each observation is given a weight equal to the natural logarithm of the total number of banks in a given country divided by the sum of the natural logarithms of all banks in each country. Year dummies are included in all specifications, but are not displayed. Forward orthogonalization is used under all specifications. The lag limits vary depending on the specification in order to deliver optimal test results. Robust standard errors at the bank level are reported in brackets and are follows:

* Robust standard errors are shown in brackets, with significance at 10%

** Robust standard errors are shown in brackets, with significance at 5%

*** Robust standard errors are shown in brackets, with significance at 1%.

Source: Author's calculations (2019).

Despite the trade-offs between the validity of the instruments and the strength of the instruments (i.e. decreasing correlation with larger distance in time), the results displayed in Table 29 do confirm the initial results from the main regressions although they need to be consider with caution. All of the DID estimators under the reserves/NPL specification follow the same pattern as under the main results except merger which no longer display a negative influence of the government intervention. Similarly, all of the specifications under the total capital ratio measure of bank performance display similar results as under the main regressions except nationalisation which now indicate a negative impact of the interventions on the bank's capital position. The specifications under both measurers of lending activities display mixed results and, thus, not discussed as these results are likely to be biased due to the large lags which had to be implemented as explained earlier.

Lastly, I carry out robustness checks on the regressions with the semi-parametric DID estimators by testing the results on the sub-sample of banks with high NPLs (Tables 30-31). As with the main results I pay more attention to the results with the sub-sample of non-US banks in order to avoid any bias coming from the US dominance in the sample. As can be noted from Table 31, nationalisation continues to deliver non-positive results which is in line with the original findings. There is a limited statistical significance for the results of the merger intervention as it was the case under the main results. There is a slight change in the degree of significance underlying the semi-parametric DID estimator coefficients for the bad-bank intervention – although many coefficients still display a positive impact of this intervention on bank performance, there are weaker and less frequent in comparison to the earlier results.

Table 30: Robustness checks -effects of government intervention on the measurers of bank performance using SDID estimator –high NPL banks sub-sample (all countries).

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
general																
Constant	-0.167	-4.575	-1.056	12.362	-2.232	-31.980	-9.910	80.020	-7.41*	-78.756	-16.348	132.880	0.548	-40.262	11.929	-123.05
	0.585	7.623	10.891	86.762	2.542	33.011	138.081	1,068.863	4.260	55.779	108.756	854.071	3.517	43.538	96.683	774.662
ROAE		0.008		0.056		0.050		0.452		-0.181		0.514		-0.139		-0.525
		0.056		0.465		0.227		5.830		0.118		4.599		0.323		4.117
TA (ln)		0.362		-1.091		2.634		-7.039		4.573		-13.259		3.068		10.587
		0.613		7.623		2.649		93.826		4.131		74.607		3.449		68.298
Liquidity		0.002		0.026		-0.033		0.143		0.26***		0.506		0.036		-0.159
		0.005		0.142		0.033		1.683		0.079		1.323		0.044		1.336
No. of banks	596	596	746	746	601	601	668	668	592	592	746	746	592	592	743	743
nationalization																
Constant	-0.316**	-13.84***	0.142	-9.19*	-1.67***	-59.2***	1.017	-29.509	-10.1***	-144.6***	-2.057	-48.334	0.526	-2.468	1.447	6.116
	0.123	1.979	0.325	5.535	0.625	10.923	1.678	32.114	1.796	30.864	5.372	104.809	1.035	8.144	1.476	14.564
ROAE		-0.001		0.005		0.013		0.035		-0.035		-0.032		0.004		-0.049
		0.005		0.008		0.021		0.036		0.042		0.036		0.027		0.067
TA (ln)		1.07***		0.702*		4.62***		2.247		9.39***		2.366		0.181		-0.380
		0.152		0.417		0.843		2.412		2.475		7.924		0.694		1.209
Liquidity		0.002		0.003		-0.007		0.021		0.29***		0.25**		0.013		0.002
		0.004		0.007		0.019		0.030		0.066		0.100		0.041		0.060
No. of banks	559	559	731	731	553	553	653	653	550	550	731	731	556	556	728	728
merger																
Constant	-0.843	0.841	0.948	7.070	-3.210	-17.786	3.252	-21.121	-14.199	-69.261	9.315	-49.354	0.960	-56.392	-1.972	-76.116
	0.687	7.942	0.608	10.370	2.454	23.003	2.573	17.495	9.428	116.474	20.646	271.285	5.036	45.977	4.100	47.209
ROAE		0.009		0.006		0.011		-0.019		0.092		0.120		-0.064		-0.024
		0.021		0.014		0.042		0.013		0.300		0.460		0.129		0.040
TA (ln)		0.243		-0.296		2.369		2.275		9.416		10.920		3.444		5.011
		0.533		0.942		1.797		2.145		8.203		22.195		2.973		6.082
Liquidity		-0.11**		-0.089		-0.33*		-0.152		-1.35**		-2.337		0.398		0.557
		0.052		0.155		0.189		0.369		0.666		3.539		0.293		1.208
No. of banks	464	464	317	317	467	467	239	239	450	450	317	317	459	459	315	315
bad bank																
Constant	-0.664*	8.846***	no. conv.	no. conv.	-2.448	51.06***	no. conv.	no. conv.	-7.464	124.97**	no. conv.	no. conv.	-2.213	7.364	no. conv.	no. conv.
	0.401	2.813			1.677	12.224			4.550	57.149			2.813	15.540		

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
ROAE		-0.005				-0.009				-0.034				0.011		
		0.005				0.026				0.079				0.021		
TA (ln)		-0.74***				-4.32***				-12.32**				-1.142		
		0.274				1.176				5.671				1.435		
Liquidity		-0.054***				-0.25**				-0.315**				0.044		
		0.015				0.076				0.146				0.066		
No. of banks	479	479			473	473			484	484			458	458		

Notes: Models (1) and (3) report estimates of the average effect of government intervention for intervened banks. Models (2) and (4) show how the effect of government intervention varies with bank's size, profitability and liquidity level. The ATT reported in (1) and (2) are estimated using a linear polynomial function to approximate the propensity score. The ATT reported in (3) and (4) are estimated using a logit specification to estimate the propensity score. All regressions include the following control variables: banking sector concentration ratio, GDP growth, inflation, business disclosure country index, time and country dummies. Standards errors are in parentheses. Significance levels are denoted as follows: * p<0.10, ** p<0.05, and *** p<0.01.
Source: Author's calculations (2019).

Table 31: Robustness checks - effects of government intervention on the measurers of bank performance using SDID estimator –high NPL banks sub-sample (non-US banks).

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
general																
Constant	-0.192	-3.565	-1.056	12.362	-2.344	-26.928	-9.910	80.020	-7.35**	-72.218	-16.348	132.880	0.973	-43.684	11.929	-123.054
	0.786	10.041	10.891	86.762	3.579	45.643	138.081	1,068.863	4.016	53.402	108.756	854.071	4.771	59.339	96.683	774.662
ROAE		0.013		0.056		0.072		0.452		-0.172		0.514		-0.170		-0.525
		0.075		0.465		0.329		5.830		0.126		4.599		0.446		4.117
TA (ln)		0.274		-1.091		2.203		-7.039		4.014		-13.259		3.337		10.587
		0.804		7.623		3.647		93.826		3.974		74.607		4.697		68.298
Liquidity		0.004		0.026		-0.027		0.143		0.269***		0.506		0.038		-0.159
		0.005		0.142		0.034		1.683		0.076		1.323		0.047		1.336
No. of banks	590	590	746	746	593	593	668	668	588	588	746	746	586	586	743	743
nationalization																
Constant	-0.265**	-12.9***	0.142	-9.19**	-1.59***	-57.0***	1.017	-29.509	-9.79***	-135.3***	-2.057	-48.334	0.653	-1.763	1.447	6.116
	0.126	1.935	0.325	5.535	0.599	10.762	1.678	32.114	1.737	29.751	5.372	104.809	1.036	8.177	1.476	14.564
ROAE		0.000		0.005		0.013		0.035		-0.030		-0.032		0.003		-0.049
		0.005		0.008		0.022		0.036		0.047		0.036		0.028		0.067
TA (ln)		0.99**		0.702**		4.413**		2.247		8.604***		2.366		0.129		-0.380
		0.149		0.417		0.830		2.412		2.388		7.924		0.696		1.209

	Reserves/NPLs				Total capital ratio				Loan ratio				Loan growth			
	LPM		SLE		LPM		SLE		LPM		SLE		LPM		SLE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Liquidity		0.004		0.003		0.000		0.021		0.302***		0.248**		0.014		0.002
		0.004		0.007		0.019		0.030		0.065		0.100		0.041		0.060
No. of banks	548	548	731	731	549	549	653	653	543	543	731	731	548	548	728	728
merger																
Constant	-1.083	-0.724	0.948	7.070	-5.11***	-29.813	3.252	-21.121	-15.876	-87.428	9.315	-49.354	1.500	-54.003	-1.972	-76.116
	0.673	8.140	0.608	10.370	1.773	22.166	2.573	17.495	9.647	122.016	20.646	271.285	4.834	45.807	4.100	47.209
ROAE		0.008		0.006		0.006		-0.019		0.085		0.120		-0.063		-0.024
		0.021		0.014		0.042		0.013		0.301		0.460		0.129		0.040
TA (ln)		0.416		-0.296		3.66**		2.275		11.378		10.920		3.179		5.011
		0.556		0.942		1.653		2.145		8.834		22.195		2.954		6.082
Liquidity		-0.13**		-0.089		-0.49**		-0.152		-1.57***		-2.337		0.432		0.557
		0.048		0.155		0.151		0.369		0.634		3.539		0.299		1.208
No. of banks	459	459	317	317	461	461	239	239	442	442	317	317	455	455	315	315
bad bank																
Constant	-0.383	7.92***	no conv.	no conv.	-0.265	44.44***	no conv.	no conv.	-5.714	116.11**	no conv.	no conv.	-2.178	6.878	no conv.	no conv.
	0.432	2.670			2.418	12.138			4.377	53.784			2.807	15.468		
ROAE		-0.003				0.011				-0.014				0.011		
		0.006				0.035				0.081				0.020		
TA (ln)		-0.616**				-3.44**				-11.19*				-1.092		
		0.264				1.261				5.349				1.428		
Liquidity		-0.05**				-0.27**				-0.28*				0.044		
		0.015				0.079				0.145				0.066		
No. of banks	474	474			468	468			477	477			450	450		

Notes: Models (1) and (3) report estimates of the average effect of government intervention for intervened banks. Models (2) and (4) show how the effect of government intervention varies with bank's size, profitability and liquidity level. The ATT reported in (1) and (2) are estimated using a linear polynomial function to approximate the propensity score. The ATT reported in (3) and (4) are estimated using a logit specification to estimate the propensity score. All regressions include the following control variables: banking sector concentration ratio, GDP growth, inflation, business disclosure country index, time and country dummies. Standards errors are in parentheses. Significance levels are denoted as follows: * p<0.10, ** p<0.05, and *** p<0.01.
Source: Author's calculations (2019).

3.4. Conclusion

My findings show that there is no 'one-size-fits-all' solution for an effective government intervention in the banking sector. There are certain trade-offs between the desirable as well as undesirable implications of interventions on banks' future lending behaviour as well as their capital and reserves positions. The effectiveness of the interventions depends on what the government is aiming to achieve in terms of the banks' performance, e.g. higher bank lending, stronger capital base of banks, lower NPLs on banks' balance sheets. These objectives should be timely assessed due to the risk of the negative contagion between the banks as well as the moral hazard which can emerge in the longer term.

The findings indicate some favourable implications of the 'bad bank' intervention towards banks' future performance. However, it is important to note that the effectiveness of 'bad bank' approach is often tied up to the state of development of the secondary NPL market . Information asymmetry is likely to play a role in the likely outcome of such intervention scenario. My results also indicate that nationalisation is the only intervention out of the studied cases which delivers net positive changes on all of my studied measurers of bank performance. However, the other interventions are more effective in producing larger magnitude of the positive change in the intervened banks on individual measurers of bank performance if government were to choose to target those separately.

My results contribute to the mixed empirical evidence from earlier studies in this field which is varied and inconsistent. This all fits well with the direction of the recent policy reforms which have endowed financial regulators with broader powers to 'bail-in' the creditors of troubled banks, with the higher aim of avoiding future 'bail-outs' funded by the taxpayers. One may argue that a combination of government intervention with a market based solution could lead to a greater success than a solo bail-in or bail-out intervention which is an interesting future research topic. Such intervention approach would require significant coordination of different policies in order to yield their combined effectiveness which could be challenging to deliver in the banking world with multiple players with very diversified profiles and areas of interest.

The chapter suffers from several limitations which leaves scope for further research. Firstly, I am not able to assess certain granularity of the studied government interventions, e.g. the size of the intervention stimulus, the timing and duration of the intervention, due to data availability.

Secondly, I did not explore the selection of the banks receiving the intervention also due to lack of access to such information. In addition to this, I could not explore specific sources of bank failures. These may have the power to predetermine the effectiveness of the government intervention which further research may explore. A deeper analysis into a multiple range of interventions to single banks or banks with close proximity could bring additional lessons. Also, I only looked at the crisis resolution policies (e.g. merger, nationalisation), but I could have extended the analysis to include any earlier intervention in the format of crisis containment policies (e.g. blanket guarantee, liquidity provisions). These could contribute to the bank's future performance and, thus, influence the performance of these banks following yet another intervention at the resolution stage of the crisis. This leaves further scope for future research which I am currently exploring. Due to the data limitation, I could also not explore the cases where government intervention into banks through recapitalisation could have been more costly than liquidation. All of these aspects and topic areas leave scope for further research which I am looking into.

4

Government-triggered changes in bank performance and financial stability

Abstract

Till today there is no consensus among scholars as to what constitutes a stable financial system. And, to even greater extent, scholars and policy makers are still in disagreement on whether government interventions into the failing banks actually help in restoring financial stability in the economy. In this chapter, I apply the model of financial stability by Goodhart et al. (2004, 2005) to illustrate how changes in the bank performance caused the government interventions impact financial stability. The applied model has been widely used by central bankers and regulators across the globe to illustrate the trade-offs between bank's performance and financial stability. Here, it is used as a risk assessment tool to assess how changes in bank performance triggered by a range of government interventions affect banking sector and financial stability in general. Specifically, I incorporate three government interventions into this model, namely nationalisation, merger and 'bad-bank'. These are the same interventions I studied under the previous chapter of this thesis. I use ex-ante bank's NPL levels as the driving factor behind the government interventions due to the role they play in the economy which I explain under the literature review. I then assess the impact of the studied interventions on banks through a calibration exercise based on the model of Goodhart et al. (2004, 2005). The model includes heterogenous agents, banks and endogenous default. It allows for various feedback and contagion channels to operate in equilibrium. Under a wide range of intervention scenarios I study in this chapter, the government injects capital and/or acquires stake when the bank struggles with high NPLs. I explore the directional changes in the endogenous variables in the model under these illustrative interventions through the assessment of the responses to the shocks in the UK economy triggered by the bailout scenarios. I am able to replicate the behaviour of important variables using this model and assess the trade-offs between bank performance and financial stability. My findings contribute to the relevant literature by bringing in a novel application of the well-known model of financial stability which can be useful for other scholars and policy makers.

4.1. Introduction

The latest financial crisis of 2007-2008 has restored the debate on how to improve and maintain the stability of the financial system. This debate is becoming even more important today as the world is faced with yet another financial crisis triggered by the Covid-19 pandemic. Banks are already faced with an increasing rate of loan defaults which can soon become a real threat to financial stability. Many economists and policy makers are still discussing whether bailing out failing banks is an effective way to restore and preserve financial stability due to inconclusive and mixed literature evidence. As reviewed and analysed empirically in the second chapter of my thesis, in most financial crises there has been some kind of government intervention. These interventions have often been launched as a prevention to even deeper credit contractions which could have negative impact on financial stability and, eventually, economic growth (Laeven and Valencia, 2008). Different mechanisms have been used in practice to prevent the propagation of crises, but all of them are costly and their effectiveness is at least uncertain as I have outlined in the second chapter of my thesis.

Computable general equilibrium (CGE) models have been introduced into the financial literature in order to shed some light on the complex relationships between banks, depositors, borrowers and economic authorities that determine the extent of financial stability. In this chapter, I apply the model by Goodhart et al. (2004, 2005) to assess the impact of government interventions introduced due to high levels of NPLs into the banking sector. The model has been widely used by scholars for analysing financial stability (Goodhart et al., 2006a; Lewis, 2010; Saade et al., 2007; Lee et al., 2013), determining the effect of monetary and fiscal expansion on an economy (Rumler, 1999) and for forecasting real-time inputs for policymakers (Altig et al., 2014). This is the first use of this model in the context of government interventions into failing banks.

This chapter comes timely as financial stability is, once again, faced with an increasing threat caused by the Covid-19 pandemic. For instance, a stock in excess of €900 billions of NPLs already continue to clutter the European banking system, endangering financial stability and further economic growth. This issue remains a key challenge for policy makers, particularly now as many banks around the world already challenged with an increasing rate of loan defaults due to the chaos caused by the latest pandemic.

High and rising levels of NPLs burden bank balance sheets and act as a drag on bank profits. Banks, striving to maintain provisions to cover bad loans, to reduce their earnings to build-up their capital buffers. This combination of weak profits and a decline in the quality of bank assets, resulting in tighter lending standards, creates challenging conditions when it comes to new lending and preserving financial stability. I explain his in more details in the literature review.

My application of the model by Goodhart et al. (2004, 2005) bring similar findings as those reached under the second chapter of my thesis. Namely, the results of the calibration exercise based on the UK bank data identify no clear winner among the assessed government interventions. Similarly to the previous chapter, the results are mixed from both angles, in-between interventions and with-in banks. Overall, both Merger scenarios as well as Bad bank 2 scenario seem to deliver the most positive directional changes for all banks in the economy, although with few trade-offs. From the policy perspective, this implies that governments need to carefully assess at ex-ante stage what they wish to target with their interventions in order to avoid causing more distraction to the entire banking sector as a whole.

The structure of this chapter is as follows. I begin with the literature review in which I outline the relevant conceptual aspects in the context of the financial stability, in particular its definition, systemic risk, banking bailouts and the role of NPLs. I also introduce the concept of CGE modelling which is at the core of this chapter. I then move to the detailed description of the specifics of the CGE model I apply in this chapter, namely the financial stability model by Goodhart et al. (2004, 2005). This is then followed by the outline of the calibration exercise using this model and its results. The final section discusses the results and which is followed by the chapter's conclusions which includes its limitations and areas for further research.

4.2. Literature review

I review several strands of literature which relate to the topic of financial stability and the research approach applied in this chapter. I begin by defining the concept of financial stability which many governments around the globe preserve as their ultimate goal for their banking sectors based on fully functioning and healthy banks. I then move to addressing the systemic risk which is strongly related to the financial stability and address in the model of Goodhart et

al. (2004, 2005) which I apply in this chapter. I then move to explaining financial stability in the context of NPLs. I explore the literature on NPL determinants in detail. I end the section by explaining the CGE modelling approach and the associated research in this field to which my chapter contributes.

4.2.1. Defining financial stability

There is no general consensus on the definition of financial stability among scholars and policy makers (Fell and Schinasi, 2005). Some scholars choose to define financial instability instead of stability, whereas others define the problem in terms of managing risks rather than safeguarding banks' stability. Crockett (1997) notes that financial stability requires key institutions and market players to be stable. Mishkin (1994) adds that financial instability occurs when shocks to the financial system interfere with information flows so that the financial system can no longer do its job of channelling funds to those with productive investment opportunities. Ghosh (2015) claims that a mainstay of financial stability is a sound banking system that efficiently channelizes funds between borrowers and savers. Haldaneet al. (2004) go further and claim that financial instability is any deviation from the optimal saving-investment plan of the economy that is due to imperfections in the financial sector. Issing (2003) and Foot (2003) argue that the financial instability is linked to financial market bubbles, or more generally, volatility in financial markets.

None of the existing studies appropriately and fully defines a precise measure to analyse financial stability. Cevik et al. (2013) and Illing and Liu (2006) conduct a general survey and mention that financial stability indices typically aggregate some variables, indicating different author-defined risks, (e.g. if values of these variables deteriorate within a certain period, then financial instability arises). All of this adds to the difficulty in assessing the role of banks' performance in delivering financial stability in a given country.

There is a vast body of recent literature analysing the impact of a wide range of accounting-, market- and general economic factors on financial stability. Papers based on accounting-methods, such as Kohler (2015), Demirgüç-Kunt and Huizinga (2000), Chiaramonte et al. (2015b), Doumpos et al. (2015), show that banks' instability is mainly driven by, for instance, low capitalisation, low earnings, large bank size and excessive loan defaults. These are useful lessons to consider in my application of the model by Goodhart et al. (2004, 2005).

In this chapter, I adopt the definition of financial instability as employed by Tsomocos (2003) and Goodhart et al. (2006), in which financial instability is considered as a combination of high risks with low profits. Several past financial crises are characterised by this definition, including the financial crisis of 2007-2008. Specifically, they define the lack of financial stability as characterized by reduced bank profitability and increased insolvency risk. They argue that when bank insolvency risk increases, bank profitability decreases. In other words, when the economy is financially more fragile, real output falls. This logic is reflected in the model of financial stability by Goodhart et al. (2005, 2006) on which I rely in my simulations and calibration exercises that are at the core of this chapter.

More formally, Tsomocos (2003) defines monetary equilibrium with commercial banks and default (MECBD) as financially instable whenever a substantial number of households and commercial banks default on some of their obligations (i.e. a liquidity crisis), without necessarily becoming bankrupt, and the aggregate profitability of the banking sector decreases significantly (i.e. a banking crisis occurs). The definition of financial instability is as follows: a MECBD $(\eta, (\sigma^h)h\epsilon H, (\sigma^b)b\epsilon B)$ is financially instable at s whenever $D_{sz}^{h*}, D_{sz}^{b*} \geq \overline{\Pi}$ for $|H*| + |B*| \geq \bar{Z}$, and $s\epsilon S*$ where $\bar{Z}\epsilon\ (0, |H| + |B|)$ and $\overline{\Pi}, \overline{D}\ \epsilon\ R_{++}$.

This definition requires both increased default and reduced aggregate profitability of banks for the financial instability to occur. Increased bank default by itself might indicate excessive risk taking without necessarily putting a serious strain on the financial sector of the economy, whereas a decrease in bank profitability by itself might indicate the onset of a recession in the real economy and not of financial vulnerability. In more general terms, this definition indicates that with the heterogenous agents in the economy, the welfare of a society depends not only on aggregate outcomes, but also on the distribution over agents. This definition explicitly hinges upon the welfare of the economy and its distributional consequences. This would be touched on in the discussion of the results from my calibration exercise.

Lastly, the applied definition of financial stability links strongly to the contagion between the agents in the economy. There are various contagion channels at play here. The first channel of contagion is the one generated by increased default in a specific sector of the economy. For example, if a specific bank charges exorbitantly high interest rates on its clients then their

subsequent default impacts upon the rest of the economy. As explained by Goodhart et al. (2006), commercial banks reduce their repayment rates in the interbank market and investors and/or commercial banks abrogate their obligation in the asset markets. Alternatively, the community markets may be affected either through reduced supply which, in turn, affects expected income of the household sector. The conclusion based on this chain of contagion is that the reduced liquidity hurts the lenders whose income is reduced. This, in turn, leads to decreasing their consumption and welfare. The same chain of logic applies for contagion through the interbank market's which is faced with an increased default triggered by high NPLs on bank's balance sheet.

Second, contagion may commence through the collapse of the banking sector's equity value in the secondary market. Since the distribution of profits to the investors is determined by the shares of ownership as they are specified in the secondary banks' equity market, a weakness of the banking sector is translated to investors' income. Reduced expected profitability of the banking sector will be reflected in a reduced value of shares of ownership of banks' equity and, thus, the reduced income will lower such agents' repayment rates of loans and asset deliveries.

Finally, the last channel of contagion can be generated by a possible ineffectiveness of monetary policy which is beyond the scope of this chapter due to its focus on government interventions. As monetary policy eases without affecting the real side of the economy (i.e. liquidity trap), the extra liquidity inflates activity in some asset markets. This, in turn, leads commercial banks to violate excessively their capital requirements which adversely affects their profitability and subsequently their equity value. Through the investor sector's ownership of bank shares contagion spreads outside the banking sector and may reduce welfare in the rest of the economy (Goodhart et al., 2006).

4.2.2. Financial stability and systemic risk

I now turn to few reflections on systemic risk which has been already discussed in more depth in the second chapter of this thesis. Despite the fact that systemic risk is a major factor in financial stability, there is a rather limited use of the economic models in assessing such risk (Allen et al., 2014). By definition, systemic risk occurs if many banks fail together or if one bank's failure brings about the failure of other banks (Acharya, 2009). The 2007-2008 financial crisis showed that systemic risk can take many forms (Georg, 2013). One example is interbank

contagion which occurs as a result of the linkages between banks from interbank lending, e.g. a default from one bank causing losses and further defaults from other banks as explained in the applied definition of financial stability. Another example is a common shock to the banking sector in general as a result of banks having similar asset holdings. Prior to the financial crisis of 2007-2008, macroprudential regulation concentrated on single institutions (Allen and Carletti, 2012). Because of this many claim that regulation failed to deal with systemic risk in the past. In more recent times, the systemic risk is taken into consideration when looking at regulation. Properly implemented capital regulation may lower systemic risk. However, the analysis of whether this is the case is beyond the focus and scope of this chapter.

Still, it is important to note that there is some evidence indicating that banks are transferring credit risk to insurance companies (Allen and Gale, 2007). On one hand, this transfer is desirable as it allows for diversification amongst various sectors of the financial industry. However, it is argued that shifting the risks to insurance companies may impact the banking sector in the form of counter-party credit risk (Hellwig, 1994, 1995, 1998). It was demonstrated that the transfer of risk indeed leads to optimal allocation of capital as a result of diversification, but, if not properly designed, could actually contribute to a further increase of systemic risk (Allen and Gale, 2007).

4.2.3. Financial stability and banking bailouts

There is a growing literature that examines various economic trade-offs that accompany bank bailouts (e.g. Merton, 1977; Keeley, 1990; Demirguc¸-Kunt and Detragiache, 2002; Dam and Koetter, 2012; Gropp et al., 2011). The optimal distance between regulators and regulated entities in the banking sector is one of the major issues in current discussions among academics and policy makers (Agarwal et al., 2014; Colliard, 2013). For example, decisions on bank bailouts are often taken by politicians, and in many cases these politicians are closely linked to the banks in distress. This adds to the difficulty of assessing the impact of government intervention on bank performance and financial stability.

At the same time, bailouts may increase investors' concerns about the financial stability and the soundness of the financial system. For instance, announcements of the government interventions may raise uncertainty about counterparty risk and eventually contribute towards contagion problems (Ait-Sahalia et al., 2012). Besides, interventions may be less effective

because of the difficulty in fully assessing the contagion channels in the banking sector. Proponents of bank bailouts argue that bank failures generate significant negative externalities that can have debilitating real effects. Thus, every effort should be made to avoid bank failures. Critics, on the other hand, voice concerns about the fiscal costs and moral hazard problems that accompany banking bailouts. Most of these discussions, however, omit an important factor that could affect bank bailout decisions, namely the personal interests of politicians involved in these decisions. Politicians may follow their own interests (i.e. constituents and special interest pressure in order to increase their probability of re-election) or their own ideological preferences (e.g. the conservative principle of limited intervention in private markets; see Peltzman 1985, Poole and Rosenthal, 1996).

Scholars have widely explored this research area. For instance, Kollmann et al. (2013) study how the support for banks had a stabilising effect on Eurozone real variables. In their model, banks can deviate from an exogenous leverage constraint at a cost. In that case, supporting constrained banks leads to higher investment and output. Farhi and Tirole (2018) highlight how bailouts generate risk-shifting from banks, making them the natural buyers of domestic bonds. A full literature review of empirical studies on the banking bailouts is available in the second chapter of this thesis.

4.2.4. Financial stability and NPLs

In my application of the model by Goodhart et al. (2004, 2005), I use NPLs as the key factor driving government interventions. NPL modelling is very often used by central banks within the stress test methodology (e.g. Buncic and Melecky, 2012; Marcelo et al., 2008). NPL is an indicator which is closely associated with weaknesses in the stability of the financial system. This can be confirmed by the strong link observed between the surge in NPLs and the occurrence of banking crises. Once again, this topic is at the core of today's attention of many central bankers and regulators as the world is faced with a growing amount of defaulted loans as triggered by the Covid-19 pandemic. Reinhart and Rogoff (2011) point out that the rise in NPLs can be used to mark the onset of banking crises. Sorge (2004) recommends the use of NPLs to test the vulnerability of the financial system. I follow this approach by assigning bank's high NPL levels as the trigger for government to step in into the banking sector.

There is no doubt that there is a strong correlation between financial stability and NPL levels. According to Digal and Kanungo (2015) one of the most desirable characteristics of a well-functioning stable financial system is the maintenance of a few NPLs. Michael et al. (2006) highlight that NPLs in loan portfolio affect operational efficiency which, in turn, affects profitability, liquidity and solvency position of banks. The deterioration of banks asset quality through high NPLs is not only financially destabilising for the banking system but may also reduce economic efficiency, impair social welfare and decline economic activity (Ghosh, 2015; Barsenghyan, 2010). Many scholars alluded NPLs as "financial pollution" due to their adverse economic consequences (Barsenghyan, 2010; Gonzales-Hermosillo, 1999; Zeng, 2012). Hence, governments often target reduction of NPLs as the necessary pre-condition required in order to restore a sounder banking system and foster overall financial stability.

Several studies examined bank failures and find that asset quality, often measured through NPLs, is an indicator of insolvency (Demirguc-Kunt, 1989; Barr and Siems, 1994). Banks generally have a high level of impaired NPL loans before their bankruptcy. Therefore, a large amount of bad loans in the banking system generally results in bank failures. The NPLs are among the main causes of the problems of economic stagnation. Each impaired loan in the financial sector increases the possibility to lead company to difficulty and unprofitability. Thus, many governments and central bankers perceive a high level of NPLs as a signal to step in into the banking sector in order to avoid bank's bankruptcy. This is why NPLs are used as the trigger for government interventions in the model application I present in the next section of this chapter.

The latest financial crisis of 2007-2008 has sparked an interest in understanding the drivers of NPLs across the globe. These have ranged from cross-country analysis, i.e. panel data models, to country-specific case studies. It is important to review these studies to present a holistic view on NPLs due to its important role in my model application. Table 30 present a summary of the latest studies which analyse the determinants of NPLs at both micro- and macro-level. I summarise the key factors which play a role in driving NPLs in order to deliver a better understanding of their role in the economy and how they interlink with various endogenous and exogenous variables which I use in the applied model of Goodhart et al. (2004, 2005) I present in the next section of this chapter.

Overall, the empirical literature on the determinants of NPLs is based on theoretical models that deal with the business cycle with an explicit role for financial intermediation. The financial accelerator theory as discussed in Bernanke and Gertler (1989), Kiyotaki and Moore (1997), is the widely used theoretical framework to link NPLs with a nation's macroeconomic environment.

A number of studies listed in Table 32 examine the feedback effects from the banking system to the real economy from a cross-country perspective. Espinoza and Prasad (2010), for instance, look at a sample of 80 banks from the Gulf Cooperation Council's region and find that an increase in NPLs reduces credit growth and the non-GDP growth. Nkusu (2011), who focuses on 26 advanced economies in the period of 1998-2009, finds that adverse shocks to asset prices, macroeconomic performance and credit to the private sector lead to a worsening of loan quality. In turn, higher NPLs led to a decline in house prices, credit-to-GDP ratio, and, eventually, GDP growth.

Klein (2013) finds that variation in NPLs can be explained by both macroeconomic conditions and bank-level variables by looking at both bank-level data and macroeconomic indicators over 1998–2011 in CESEE economies. Festic and Beko (2008) employ the vector autoregression approach for the NPLs dynamics in the five CEE countries and they concluded that GDP growth, FDI growth, real interest rates, and credit growth are significant macroeconomic variables. Festic et al. (2009) use panel estimates to explain the NPLs, by introducing macroeconomic and banking sector variables. They find that credit/asset ratio and gross fixed capital formulation have a positive impact on the NPLs, and that the deposit/loan ratio, exports of goods and services, real effective exchange rate, and long-run (real) interest rates have a negative impact on the NPLs. Festic et al. (2011) test the determinants of the NPLs for the same five CEE countries by using instrumental variables (2SLS) approach. Their estimates support the view that the growth of credit and amount available to finance may harm banking performance.

Other scholars focus on bank-level determinants of NPLs. For instance, Salas and Saurina (2002) analyse problem loans of the Spanish commercial and savings banks and find that credit risk is determined by microeconomic individual bank level variables, such as bank size, net interest margin, capital ratio and market power, in addition to real GDP growth. Bercoff, Giovanni and Grimard (2002) show that asset growth, operating efficiency and exposure to

local loans helps in explaining NPLs at bank-level. Laeven and Majnoni (2003) analyse bank-level data from 45 countries to shed light on factors influencing the loan loss provisioning and income smoothing of more than 1,000 large commercial banks during the period 1988–1999. They find that, on average, banks provision too little in good times of the cycle and are forced to overreact in bad times. They also detect a significantly negative contemporaneous relation between loan growth and loan losses, suggesting an imprudent provisioning behaviour of banks.

Similarly, Bikker and Metzemakers (2005) examine the contemporaneous relation between loan loss provisioning of individual commercial banks and the business cycle during the period 1991–2001. Based on the bank-level data from a subset of OECD countries, they find a negative relation between GDP growth and loan loss provisioning, i.e. a procyclical effect. This relation is partially mitigated by a positive contemporaneous link between loan loss provisioning and loan growth, which is in contrast to the findings from Laeven and Majnoni (2003). Hess et al. (2009) analyse determinants of credit losses at 32 Australasian banks during the period 1980–2005. They document that strong loan growth translates into higher credit losses with a lag of two to four years. Iannotta et al. (2007) as well as Illueca et al. (2008) find that bank ownership is an important determinant of bank's NPLs, their lending behaviour, risk taking and bank performance. All of these findings provide a valuable foundation on which I assign the NPLs as the driver of government interventions in the applied CGE model to which I turn next.

Table 32: Determinants of NPLs – literature review.

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level	Dimitrios et al. (2016)	Determinants of NPLs in Euro-zone area countries	1999 Q1- 2015 Q2, 15 Euro-area countries	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Lithuania, Luxembourg, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.	GMM estimates	ROA	negative (significant)
						ROE	negative (significant)
						Loans-to-deposits ratio	not significant
						Unemployment	positive (significant)
						Taxed (personal) income as % of GDP	positive (significant)
						Government budget balance as % of GDP	not significant
						General gross government debt as % of GDP	not significant
						Real GDP real growth rate	n/a
						CPI (change)	n/a
NPL micro-level	Espinoza and Prasad (2010)	NPLs in GCC banking system and their macroeconomic effects	1995-2008, 80 banks in GCC region	Bahrain, Kuwai, Oman, Qatar, Saudi Arabia, UAE	VAR model, dynamic panel specifications: OLS, fixed effects, difference GMM, System GMM	ln(NPL/(1-NPL))-1	n/a
						ln(equity)-1	n/a
						(expenses/avg. assets)-1	positive (significant)
						loans growth -2	n/a
						non-oil GDP growth	negative (significant)
						interest rate -1	negative (significant)
						VIX index	positive (significant)
						Asian financial crisis 1997-1998 dummy	not significant
	Ghosh (2015)	Determinants of NPLs in US	1984-2013, commerical and	U.S. states		NPL ratio	n/a
						equity capital-to-assets	significant

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level		states: banking-industry specific and regional economic	savings institutions from 50 US states and the District of Columbia		fixed-effects and dynamic-GMM estimations	loans-to-assets	
						loans and lease loss provision-to-total loans	significant
						non-interest income to total income	n/a
						non-interest expenses to total assets	significant
						net pre-tax income to total assets	significant
						log of total assets to number of banks	significant
						others (regional economic conditions and national economic conditions)	n/a
NPL macro-level	Beck et al. (2015)	Determinants of NPLs: global sample	75 countries	[multiple]	dynamic panel estimates	NPL stock	n/a
						real GDP	significant
						nominal effective exchange rate	significant
						lending interest rate	significant
						share prices	significant
						international claims	n/a
						stock market capitalization	n/a
NPL macro-level	Cifter (2015)	Bank concentration and NPLs in CEE countries	2000-2009, 10 CEE countries	Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia	fully modified OLS approach, GMM-system, IV	NPL to total bank loans	n/a
						bank concentration ratio (assets share of the 3 largest banks in the total assets of the banking system)	not significant
						gross fixed capital formulation	n/a
						exports of goods and services	n/a
						credit/deposit ratio	n/a
						others	

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level	Louzis et al. (2012)	Macroeconomic and bank-specific determinants of NPLs in Greece	9 largest Greek banks, 2003Q1 - 2009Q3	Greece	dynamic panel data methods	NPL ratio	n/a
						Debt ratio	not significant
						ROE	significant
						solvency ratio	not significant
						inefficiency	significant
						Size (TA)	significant
						non-interest income	n/a
						leverage ratio and size	n/a
						ownership concentration	n/a
						Macroeconomic factors (GDP, unemployment, interest rate, public debt)	significant
NPL micro-level	Messai and Jouni (2013)	Micro and macro determinants of NPLs	85 banks, 3 countries, 2004-2008	Italy, Greece, Spain	panel regression model	NPL ratio	n/a
						real GDP growth	negative (significant)
						rate of unemployment	positive (significant)
						real interest rate	positive (significant)
						loan losses reserves/total loans	positive (significant)
						loan growth rate	not significant
						ROA and ROE	negative (significant)
NPL micro-level	Nkusu (2011)	NPLs and macrofinancial vulnerabilities in advanced economies	1998-2009, 26 advanced economies	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Israel, Italy, Japan, Korea, Luxembourg, the Netherlands, New	single-equation panel regression, panel vector autoregressive models	NPL ratio	n/a
						stock price index, house price index	significant
						GDP, unemployment, credit to private sector % GDP, change in CPI and others	significant

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
				Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, UK, USA			
NPL micro-level	Berger and DeYoung (1997)	NPL and cost efficiency in US commercial banks	1985-1994, US commercial banks	USA	Granger-causality techniques	NPL ratio	n/a
						short-term cost effciency	negative (significant)
						equity capital ratio	positive (significant)
						risk-weighted asset ratio	not significant
						regional dummies	n/a
						time dummies	n/a
NPL micro-level	Podpiera and Weill (2008)	Causality between NPL and cost efficiency as determinants of bank failures	1994-2005, Czech commercial banks (all - 43 banks)	Czech Republic	GMM dynamic panel estimators within Granger causality framework	NPL ratio	n/a
						Loans ratio	significant
						measure of cost efficiency (based on price for labour, price of physical capital, price of borrowed funds, total costs)	negative (significant)
NPL micro-level	Ozili (2015)	determinants of NPL by bank managers by balance sheet adjustments	82 banks, countries: US, Europe, Asia and Africa; 2004-2013	USA, Europe, Asia, Africa	panel OLS with fixed effects	NPL as ratio of impaired loans to gross loans	n/a
						growth in gross loans	not significant
						total loan to total assets	significant
						size of the gross loan	significant
						GDP	significant
						ratio of loan loss reserves to gross loans	significant
						regulatory dummy (strict post-2008 banking regulation)	significant

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level	Klein (2013)	Determinants of NPLs and their impact on macroeconomic performance in CESEE	1998-2011 in 16 CSEE countries, 976 observations	Bosnia and Herzegovina, Bulgaria, Croatia, Czech Rep, Estonia, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Serbia, Slovak Rep., Slovenia, Ukraine	fixed effects model, difference GMM, system GMM, VAR analysis	NPL ratio	n/a
						equity to asset ratio	negative (significant)
						ROE	negative (significant)
						loan to asset ratio	positive (significant)
						loans growth rate	positive (significant)
						three country specific variables (inflation, the change in FX rate vis a vis Euro, the change in unemployment	n/a
						two global variables (the Euro's zone GDP growth, global risk aversion (SP500 index)	n/a
NPL micro-level	Foos et al. (2010)	Loan growth and riskiness of banks	16,000 banks (130, 368 annual observations), 1997-2007, 16 countries	USA, Canada, Japan, Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK	system-GMM, modified VAR model	loan growth provision	n/a
						loan growth	positive (significant)
						total customer loans	n/a
						capital ratio	negative (significant)
						relative interest income (fraction of the total gross interest income over total customer loans)	negative (significant)
						equity to total assets ratio	n/a
						specialization dummies	n/a
						country-year dummies	n/a
	Hou and Dickinon (2007)	Bank-level evidence on NPLs		USA, Japan, Hong Kong, Philippines,	IV model, threshold method	NPL ratio	(varies depending on the country)
						loan growth rate	

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level			commercial banks in 19 countries, 1998-2005	Indonesia, Thailand, Korea, France, Poland, Croatia, Latvia, Romania, Serbia and Montenegro, Ukraine, Czech Republic, Bosnia, Hungary, Slovakia, Turkey		deposit growth rate	
						capital growth rate	
						other assets growth rate	
						NPL growth rate of the previous year	
NPL micro-level	Shehzad et al. (2010)	The impact of bank ownership concentration on impaired loans and capital adequacy	500 commercial banks, 50 countries, 2005-2007	[multiple]	country random effects models	NPLs (impaired loans/ gross loans)	n/a
						risk-weighted capital adequacy	positive (significant)
						different levels of shareholding	negative (significant)
						shareholder protection rights	negative (significant)
						supervisory control	negative (significant)
						cost/income	not significant
						bank equity	not significant
						others (activities restrictions, loan growth, bank concentration, listed bank, GDP per capita)	n/a
NPL micro-level	Ikram et al. (2016)	Bank-specific microeconomic determinants of NPLs	49 branches of 9 commercial banks, Pakistan, 2014-2015	Pakistan	descriptive stats only	NPL ratio	n/a
						branch age	significant
						duration of the loan	significant
						credit policy	significant
						risk management practices	n/a
						others	n/a
			2005-2015, Greece	Greece		NPL ratio	n/a

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level	Monokroussos et al. (2016)	NPLs in Greece: effects of recession and banking practices			VEC (vector error correction) and VAR models	total stock of bad loans	significant
						other: consumer bad loans, mortgage bad loans, corporate bad loans	mixed results
						total stock of restructured bad loans	significant
						macro variables: real GDP, labour market conditions, domestic inflation, collateral values, debt service cost	n/a
						bank-specific variables: loans to deposits interest rate spread, growth of stock of performing loans, bank solvency and capitalization	n/a
NPL macro-level	Skarica (2014)	determinants of NPLs in CEE countries	7 CEE countries, Q32007- Q32012, 188 entries	Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Romania, Slovakia	fixed effects estimators	NPL ratio	n/a
						real GDP growth	positive (significant)
						appreciation of domestic currency	n/a
						inflation	positive (significant)
						interest rates	n/a
						share prices	n/a
						credit growth	n/a
						unemployment	positive (significant)
	Vouldis and Louzis (2018)	determinants of NPLs in Greece:	9 largest Greek banks spanning	Greece	quasi-AIM (aggregating	NPL ratio	n/a

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
NPL micro-level		information content of macro-, micro- and bank-specific factors	from 2003Q1 until 2009Q3.		individual markets) forecasting methodology	ROE, ROA, solvency ratio, leverage ratio, inefficiency, growth of bus loans/consumer loans/mortgages	significant
						real GDP growth, change in industrial production, real change in exports, real change in imports, change in unemployment, interest rate on consumer loans, others	mixed
NPL micro-level	Mannasoo and Mayes (2005)	determinants of NPLs in Eastern European transition economies	118 distress episodes, 600 banks in 19 countries, 1995-2004	Belarus, Serbia, Russia, Bosnia and Herzegovina, Ukraine, Albania, Moldova, Macedonia, Romania, Bulgaria, Lithuania, Slovakia, Croatia, Slovenia, Latvia, Poland, Czech Republic, Estonia, Hungary	survivor function analysis, cloglog hazard model	NPL ratio	n/a
						ROA	positive (significant)
						capital-asset ratio	positive (significant)
						cost-to-income ratio	not significant
						equity investments to total assets, trade-income or other operating income to pre-tax profit	positive (significant)
						volatile short-term liabilities to liquid assets i.e. inverse liquidity ratio	positive (significant)
						macroeconomic and structural indicators	n/a
						various bank dummies	n/a
NPL micro-level	Boudriga, Taktak, Jellouli (2010)	determinants of NPLs in MENA countries	46 commercial banks, 12 MENA countries, 2002-2006	Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman,	random-effects panel regression model	NPL ratio	n/a
						Credit growth ratio	negative (significant)

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
				Qatar, Saudi Arabia, Tunisia, UAE, Yemen		CAR minus min required capital	positive (significant)
						ROA	positive (significant)
						Loan loss provision ratio to total loans ratio	negative (significant)
						Total assets	n/a
						Foreign participation dummy	negative (significant)
						State controlled bank dummy	n/a
						Others (macro and institutional)	n/a
NPL micro-level	Jakubik and Reininger (2013)	determinants of NPLs in central, eastern and SEE Europe	9 CESEE countries, 294 observations	Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia, Ukraine	difference GMM model, system GMM model, system GMM model with constant	NPL ratio (& lagged)	n/a
						real GDP	significant
						private sector credit to GDP	significant
						ROA and ROE	not significant
						national stock index	significant
						FX rate (weighted by foreign currency share)	n/a
NPL micro-level	Festic et al. (2011)	macroeconomic sources of systemic risk in the banking sector in 5 new EU member states	5 countries	Estonia, Latvia, Lithuania, Bulgaria, Romania	TSLS fixed effects, TSLS random effects	NPL ratio	n/a
						deposit to loan ratio	positive (significant)
						loan to asset ratio	negative (significant)
						net foreign assets to net asset ratio	n/a
						FDI in financial intermediation and RE market	negative (significant)
						export of goods and services	n/a
						gross fixed capital formulation relative to GDP	negative (significant)

Type of NPL data	Author(s)	Topic	Sample coverage	Region/ Country	Methods used	Key variables	Results in relation to the impact on NPLs (if applicable)
						compensation of employees relative to domestic demand of households	n/a
						Basel Core Principles	negative (significant)
						interaction effects between Basel Core Principles and stages of the business cycle	n/a

Source: Author (2019).

4.2.5. Computable general equilibrium models

Before the financial crisis of 2007-2008, a standard macroeconomic theory largely abstracted from financial intermediaries. The crisis has simulated much research that incorporates banks into dynamic stochastic general equilibrium modelling (e.g. Gerali et al., 2010; Curdia and Woodford, 2009; Veld et al., 2011; Meh and Moran, 2010; Kollmann et al., 2011). The importance of risk assessment in the banking sector, especially of systemic risk nature, cannot be overemphasised as failure to adequately assess the risks in the banking sector have led to serious financial crisis including the collapse of major banks. It is, thus, important to find a model that allows almost all possible risks to be detected. The CGE models, like the one used in this chapter, consider interactions among various entities in the economy and could identify some risks in the banking system which may not be detected by other models.

More formally, CGE model is defined as an economy-wide model that describes the motivations and behaviour of all consumers and producers in an economy and the linkages between them (Burfisher, 2011). In a standard CGE model, a set of equations is used to describe the economy and the interactions of its various elements. The model comprises of two distinct variables, exogenous and endogenous, as well as market clearing constraints. The user of the model provides or inputs the exogenous variables whilst the values of the endogenous variables are determined as solutions to the equations of the model. The solutions of the equations at equilibrium are the set of prices which make the quantities of supply and demand equal in every market. A similar logic is applied in the model of Goodhart et al. (2004, 2005) which I use and describe in more depth in the next section of this chapter.

Any CGE model is computable because of its capacity to quantify the ‘shock’. In this chapter, ‘shock’ is defined as a government intervention into banks which suffer from high NPLs and, thus, provide risk to the financial stability in a given country. A change in the exogenous variable does not only give the directional changes in the endogenous variable but also the size of the change. It is general in the sense that all the economic activities can be covered simultaneously. These activities include spending, taxation, investing or employment, among the others. When an economy is in equilibrium, there is stability of supply and demand at certain prices which ensures that the variables do not change on their own until an input is changed.

The original CGE model by Goodhart et al. (2004, 2005), which a later application is used in this chapter, has been widely used by scholars in various contexts. For instance, Aspachs et al. (2007) analyse the welfare of agents in a simplified version of Goodhart et al. (2006a). They propose that a measure of financial stability should be built using a combination of probability of default and bank profitability. Goodhart et al. (2010) uses a framework of Goodhart et al. (2006a) and they show that restrictions on the payout of dividends by banks reduce their default while increasing liquidity in the interbank market and improving social welfare. Pederzoli et al. (2010), on the other hand, extends the analysis of Catarineu-Rabell et al. (2005) regarding the effects of different Basel II rating systems on banks' portfolios. They elaborate on some heterogeneity in banks behaviour and portfolio and confirm the dynamics of the contagion effects on the financial stability as defined by Goodhart et al. (2005).

The class of models developed therefrom (Goodhart et al., 2004; Goodhart et al., 2005; Goodhart et al., 2006) has several features which makes this model different from the traditional ones. Firstly, it takes into account the heterogeneity of banks (i.e. a unique risk/return portfolio) which allows for the analysis of the interbank market. Secondly, the model allows for agents who trade with each other through multiple markets and who can choose to default voluntarily, facing default penalties and comparing losses with benefits arising there from. The model has been calibrated and used by central banks and researchers in many countries, e.g. UK, Bulgaria, Brazil, Colombia, South Korea, Czech Republic. It allows to predict the effects of regulatory tools and changes in exogenous conditions which are otherwise difficult to assess.

Given the presence of a large number of domestic and foreign banks that engage in significant cross-border lending, the UK banking system is an ideal place to coherently investigate how government interventions can affect banks' performance (e.g. their lending, capital position) and financial stability in general.

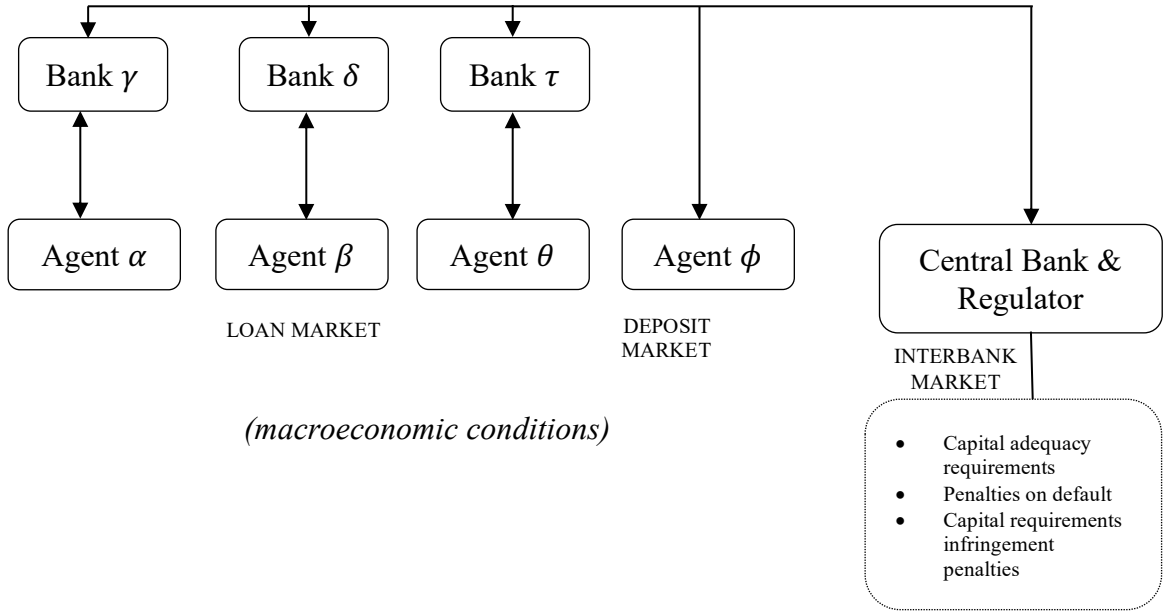
4.3. Theoretical model

4.3.1. Description of the model

I apply the CGE model of financial stability of Goodhart et al. (2004, 2005) in order to assess banks' future performance in the event of contagious systemic banking crises in which government intervenes into failing banks. Such application is becoming increasingly relevant as the world witnesses the unfolding of yet another financial crises triggered by Covid-19 pandemic. The model by Goodhart et al. (2004, 2005) carries characteristics of a partially-microfounded GE model. As shows in Figure 11, the model incorporates three heterogenous banks, $b \in B = \{\gamma, \delta, \tau\}$, four private sector agents $h \in H = \{\alpha, \beta, \theta, \phi\}$, a Central Bank and a regulator. They all operate in incomplete markets with money and default and within the loan, deposit and interbank markets.

As explained earlier under the literature review, default is potentially desirable because it supports higher level of consumption, due to suspension of debt service payments, but it is also costly because it leads to temporary financial autarky and an exogenous loss of income. This captures in reduced – form any real costs or disruptions caused by default as discovered by Coimbra (2020).

Figure 11: The conceptual structure of the applied model by Goodhart et al. (2004, 2005) – channels of agent and the dynamics of market interactions.



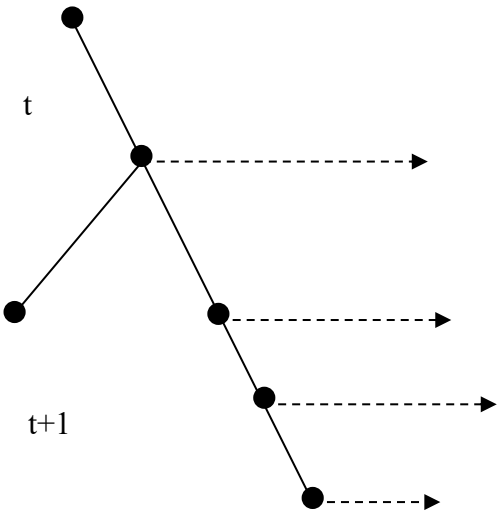
Source: Modified version from Lewis (2010: 10).

The model extends over two periods, $t \in T = \{1,2\}$, and two possible states in the second period, $s \in S = \{i, ii\}$. All uncertainty is resolved in the second period. At time $t \in T$, the probability of state *i* occurring at t+1 is denoted by p. This probability is assumed to be known by all agents and constant over time. The time structure of the model is presented in Figure 12. At t, markets open and banks decide on how much to lend or borrow in each market in the context of the assumed state of nature, i.e. the good/normal state or the bad/extreme (i.e. crisis) state. The good state is represented by i and a probability p of occurring and the bad state ii with probability of occurring, 1 – p. These probabilities are constant over time and are known by the private sector agents. The expected value is taken over all possible states. The central bank conducts open market operations (OMOs) in the interbank market. The capital adequacy requirements on banks are set by the regulator. At t+1, depending on the state of nature, all financial contracts are settled, subject to any defaults or capital requirements' violations which are then penalised. At the end of the second period, all banks are wound up.

The model assumes that individual bank's borrowers are assigned during two periods, by history or by informational constraint, to borrow from a single bank. In other words, it implies multiple active markets for deposits (by separate bank) and for loans (by borrower and bank). Agents α, β, and θ borrow from banks γ , δ and τ, respectively. The remaining agent , Mr. ϕ, represents the pool of depositors in this economy which supplies funds to every bank. There is a single, undifferentiated, interbank market where deficit banks are allowed to borrow from surplus banks, and wherein the Central Bank conducts OMOs.

The banks in the model are assumed to operate under a perfectly competitive environment and they endogenize their decisions in the loan, deposit and interbank markets. This means that they take all interest rates as exogenously given when making their optimal portfolio decisions. This is a strong assumption, however, which may not be plausible in many markets. For instance, the EU banking sector has become even more concentrated post-2008 financial crisis. This brings some limits on the application of this model in other countries and also reduces the external validity of its findings.

Figure 12: The time structure of the Goodhart et al. (2004, 2005)'s model.



1. Borrow and deposit in the interbank market (B)
2. OMOs (CB)
3. Borrow and deposit in the commercial bank loan and deposit market (B and H)

Nature decides which of the state $s \in S$ occurs

1. Settlement of loans and deposits (H and B)
2. Settlement of interbank loans and deposits (CB and B)
3. Default and capital requirements' violation settlement

All banks are wound-up

Source: Goodhart et al. (2005: 200).

The simplified structure of banks' balance sheets is shown in Figure 13 and the full list of variables used in the model is listed under Figure 14 which follows next. The variable list is divided by the category of the variables, i.e. endogenously-solved variables, calibrated variables, arbitrarily selected and, finally, exogenous variables.

Figure 13: The structure of banks' balance sheets.

Assets	Liabilities
Loans to individual agents	Deposits from individual agents
Interbank deposits	Interbank borrowing
Market book	Equity
	Others

Source: Goodhart et al. (2005: 200).

Figure 14: List of variables used in the applied model by Goodhart et al. (2004, 2005).

General cross-reference: $b \in B = \{\gamma, \delta, \tau\}$; $a \in A = \{\alpha, \beta, \theta, \phi\}$

At initial equilibrium

Endogenously-solved variables:

r_t^b: lending rate offered by bank *b* in period *t*

$r_{d,t}^b$: deposit rate offered by bank *b* in period *t*

$\mu_{d,t}^b$: Bank *b*'s debt in the interbank market in period *t*

$k_{t+1,i}^b$: Bank *b*'s capital adequacy ratio (CAR) in period *t+1* in state *i*

$k_{t+1,ii}^b$: Bank *b*'s capital adequacy ratio (CAR) in period *t+1* in state *ii*

$\pi_{t+1,i}^b$: Bank *b*'s profit in period *t+1* in state *i*

$\pi_{t+1,ii}^b$: Bank *b*'s profit in period *t+1* in state *ii*

$e_{t+1,i}^b$: Bank *b*'s capital in period *t+1* in state *i*

$e_{t+1,ii}^b$: Bank *b*'s capital in period *t+1* in state *ii*

$\tilde{R}_{t+1,i}$: Repayment rate expected by banks from interbank lending at period t+1 in state i

$\tilde{R}_{t+1,ii}$: Repayment rate expected by banks from interbank lending at period t+1 in state ii

$\mu_t^{a^b}$: Amount of money that agent *a* chooses to owe in the loan market of bank *b* at time t

$\bar{B}$: Government bonds

Calibrated variables:

$\bar{m}_t^b$: Amount of credit that bank *b* extends in the loan market in period *t*

$d_{b,t}^{\phi}$: Amount of money that agent ϕ chooses to deposit with bank *b* at time *t*

d_t^b: Bank *b*'s interbank lending in period *t*

μ_t^{τ}: Amount of money that bank τ owes in the interbank market in period t

$v_{t+1,i}^{a^b}$: Repayments rates of agent a^b in the loan market in period t+1 in state i

$GDP_{t+1,\,i}$: GDP in period t+1 in state i

Arbitrarily selected:

$v_{t+1,ii}^{a^b}$: Repayments rates of agent a^b in the loan market in period t+1 in state ii

$v_{t+1,i}^b$: Repayment rate of bank *b* in period *t+1* in state *i*

$v_{t+1,ii}^b$: Repayment rate of bank *b* in period *t+1* in state *ii*

$GDP_{t+1,\,ii}$: GDP in period t+1 in state ii

Exogeneous variables in the model

$Other_t^b$: The 'other' items in the balance sheet of bank *b* in period *t*

$g_{a^b,i,1}$: household's repayment rate functional form for agent *a* in regards to bank *b* in state *i*

$g_{a^b,ii,1}$: household's repayment rate functional form for agent *a* in regards to bank *b* in state *ii*

$a_{a^b,1}$: household's demand for loans functional form for for agent *a* in regards to bank *b*

$z_{b,1}$: deposit supply functional form for bank *b*

$u_{i,1}$: GDP function form in state *i*

$u_{ii,1}$: GDP function form in state *ii*

c_i^b: coefficient of risk aversion in the utility function of bank *b* in state *i*

c_{ii}^{γ}: coefficient of risk aversion in the utility function of bank *b* in state *ii*

$a_{h^b,3_{(\forall h \in H^b)}}$: household's demand for loans functional form
$a_{h^b,4_{(\forall h \in H^b)}}$: household's demand for loans functional form
A_t^b: Other assets of bank *b* in period *t*
e_t^b: Bank *b*'s capital in period *t*
$\bar{\omega}$: Risk weight on consumer loans
$\omega(\widetilde{\omega})$: Risk weight on investment (risk weight on market book)
ρ_t: Interbank rent in period t
$g_{h,i,2_{(\forall h \in H^b)}}$: elements of the household's repayment rate functional form in state *i*
$g_{h,ii,2_{(\forall h \in H^b)}}$: elements of the household's repayment rate functional form in state *ii*
$g_{h,i,3_{(\forall h \in H^b)}}$: elements of the household's repayment rate functional form in state *i*
$g_{h,ii,3_{(\forall h \in H^b)}}$: elements of the household's repayment rate functional form in state *ii*
$\bar{k}^{\gamma}_{t+1,S(\forall s \in S)}$: *Capital adequacy requirements*
$\lambda^b_{ks(\forall b \in B, s \in S)}$: *Non-pecuniary penalty for capital adequacy requirement violation of bank b in state s*
$\lambda^b_{i(b \in B)}$: *Non-pecuniary penalty for capital adequacy requirement violation of bank b in state i*
$\lambda^b_{ii(b \in B)}$: *Non-pecuniary penalty for capital adequacy requirement violation of bank b in state ii*
$u_{s,3_{(\forall s \in S)}}$: elements of the GDP functional form
$z_{b,2_{(\forall b \in B)}}$: elements of the deposit supply form
$z_{b,3_{(\forall b \in B)}}$: elements of the deposit supply form
$z_{b,4_{(\forall b \in B)}}$: elements of the deposit supply form
$u_{s,2_{(\forall s \in S)}}$: elements of the GDP functional form
r_t^A: The rate of return on market book in period t
ρ: Probability that state i will occur in the next period
$a_{a^b,2}$: elements of the household's demand for loans functional form for agent *a* in relation to bank *b*

Source: Goodhart et al. (2004, 2005).

I now move to outlining the model's optimisation problems following Goodhart et al. (2004, 2005). I begin with the optimisation problem of the **interbank net borrowers' (banks γ and τ)**. Bank b ∈ {γ, τ} maximises its payoff, which is a quadratic function of expected profits in the second period minus non-pecuniary penalties that it has to incur if it defaults on its deposit and interbank obligations. It also suffers a capital violation penalty proportional to its capital requirement violation. Formally, the optimisation problem of bank b∈{γ, τ}is as follows:

$$\max_{\bar{m}^b, \mu^b, \mu_d^b, v_s^b, s \in S} \prod b = \sum_{s \in S} p_s [\pi_s^b - c_s^b (\pi_s^b)^2] - \sum_{s \in S} p_s \left[\lambda_{ks}^b \max\left[0, \bar{k}^b - k_s^b\right] + \lambda_s^b [\mu^b - v_s^b \mu^b] + \lambda_s^b \left[\mu_d^b - v_s^b \mu_d^b\right]\right] \quad (1)$$

subject to

$$\bar{m}^b + A^b = \frac{\mu^b}{(1+p)} + \frac{\mu_d^b}{(1+r_d^b)} + e_0^b + Others^b \quad (2)$$

$$v_s^b \mu^b + v_s^b \mu_d^b + Others^b + e_0^b \leq v_{sb}^{h^b} (1+r^b) \bar{m}^b + (1+r^A) A^b, s \in S \quad (3)$$

where,

$$\pi_s^b = \Delta\,(3) \quad (4)$$

$$e_s^b = e_0^b + \pi_s^b, s \in S \quad (5)$$

$$k_s^b = \frac{e_s^b}{\bar{\omega} v_{sb}^{h^b} (1+r^b) \bar{m}^b + \tilde{\omega} (1+r^A) A^b}, s \in S \quad (6)$$

where:
$\Delta(x)$ ≡ the difference between RHS and LHS of inequality (x)
p_s ≡ probability that state s ∈ S will occur,
c_s^b ≡ coefficient of risk aversion in the utility function of bank b ∈ B,
λ_{ks}^b ≡ capital requirements' violation penalties imposed on bank b ∈ B in state s ∈ S ,
$\bar{k}^b$ ≡ capital adequacy requirement for bank b ∈ B,
λ_s^b ≡ default penalties on bank b ∈ B,
μ^b ≡ amount of money that bank b ∈ {γ, τ} owes in the interbank market,
μ_d^b ≡ amount of money that bank b ∈ B owes in the deposit market,
v_s^b ≡ repayment rates of bank b ∈ B to all its creditors in state s ∈ S,
$\bar{m}^b$ ≡ amount of credit that bank b ∈ B extends in the loan market,
A^b ≡ the value of market book held by bank b ∈ B,
e_s^b≡ amount of capital that bank b ∈ B holds in state s ∈ {0} ∪ S,
$Others^b$ ≡ the 'others' item in the balance sheet of bank b ∈ B,
r^b ≡ lending rate offered by bank b ∈ B,
r_d^b ≡ deposit rate offered by bank b ∈ B,
ρ ≡ interbank rate,
r^A ≡ the rate of return on market book,
$v_{sb}^{h^b}$ ≡ repayment rates of agent $h^b \in H^b = \{\alpha^\gamma, \beta^\delta, \theta^\tau\}$ to his nature-selected bank b ∈ B in the consumer loan market,
$\bar{\omega}$ ≡ risk weight on consumer loans, and
$\tilde{\omega}$ ≡ risk weight on market book.

Equation (2) implies that, at t = 1, the assets of bank b ∈ {γ, τ}, which consist of its credit extension and market book investment, must be equal to its liabilities obtained from interbank and deposit borrowing and its initial equity endowment, where $Others^b$ represents the other assets. Equations (3) and (4) then show that, depending on which of the s ∈ S actually occurs, the profit that bank b incurs in the second period is equal to the difference between the amount of money that it receives from its asset investment and the amount that it has to repay on its

liabilities, adjusted appropriately for default in each market. As shown in equation (5), the profit earned is then added to its initial capital, which, in turn, becomes its capital in the second period. Finally, equation (6) implies that the capital to asset ratio of bank b in state s ∈ S is equal to its capital in state s divided by its risk-weighted assets in the corresponding state.

I now move to the optimisation problem of the **interbank net lender's (bank δ).** Bank δ, unlike the other two banks, is a net lender in the interbank market. Thus, it suffers only a default penalty in the deposit market. Formally, bank δ's optimisation problem is as follows:

$$\underset{\bar{m}^{\delta}, d^{\delta}, \mu_d^{\delta}, v_s^{\delta}, s \in S}{max} \prod \delta = \sum_{s \in S} p_s \left[\pi_s^{\delta} - c_s^{\delta}\left(\pi_s^{\delta}\right)^2\right] - \sum_{s \in S} p_s\left[\lambda_{ks}^{\delta}\, max\left[0, \bar{k}^{\delta} - k_s^{\delta}\right] + \lambda_s^{\delta}\left[\mu_d^{\delta} - v_s^{\delta}\mu_d^{\delta}\right]\right]$$

subject to

$$A^{\delta} + d^{\delta} + \bar{m}^{\delta} = e_0^{\delta} + \frac{\mu_d^{\delta}}{(1 + r_d^{\delta})} + Others^{\delta} \qquad (7)$$

$$v_s^{\delta}\mu_d^{\delta} + Others^{\delta} + e_0^{\delta} \leq v_{s\delta}^{\beta^{\delta}}\bar{m}^{\delta}\left(1 + r^{\delta}\right) + A^{\delta}(1 + r^{A}) + \tilde{R}_s d^{\delta}(1 + \rho) \quad (8)$$

where,

$$\pi_s^{\delta} = \Delta\,(8) \qquad (9)$$

$$e_s^{\delta} = e_0^{\delta} + \pi_s^{\delta} \qquad (10)$$

$$k_s^{\delta} = \frac{e_s^{\delta}}{\bar{\omega} v_{s\delta}^{\beta^{\delta}}(1 + r^{\delta})\bar{m}^{\delta} + \tilde{\omega}\tilde{R}_s d^{\delta}(1 + \rho) + \tilde{\omega}(1 + r^{A})A^{\delta}} \qquad (11)$$

where:
d^{δ} ≡ bank δ's investment in the interbank market,
$\tilde{R}_s$ ≡ the rate of repayment that bank δ expects to get from its interbank investment, and
ω ≡ risk weight on interbank investment.

The budget set of bank δ is similar to those of the other two banks except that it invests in, instead of borrows from, the interbank market. Moreover, its risk weighted assets in the second period, as shown in equation (11), also includes bank δ's expected return on its interbank investment.

Next, I describe the role of the **central bank and the regulator** in the model. Namely, the Central Bank conducts monetary policy in the model by engaging in open market operations in the interbank market. It can either set its base money (*M*) as its monetary policy instrument, allowing the interbank rate to be determined endogenously, or it can fix the interbank rate and let its base money adjust endogenously to clear the interbank market. The regulator sets capital

adequacy requirements for all banks ($\bar{k}^b$) and imposes penalties on their failure to meet such requirements (λ_{ks}^b) and on default on their financial obligations in the deposit and interbank markets (λ_s^b). The regulator also sets the risk weights on consumer loan, interbank and market book investment ($\bar{\omega}, \omega, \tilde{\omega}$).

In terms of the **household sector**, the government intervention is modelled to be funded by general tax revenues coming from household agents. Agents α, β, and θ borrow from banks γ, δ and τ, respectively, based on their demand for consumer loans. Goodhart et al. (2004, 2005) do not explicitly model the optimisation problems of households, mostly because it is very difficult, if at all possible, to find real disaggregated data for private agent sectors, e.g. monetary and goods endowment for each bank's borrowers and depositors. Thus, instead of explicitly providing microfoundations for households' decisions, they, and I as well, endogenies them by assuming the following reduced-form equations:

each household borrower, $h^b = \{\alpha^\gamma, \beta^\delta, \theta^\tau\}$, demands consumer loans from his nature selected bank and chooses whether to default on his loans in state s ∈ S. The remaining agent, ϕ, supplies his deposits to each bank b.

Next, I describe the **household borrowers' demand for loans.** Because of the limited participation assumption in every consumer loan market, each household's demand for loans is a negative function of the lending rate offered by his nature selected bank. His demand for loans also depends positively on the expected GDP in the subsequent period. Thus, I implicitly assume that household borrowers rationally anticipate GDP in both states of the next period, which then determines their expected future income, and adjust their loan demand in the initial period accordingly in order to smooth their consumption over time. The money demand function manifests the standard Hicksian elements whereby it responds positively to current and expected income and negatively to interest rates. As in Goodhart et al. (2004, 2005), I introduce a linear time trend in each household borrower's loan demand function to improve the empirical fit (i.e. $trend$). More formelly, household h^b's loan demand from his nature-selected bank b which under government intervention, $\forall h^b \in H^b$, and b ∈ B is as follows:

$$\ln\left(\mu^{h^b}\right) = a_{h^b,1} + a_{h^b,2}trend + a_{h^b,3}ln\left[p(GDP_{t+1,i}) + (1-p)GDP_{t+1,ii}\right] + a_{h^b,4r^b} \qquad (12)$$

where,

μ^{h^b} ≡ amount of money that agent $h^b \in H^b$ chooses to owe in the loan market of bank b ∈ B in period t,
$GDP_{t+1,s}$ ≡ Gross Domestic Product in period t+1 if state s ∈ S occurs.

In terms of the **deposit supply**, unlike in the loan markets, the model by Goodhart et al. (2004, 2005) does not assume limited participation in the deposit markets. This implies that ϕ can choose to diversify his deposits with every bank. Thus, Mr. ϕ's deposit supply with bank b depends not only on the deposit rate offered by b but also on the rates offered by the other banks. Moreover, since banks can default on their deposit obligations, the expected rate of return on deposit investment of ϕ with each bank has to be adjusted appropriately for each bank's corresponding expected default rate. Next, ϕ's deposit supply is a positive function of the expected GDP. In symbols, ϕ's deposit supply function with bank b is as follows:

$$\ln\left(d_b^{\phi}\right) = z_{b,1} + b_{b,2} ln\left[p(GDP_{i)} + (1-p)GDP_{ii}\right] + z_{b,3}\left[r_d^b(pv_i^b)\right] + z_{b,4}\sum_{\dot{b}\neq b\in B}\left[r_d^{\dot{b}}(pv_i^{\dot{b}} + (1-p)v_{ii}^{\dot{b}}\right] \quad (13)$$

where,

d_b^{ϕ} ≡ amount of money that agent ϕ chooses to deposit with bank $b \in B$.

The model assumes that each **household's loan repayment rate** on his loan obligation to his nature-selected bank in state s ∈ S is a positive function of the corresponding GDP level as well as the aggregate credit supply in the economy. The latter variable captures the effect of 'credit crunch' in the economy whereby a fall in the overall credit supply in the economy aggravates the default probability of every household. Specifically, the functional form of the repayment rate of household h^b, $\forall h^b \in H^b$, to his nature-selected bank b ∈ B, in state s ∈ S is as follows:

$$\ln\left(v_{s^b}^{h^b}\right) = g_{h^b,s,1} + g_{h^b,s,2}\ln(GDP_s) + g_{h^b,s,3}\left[\ln(\overline{m}^{\gamma}) + \ln(\overline{m}^{\delta}) + ln(\overline{m}^{\tau})\right] \quad (14)$$

Next, the model assumes that households' actions depend on their **expected GDP** in the second period. For this reason, the model endogenises GDP in both states of the second period. Goodhart et al. (2004, 2005) assumes that GDP in each state is a positive function of the aggregate credit supply available in the previous period. Since the Modigliani-Miller proposition does not hold in the model, higher credit extension as a result of loosening

monetary policy, or any other shocks, generates a positive real balance effect that raises consumption demand and ultimately GDP. In particular, the following functional form for GDP in state s ∈ S of the second period (GDPs) holds.

$$\ln(GDP_s) = u_{s,1} + u_{s,2}\,[\ln(\overline{m}^{\gamma}) + \ln(\overline{m}^{\delta}) + ln(\overline{m}^{\tau})] + u_{s,3}\,[\ln(e_s^{\gamma}) + \ln(e_s^{\delta}) + \ln(e_s^{\tau})] \quad (15)$$

Finally, I end by outlining the model's **market clearing conditions.** There are seven active markets in the model (i.e. three consumer loan, three deposit and one interbank markets). Each of these markets determines an interest rate that equilibrates demand and supply in equilibrium.

$1 + r^b = \frac{\mu^{h^b}}{\overline{m}^b}, h^b \in H^b, \forall b \in B$ (i.e. bank b's loan market clears) (16)

$1 + r_d^b = \frac{\mu_d^b}{d_b^{\phi}}, \forall b \in B$ (i.e. bank b's deposit market clears) (17)

$1 + \rho = \frac{\mu^{\gamma} + \mu^{\tau}}{M + d^{\delta}}$ (i.e. interbank market clears) (18)

It is important to note that the interest rates, i.e. r^b, r_d^b and ρ, b ∈ B, are the ex-ante nominal interest rates that incorporate default premium since default is permitted in equilibrium. Their effective (ex-post) interest rates have to be suitably adjusted to account for default in their corresponding markets.

The **equilibrium** in this economy is characterised by a vector of all choice variables of active agents such that banks maximise their payoff function subject to their budget constraints, all markets clear (i.e. conditions 16, 17, and 18 are satisfied), bank δ is correct in its expectation about the repayment rates that it gets from its interbank investment, and, finally, loan demand, deposit supply, repayments rates, and GDP in both states s satisfy the reduced form equations (12)-(15).

4.3.2. Model application to the research topic

I apply the model of Goodhart et al. (2004, 2005) in the context of government interventions. Specifically, I analyse the same three government interventions which were analysed in the previous chapter of this thesis, i.e. nationalisation, government-assisted merger, and a 'bad bank'. The aim is to see through the application of this model what is the impact on government interventions on banks' future performance in the banking sector and in relation to financial stability.

As explained earlier, the decisions of private agents and banks are considered to be endogenous, while the Central Bank and the regulator, or a government in general, have predefined strategies. Government interventions are, thus, taken as given which removes the issue of selection bias. Although this is a strong assumption, it is necessary in order to fully utilise the dynamics of the Goodhart et al. (2004, 2005)'s model. Future research could explore this aspect by modelling in the selection process into the GE model by, for instance, analysing the typology of banks which received the government support. This is, however, beyond the scope of this chapter. Here, it is assumed that there is a government agent in the applied model whose objective is to resolve banks' high NPLs in order to maximise the total output generated by the banking sector net of any costs associated with the resolution policies. These policies are assumed to be rationally anticipated by the banks and depositors and the government's choice of a bank for intervention as well as the type of interventions are both assumed to be rational.

The possibility of contagion is assumed to be a crucial factor motivating government intervention in the banking sector. Namely, owing to the risk of contagion, failure in one bank can generate failures in other banks. But, at the same time, more capital in distressed bank γ can also help to protect depositors in bank δ. In other words, the government intervention can help the distressed bank γ to fix its balance sheet and, at the same time, it can also have a positive impact on the bank δ.

The banks' profit maximization horizon assumption holds in my application of the model. Bank's managers choose to maximize their banks' profit over finite horizon because they could depart from these banks for better alternative contracts. Although the same logic is unlikely to be fully applicable to all form of bank behaviour, it can still be argued that these are likely to be maximised over the finite time period.

In order to be in line with the design of the model, I interpret the bank's default rate as a probability that such bank chooses to shut down, and, hence, in the short run to default completely on its financial obligations. Thus, a bank's decision to increase its default rates is isomorphic to its decision to adopt a riskier position in pursuit of higher expected performance, whether in terms of its future lending, capital or reserves position.

Bank's recapitalisation is the driving force behind my selected intervention scenarios and it is assumed to be non-regulatory. In my application of the model, banks are endowed with some capital in the initial period. There is an additional injection of capital by the government to distressed banks under each of the intervention scenarios except 'Merger 1' scenario (see Table 33). Hence, bank capital is an exogenous variable in the model. However, bank capital becomes endogenous in the subsequent period, i.e. in period t+1, which allows me to fully test the impact of the government-led interventions on banks. It is important to note that the model does not consider the time lag between the timing of intervention and the timing at which the impact of such intervention can be objectively measured. Table 33 summarises the set-up of the model applied in order to show the dynamics behind the interventions. These scenarios are then calibrated under the next section.

It is important to add that the model assumes that each bank wants to keep a buffer above the required capital minimum, so that there is a non-pecuniary loss of reputation as capital declines, i.e. the ratios are always binding. This rules out any corner equilibria. Also, the amount of recapitalisation under each scenario is the same for each of the interventions in order to ease the comparative analysis. Lastly, all of the scenarios are considered as mutually exclusive for simplification.

Table 33: Set-up for the calibration exercise.

Intervention scenario	Banks set-up	Intervention set-up
1. No intervention (baseline scenario)	Bank γ: high NPLs Bank δ: moderate NPLs Bank τ: no NPLs	n/a *(see Table 32 for initial equilibrium results)*
2. Nationalisation (of Bank γ)	Bank γ: high NPLs – intervened Bank δ: moderate NPLs Bank τ: no NPLs	- the government increases the household tax to finance the bank intervention in the form of capital injection into Bank γ - this, in effect, decreases household loan demand and deposit supply functions: $a_{\alpha,\beta,\theta} : \downarrow 15\%$ $z_{b,1} : \downarrow 15\%$ - the intervention involves recapitalisation of Bank γ through capital injection: $e_t^{\gamma} : \uparrow 15\%$

Intervention scenario	Banks set-up	Intervention set-up
3. Government-assisted merger (Bank γ and Bank τ)	Bank γ: high NPLs – intervened Bank δ: moderate NPLs Bank τ: no NPLs - intervened	- the government assists in a merger of Bank γ with Bank τ - all of the Bank γ's balance sheet is combined with the balance sheet of Bank τ, and reported under Bank τ - there are two possible options for the government to complete the merger intervention with: to assist in the merger without any capital injection (**Merger 1**); to assist in the merger with an instant capital injection (**Merger 2**) - if the latter option is chosen, the government increases the household tax to finance the recapitalisation of Bank τ through: $e_t^{\tau}: \uparrow 15\%$ - this, in effect, decreases household loan demand and deposit supply functions: $a_{\alpha,\beta,\theta}: \downarrow 15\%$ $z_{b,1}: \downarrow 15\%$
4. 'Bad-bank' (Bank γ)	Bank γ: high NPLs – intervened Bank δ: moderate NPLs Bank τ: no NPLs - intervened	- the government assists in restructuring the balance sheet of the 'bad' bank (i.e. Bank γ) by shifting all of its healthy assets to Bank τ ('Good bank') excluding the capital of Bank γ - the government gradually (**Bad bank 1**) or instantly (**Bad bank 2**) injects capital to Bank γ: $e_t^{\gamma}: \uparrow 15\%$ - this capital injection is financed by taxpayer money which, in effect, gradually (**Bad bank 1**) or instantly (**Bad bank 2**) decreases household loan demand and deposit supply functions: $a_{\alpha,\beta,\theta}: \downarrow 15\%$ $z_{b,1}: \downarrow 15\%$

Source: Author (2019).

4.3.3. Model calibration exercise

I now turn to the application of the model under the studied three government interventions. The data comes from the annual accounts of seven largest UK banks as used in the paper by Goodhart et al. (2006).[17] In this comparative static exercise, I categorise the levels of banks' NPLs in the initial period in order to study the contagion between banks and the subsequent

[17] In Goodhart et al. (2005) the seven largest UK banks are assumed to represent the British banking sector. They are measured in terms of their total assets as at the end of 2003 (i.e. Abbey National, Barclays, HBOS, HSBC, Lloyds, Royal Bank of Scotland, Standard Chartered) and other major banks which have either been merged with or acquired by these seven banks over the sample period (i.e. Nat West, Bank of Scotland, and Halifax).

impact of the government interventions on banks' future performance and financial stability of the UK economy. I, thus, assign Bank γ as a distressed bank with high NPLs, Bank δ as a bank with moderate stock of NPLs and Bank τ as an example of a healthy bank. Since the 2007-2008 global financial crisis, NPLs are at the spotlight for both regulators and banks as they have been linked to bank failures, and are often the harbingers to the banking crisis (Ghosh, 2015). This deterioration of banks asset quality is not only financially destabilizing for the banking system but may reduce economic efficiency, impair social welfare and decline economic activity as I have explained in depth in the literate review section of this chapter (e.g. Barseghyan, 2010; Gonzales-Hermosillo, 1999; Zeng, 2012).

My calibration procedure follows the steps presented in Goodhart et al. (2005). In each period t, excluding the Lagrange multipliers, I follow a system of 56 equations in 143 unknown variables, 87 of which are exogenous variables in the model. This implies that there are 87 variables whose values have to be chosen in order to obtain the numerical solution to the model. Thus, they represent the degrees of freedom in the system and can either be set appropriately or calibrated against the real data. Table 34 presents the results for the initial equilibrium under the baseline scenario. The table also summarises whether the value of each variable reported is (1) calibrated against real data sourced from Bank of England, (2) arbitrarily selected and based on the official statistics, or (3) endogenously solved through the model. I define each of the variables under Figure 14.

Table 34: Exogenous variables and the resulting initial equilibrium under the baseline scenario.

	Initial equilibrium			Exogenous variables in the model	
Endogenously solved	r_t^{γ}=0.154	$k_{t+1,i}^{\delta}$=0.20	$e_{t+1,ii}^{\gamma} = 0.83$	$Other_t^{\gamma}$=-11.0	$z_{\gamma,1}$=1.56
	r_t^{δ}=0.453	$k_{t+1,ii}^{\delta}$=0.21	$e_{t+1,i}^{\delta}$= 3.90	$Other_t^{\delta}$=-2.69	$z_{\delta,1}$=2.53
	r_t^{τ}=0.155	$k_{t+1,i}^{\tau}$=0.17	$e_{t+1,ii}^{\delta}$= 3.43	$Other_t^{\tau}$=27.06	$z_{\tau,1}$=3.3
	$r_{d,t}^{\gamma}$=0.04	$k_{t+1,ii}^{\tau}$=0.13	$e_{t+1,i}^{\tau}$= 10.59	$g_{\alpha^{\gamma},i,1}$=-0.75	$u_{i,1}$=3.61
	$r_{d,t}^{\delta}$=0.024	$\pi_{t+1,i}^{\gamma}$=0.26	$e_{t+1,ii}^{\tau}$= 7.31	$g_{\alpha^{\gamma},ii,1}$=-1.04	$u_{ii,1}$=0.1
	$r_{d,t}^{\tau}$=0.04	$\pi_{t+1,ii}^{\gamma}$= -0.34	$\tilde{R}_{t+1,i}$= 1.28	$g_{\beta^{\delta},i,1}$=-0.76	c_i^{γ}=0.214
	$\mu_{d,t}^{\gamma}$=11.47	$\pi_{t+1,i}^{\delta}$= 0.33	$\tilde{R}_{t+1,ii}$= 0.75	$g_{\beta^{\delta},ii,1}$=-1.04	c_{ii}^{γ}=0.129

	Initial equilibrium			Exogenous variables in the model	
	$\mu_{d,t}^{\delta}$=43.71	$\pi_{t+1,ii}^{\delta}$= -0.13	$\mu_{t}^{\alpha^{\gamma}}$= 10.83	$g_{\theta^{\tau},i,1}$=-0.75	c_{i}^{δ}=0.159
	$\mu_{d,t}^{\tau}$=65.32	$\pi_{t+1,i}^{\tau}$= 2.11	$\mu_{t}^{\beta^{\delta}}$= 14.59	$g_{\theta^{\tau},ii,1}$=-1.04	c_{ii}^{δ}=0.351
	$k_{t+1,i}^{\gamma}$= 0.138	$\pi_{t+1,ii}^{\tau}$= -1.17	$\mu_{t}^{\theta^{\tau}}$= 63.45	$a_{\alpha^{\gamma},1}$=-3.85	c_{i}^{τ}=0.024
	$k_{t+1,ii}^{\gamma}$= 0.09	$e_{t+1,i}^{\gamma}$=1.43	M= -16.81	$a_{\beta^{\delta},1}$=-3.35	c_{ii}^{τ}=0.042
				$a_{\theta^{\tau},1}$=-2.08	
Calibrated	$\bar{m}_{t}^{\gamma}$=9.39	$d_{\delta,t}^{\phi}$=33.79	$v_{t+1,i}^{\alpha^{\gamma}}$= 0.91	$a_{h^{b},2_{(\forall h\in H^{b})}}$= 1.41	e_{t}^{δ}=3.567
	$\bar{m}_{t}^{\delta}$=10.04	$d_{\tau,t}^{\phi}$=62.81	$v_{t+1,i}^{\beta^{\delta}}$= 0.90	$a_{h^{b},3_{(\forall h\in H^{b})}}$= 0.68	e_{t}^{τ}=8.48
	$\bar{m}_{t}^{\tau}$=54.95	d_{t}^{δ}=15.96	$v_{t+1,i}^{\theta^{\tau}}$= 0.91	A_{t}^{γ}=2.462	$\bar{\omega}$=1
	$d_{\gamma,t}^{\phi}$=11.03	μ_{t}^{τ}=11.96	$GDP_{t+1,\ i}$ = 89.83	A_{t}^{δ}=8.669	$\omega(\widetilde{\omega})$=0.2
				A_{t}^{τ}=31.903	ρ_{t}=0.04
				e_{t}^{γ}=1.175	
Arbitrarily selected	$v_{t+1,ii}^{\alpha^{\gamma}}$= 0.80	$v_{t+1,i}^{\gamma}$= 0.975	$v_{t+1,ii}^{\delta}$= 0.963	$g_{h,i,2_{(\forall h\in H^{b})}}$=0.05	$u_{s,2_{(\forall s\in S)}}$=0.1
	$v_{t+1,ii}^{\beta^{\delta}}$= 0.80	$v_{t+1,ii}^{\gamma}$= 0.952	$v_{t+1,i}^{\tau}$= 0.997	$g_{h,ii,2_{(\forall h\in H^{b})}}$=0.05	$z_{b,2_{(\forall b\in B)}}$=0.19
	$v_{t+1,ii}^{\theta^{\tau}}$= 0.80	$v_{t+1,i}^{\delta}$= 0.963	$v_{t+1,ii}^{\tau}$= 0.937	$g_{h,i,3_{(\forall h\in H^{b})}}$=0.05	$z_{b,3_{(\forall b\in B)}}$=0.5
			$GDP_{t+1,\ ii}$ = 85.24	$g_{h,ii,3_{(\forall h\in H^{b})}}$=0.1	$z_{b,4_{(\forall b\in B)}}$= 0.1
				$\bar{k}_{t+1,S(\forall s\in S)}^{\gamma}$ =0.11	$u_{s,2_{(\forall s\in S)}}$=0.1
				$\bar{k}_{t+1,S(\forall s\in S)}^{\delta}$ =0.16	r_{t}^{A}=0.045
				$\bar{k}_{t+1,S(\forall s\in S)}^{\tau}$ =0.13	ρ=0.95
				$\lambda_{ks(\forall b\in B,s\in S)}^{b}$ =0.1	$a_{\alpha^{\gamma},2}$=0.025
				$\lambda_{i(b\in B)}^{b}$ =0.9	$a_{\beta^{\delta},2}$=-0.12
				$\lambda_{ii(b\in B)}^{b}$ =1.1	$a_{\theta^{\tau},2}$=0.04

Source: Author (2019).

I now use these initial equilibrium calibration results to derive directional responses of the endogenous variables of interest to simulated shocks to the economy triggered by the

intervention scenarios as outlined in Table 33. I carry out this comparative analysis by changing the exogenous variables in order to reflect the intervention dynamics. I then assess how the equilibrium is impacted by these series of changes. I report my results in the following tables (35-40) which follow the same order as the intervention scenarios set-up in Table 33. I then bring al of these results together and summarise them in Table 41 which I use to discuss the results.

Table 35: Directional changes in the endogenous variables in the model caused by deteriorating NPL ratios of Bank γ ('high NPLs') and Bank δ ('moderate NPLs').

Endogenous variable	Bank γ	Bank δ	Bank τ
r^b(lending rate)	-~+-++~ | +~	-+--+~ | -	-~+-++~ | +~
r_d^b(deposit rate)	00000 | 0	-+--+~ | -	00000 | 0
$\bar{m}_t^b$(credit in the loan market)	+~-+~-- | -~	+~-+--~ | -~	+~-+~-- | -~
π_i^b (profit in state i)	-~+~-+~+~ | -~	+~+-++~ | +~	-+~-+~+~ | -~
π_{ii}^b (profit in state ii)	-~+-+~+~ | -~	+~+~-~+~+~ | +~	-+~-+~+~ | +~
e_i^b(capital in state i)	-~+-~++~ | +~	+~+~-~+~+~ | +~	0+-++~ | +~
e_{ii}^b (capital in state ii)	-~+-~++~ | +~	+~+-~+~+~ | +~	-~+-++~ | +~
$\mu_{d,t}^b$(debt in interbank market)	+-+-~-~ | +~	-~+-++~ | +	+-~+--~ | -~
k_i^b (CAR in state i)	-~+-++~ | +~	++-++~ | +	-~+-++~ | +~
k_{ii}^b (CAR in state ii)	-~+-~++~ | +~	++-++~ | +	-~+-++~ | +~
v_i^b(repay. rate in state i)	--+~--~ | -	-~-+~-~-~ | -~	+~-+~--~ | -~
v_{ii}^b(repay. rate in state ii)	+~-+~-+~ | -~	+~-~+~--~ | -~	+~-+~--~ | -~
GDP_i	+~-+--~ | -~		
GDP_{ii}	+~-+--~ | -~		
M	+-+--~ | +~		

Source: Author (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend.

Table 36: Directional changes in the endogenous variables in the model under 'Nationalisation' scenario.

Endogenous variable	Bank γ	Bank δ	Bank τ
r^b(lending rate)	-++~+~+~ | +~	-+-~-~-~ | -~	-+--~-~ | -~
r_d^b(deposit rate)	00000 | 0	+~-+~-+~ | -~	00000 | 0
$\bar{m}_t^b$(credit in the loan market)	+--~-~-~ | -~	+-+~+~+~ | +~	+-+~+~+~ | +~
π_i^b (profit in state i)	-~+-~-~-~ | -~	-~+~-~-~-~ | -~	-~+--~-~ | -~
π_{ii}^b (profit in state ii)	+~--~-~-~ | -~	-~+~-~-~-~ | -~	-~+-~-~-~ | -~
e_i^b(capital in state i)	+~+-~+~+~ | +~	+~+~-~-~-~ | -~	-~+-~-~-~ | -~
e_{ii}^b (capital in state ii)	+~++~+~+~ | +~	-~+-~-~-~ | -~	-~+-~-~-~ | -~

$\mu_{d,t}^{b}$(debt in interbank market)	-~---~-~~ | -~	----~-~ | -	----- | -
k_{i}^{b} (CAR in state i)	-~++~+~+~ | +~	-~+--~-~ | -~	-~+--~-~ | -~
k_{ii}^{b} (CAR in state ii)	-~++~+~+~ | +~	-+--- | -	-+---~ | -
v_{i}^{b}(repay. rate in state i)	+~---~+~+~ | +~	-~++~-~-~ | -	-~-+++~ | +~
v_{ii}^{b}(repay. rate in state ii)	+--~+~-~ | -~	+---~- | -	++~--~-~ | -
GDP_i	+-+~+~+~ | +~		
GDP_{ii}	+-+~+~+~ | +~		
M	+-+~++ | +~		

Source: Author (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend

Table 37: Directional changes in the endogenous variables in the model under 'Government-assisted merger' scenario without any capital injection (Merger 1).

Endogenous variable	Bank γ	Bank δ	Bank τ
r^{b}(lending rate)	n/a	++++~+ | +	+~++++ | +
r_{d}^{b}(deposit rate)	n/a	++~+++ | +	00000 | 0
$\bar{m}_{t}^{b}$(credit in the loan market)	n/a	-~---~-~ | -~	--~--~-~ | -~
π_{i}^{b} (profit in state i)	n/a	-+~+~+~+~ | +~	+~+~-~+~+~ | +~
π_{ii}^{b} (profit in state ii)	n/a	+~+~+~+~+~ | +~	-~-~-~-~-~ | -~
e_{i}^{b}(capital in state i)	n/a	-~0+~+~0 | +~	0+~000 | 0
e_{ii}^{b} (capital in state ii)	n/a	+~+++~+~ | +~	+~++~+~+~ | +~
$\mu_{d,t}^{b}$(debt in interbank market)	n/a	+~++~++~ | +~	--~--~-~ | -~
k_{i}^{b} (CAR in state i)	n/a	+~+~++~+~ | +~	++~+~+~+~ | +~
k_{ii}^{b} (CAR in state ii)	n/a	+~+~++~+~ | +~	+~+~++~+~ | +~
v_{i}^{b}(repay. rate in state i)	n/a	-~-~--~-~ | -~	+~+~+~+~+~ | +~
v_{ii}^{b}(repay. rate in state ii)	n/a	-~-~--~-~ | -~	-~-~-~-~-~ | -~
GDP_i	-~-~--~-~ | -~		
GDP_{ii}	-~-~--~-~ | -~		
M	+~+~++~+~ | +~		

Source: Author (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend

Table 38: Directional changes in the endogenous variables in the model under 'Government-assisted merger' scenario with an instant capital injection (Merger 2).

Endogenous variable	Bank γ	Bank δ	Bank τ
r^{b}(lending rate)	n/a	----- | -	----- | -
r_{d}^{b}(deposit rate)	n/a	----~-~ | -	00000 | 0

$\bar{m}_t^b$(credit in the loan market)	n/a	+++++~ | +	+++++ | +
π_i^b (profit in state i)	n/a	-~-~-~-~-~ | -~	--~-~-~-~ | -~
π_{ii}^b (profit in state ii)	n/a	-~-~-~-~-~ | -~	--~-~--~ | -~
e_i^b(capital in state i)	n/a	-~-~-~-~-~ | -~	+++++ | +
e_{ii}^b (capital in state ii)	n/a	-~-~-~-~-~ | -~	+++++ | +
$\mu_{d,t}^b$(debt in interbank market)	n/a	-----~ | -	----- | -
k_i^b (CAR in state i)	n/a	----- | -	----- | -
k_{ii}^b (CAR in state ii)	n/a	----- | -	----- | -
v_i^b(repay. rate in state i)	n/a	-~-~-~-~-~ | -~	--~--~-~ | -~
v_{ii}^b(repay. rate in state ii)	n/a	+~++++ | +	-+~+++ | +
GDP_i	+++++ | +		
GDP_{ii}	+++++ | +		
M	+++++ | +		

Source: Author (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend

Table 39: Directional changes in the endogenous variables in the model under 'Bad bank' scenario with a gradual capital injection (Bad bank 1).

Endogenous variable	Bank γ	Bank δ	Bank τ
r^b(lending rate)	-+~+---- | -	--~----~- | -	------- | -
r_d^b(deposit rate)	0000000 | 0	++~+~+~+~+~ | +~	0000000 | 0
$\bar{m}_t^b$(credit in the loan market)	+++++++ | +	+++++++ | +	+++++++ | +
π_i^b (profit in state i)	+------ | -	----~--~-~ | -	------- | -
π_{ii}^b (profit in state ii)	------- | -	------~- | -	------- | -
e_i^b(capital in state i)	++++++ | +	------~- | -	------- | -
e_{ii}^b (capital in state ii)	++++++ | +	-------~ | -	------- | -
$\mu_{d,t}^b$(debt in interbank market)	------- | -	------- | -	------- | -
k_i^b (CAR in state i)	------- | -	------- | -	------- | -
k_{ii}^b (CAR in state ii)	------- | -	------- | -	------- | -
v_i^b(repay. rate in state i)	+++++++ | +	+------ | -	++~-~--~-- | -~
v_{ii}^b(repay. rate in state ii)	+++++++ | +	-++++++ | +	+++++++ | +
GDP_i	+++++++ | +		
GDP_{ii}	+++++++ | +		
M	+++++++ | +		

Source: Authors (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend

Table 40: Directional changes in the endogenous variables in the model under 'Bad bank' scenario with an instant capital injection (Bad bank 2).

Endogenous variable	Bank γ	Bank δ	Bank τ
r^b(lending rate)	-0-~0000 | 0	--~-~0-~--~ | -~	-000000 | 0
r_d^b(deposit rate)	0000000 | 0	-+~+~+~+~+~ +~ | +~	0000000 | 0
$\bar{m}_t^b$(credit in the loan market)	+0-~0-~-~0 | -~	+0-~0000 | 0	--~000-~0 | -~
π_i^b (profit in state i)	-+~+~+~+~+~ +~ | +~	-0-~0000 | 0	-~00-~000 | 0
π_{ii}^b (profit in state ii)	-+~+~+~+~+~ +~ | +~	-~0-~0000 | 0	-~00+~000 | 0
e_i^b(capital in state i)	+0+~00+~0 | +~	-~000000 | 0	-~000000 | 0
e_{ii}^b (capital in state ii)	++~+~+~+~+~ +~ | +~	-000000 | 0	-~00-~000 | 0
$\mu_{d,t}^b$(debt in interbank market)	-00-~000 | 0	-0-0000 | 0	-+~00000 | 0
k_i^b (CAR in state i)	-~+~+~+~+~ +~+~ | +~	-+~00+~00 | 0	-~-~-~-~-~+~-~ | -~
k_{ii}^b (CAR in state ii)	-+~+~+~+~+~ +~ | +~	-+~00+~00 | 0	--~-~-~-~-~-~ | -~
v_i^b(repay. rate in state i)	+-~--~-~-~-~ | -~	+000000 | 0	-~+~+~+~+~+~+~ | +~
v_{ii}^b(repay. rate in state ii)	+-~-~-~-~00 | -~	+00-~000 | 0	+-~-~0-~-~0 | -~
GDP_i	+000000 | 0		
GDP_{ii}	+000000 | 0		
M	+0-~00-~0 | 0		

Source: Author (2019).
Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change; | overall trend.

Table 41 reports the summary of this exercise based on the outputs displayed in the above tables 35-40. I apply colour coding to ease the assessment of these results. Interventions marked in red are the least favourable options for a given bank among the studied intervention scenarios if one considers them at the single endogenous variable level, and vice versa for the interventions marked in green.

Table 41: Summary of the directional changes in the main endogenous variables in the model under each government-led intervention scenario.

Endogenous variable	Bank γ (high NPL)	Bank δ (moderate NPL)	Bank τ (no NPL)
repayment rate in state i (v_i^b)	No intervention: - Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: + Bad bank 2: -~	No intervention: -~ Nationalisation: - Merger 1: -~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0	No intervention: -~ Nationalisation: +~ Merger 1: +~ Merger 2: -~ Bad bank 1: -~ Bad bank 2: +~
repayment rate in state ii (v_{ii}^b)	No intervention: -~ Nationalisation: -~ Merger 1: n/a Merger 2: n/a Bad bank 1: + Bad bank 2: -~	No intervention: -~ Nationalisation: - Merger 1: -~ Merger 2: + Bad bank 1: + Bad bank 2: 0	No intervention: -~ Nationalisation: - Merger 1: -~ Merger 2: + Bad bank 1: + Bad bank 2: -~
credit in the loan market ($\bar{m}_t^b$)	No intervention: -~ Nationalisation: -~ Merger 1: n/a Merger 2: n/a Bad bank 1: + Bad bank 2: -~	No intervention: -~ Nationalisation: +~ Merger 1: -~ Merger 2: + Bad bank 1: + Bad bank 2: 0	No intervention: -~ Nationalisation: +~ Merger 1: -~ Merger 2: + Bad bank 1: + Bad bank 2: -~
capital in state i (e_i^b)	No intervention: +~ Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: + Bad bank 2: +~	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0	No intervention: +~ Nationalisation: -~ Merger 1: 0 Merger 2: + Bad bank 1: - Bad bank 2: 0
capital in state ii (e_{ii}^b)	No intervention: +~ Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: + Bad bank 2: +~	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: + Bad bank 1: - Bad bank 2: 0
profit in state i (π_i^b)	No intervention: -~ Nationalisation: -~ Merger 1: n/a Merger 2: n/a Bad bank 1: - Bad bank 2: +~	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0	No intervention: -~ Nationalisation: -~ Merger 1: +~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0
profit in state ii (π_{ii}^b)	No intervention: -~ Nationalisation: -~ Merger 1: n/a Merger 2: n/a Bad bank 1: - Bad bank 2: +~	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0	No intervention: +~ Nationalisation: -~ Merger 1: -~ Merger 2: -~ Bad bank 1: - Bad bank 2: 0
debt in interbank market ($\mu_{d,t}^b$)	No intervention: +~ Nationalisation: -~ Merger 1: n/a	No intervention: + Nationalisation: - Merger 1: +~	No intervention: -~ Nationalisation: - Merger 1: -~

Endogenous variable	Bank γ (high NPL)	Bank δ (moderate NPL)	Bank τ (no NPL)
	Merger 2: n/a Bad bank 1: - Bad bank 2: 0	Merger 2: - Bad bank 1: - Bad bank 2: 0	Merger 2: - Bad bank 1: - Bad bank 2: 0
CAR in state i (k_i^b)	No intervention: +~ Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: - Bad bank 2: +~	No intervention: + Nationalisation: -~ Merger 1: +~ Merger 2: - Bad bank 1: - Bad bank 2: 0	No intervention: +~ Nationalisation: -~ Merger 1: +~ Merger 2: - Bad bank 1: - Bad bank 2: -~
CAR in state ii (k_{ii}^b)	No intervention: +~ Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: - Bad bank 2: +~	No intervention: + Nationalisation: - Merger 1: +~ Merger 2: - Bad bank 1: - Bad bank 2: 0	No intervention: +~ Nationalisation: - Merger 1: +~ Merger 2: - Bad bank 1: - Bad bank 2: -~
lending rate (r^b)	No intervention: +~ Nationalisation: +~ Merger 1: n/a Merger 2: n/a Bad bank 1: - Bad bank 2: 0	No intervention: - Nationalisation: -~ Merger 1: + Merger 2: - Bad bank 1: - Bad bank 2: -~	No intervention: +~ Nationalisation: -~ Merger 1: + Merger 2: - Bad bank 1: - Bad bank 2: 0
deposit rate (r_d^b)	No intervention: 0 Nationalisation: 0 Merger 1: n/a Merger 2: n/a Bad bank 1: 0 Bad bank 2: 0	No intervention: - Nationalisation: -~ Merger 1: + Merger 2: - Bad bank 1: +~ Bad bank 2: +~	No intervention: 0 Nationalisation: 0 Merger 1: 0 Merger 2: 0 Bad bank 1: 0 Bad bank 2: 0

Note: +(-) substantial increase (decrease); +~(-~) weak increase (decrease); 0 – no change. Colour coding: green – top positive results for a given bank at the given variable level, red – top negative results for a given bank at the given variable level.
Source: Author (2019).

4.3.4. Discussion of results

My simulation results identify no clear winner among the assessed government interventions. The results are mixed from both angles, in-between interventions and with-in banks. Overall, both Merger scenarios as well as Bad bank 2 scenario seem to deliver the most positive directional changes for all banks in the economy, although with few trade-offs. From the policy perspective, this implies that governments need to carefully assess at ex-ante stage what they wish to target with their interventions in order to avoid causing more distraction to the entire banking sector as a whole due to the contagion between banks.

The common element in all assessed interventions (except Merger 1) is the capital injection by the government. This injection represents a positive shock to the deposit supply to the intervened bank in the initial period. In other words, this shock to deposits represents a change in the overall broad money supply. Even through the effect of the government capital injection is initially concentrated on Bank γ (or Bank τ in the Merger 2 scenario), I observe that the other banks also benefit from increased liquidity through their interactions in the interbank market. In particular, the additional capital from the government spillovers into the interbank market in the form of a higher liquidity. Such higher liquidity is then passed to the other banks in the form of a lower cost of interbank borrowing.

Specifically, this chain of contagion triggered by a higher supply of credit by the intervened bank in all scenarios (except Merger 1) causes the overall credit supply in the economy to increase. This implies that every household benefits directly from greater liquidity as well as from higher income (GDP) in both states of nature as can be seen clearly under Merger 2 and Bad bank 1 scenarios. Thus, the default probability of every household in the consumer loan market decreases, causing the expected rate of return from extending more loans to increase to all banks in the market. Consequently, their respective lending rates fall. Since the cost of interbank borrowing is fixed regardless of the amount demanded, the banks finance their greater credit extension by borrowing more from the interbank market. It is important to note that the money supply multiplier is larger when the central bank does not target the interest rates since besides their direct effect due to increased deposits, a second order effects from allowing the interbank rate to change enhances credit supply of the entire banking sector.

This chain reaction continues with higher expected GDP in both states under Merger 2 and Bad Bank 1 which results in every household borrower demanding more loans which imposes a positive pressure on lending rates offered by their respective nature-selected banks. However, this 'crowding-out' effect is dominated by the corresponding negative pressure from greater credit supply by all banks.[18] This is why I observe that their lending rates actually decline. In other words, greater aggregate credit supply directly increases households' liquidity under Merger 2 and Bad Bank 1 scenarios and it also increases their income in both states of the subsequent period. GDP increases in both states under both scenarios. Thus, the expected rate

[18] The relative strength of the pressures caused by the bank's and the borrower's portfolio adjustment depends in general on the relative elasticities of demand and supply in such a market.

of return from extending loans increases for all banks, implying that their willingness to supply more credit rises even further.

As a general rule, banks in the model are assumed to choose their optimal expected level of profitability by equating their derived marginal benefit with the corresponding marginal cost regardless of the scenario. On the one hand, higher profitability not only directly increases their utility but also raises their capital to asset ratios, allowing them to suffer less capital violation penalties. Consequently, their capital decline slightly in both states compared with the initial equilibrium under Merger 2 and Bad Bank 1 scenarios. This, together with the fact that the values of their risk-weighted assets increase, causes all banks to suffer greater capital violation penalties under these scenarios.

The effect of liquidity injection in the Bank γ's (or Bank τ in the Merger 2) produces negative contagion effects into the rest of the bank(s) in the banking sector. As flagged by Goodhart et al. (2005), the central bank's sterilisation policy in the interbank market increases the relative attractiveness of interbank investment, implying that bank γ (or bank τ in the Merger 2) responds to higher capital by increasing its investment in the interbank market. The extent of such increase is so large that bank γ's (or Bank τ in the Merger 2) has to switch part of its investment away from the loan market. This negative contagion effect depresses the other bank(s)' expected return on their credit extension. Thus, they extend less credit, causing the aggregate output to fall in both states and threaten the financial stability. This, in turn, worsens the severity of credit crunch in the economic system even further. I also observe that the other banks now violate 'less' their capital adequacy requirements and, thus, suffer less capital violation penalties under most of the scenarios. This is because higher default probability of every household causes the values of the other banks risk weighted assets to decrease.

The increase in the aggregate bank lending and in the loan rates is the result of the effect on demand and supply of credit of the initial shock to capital due to the government intervention. All banks have more available funds: Bank γ (or Bank τ in the Merger 2) because of the increase in its own capital, the other banks because now they can borrow more in the interbank market. A second-round effect on loan supply comes through the effect of the increase in lending and in Bank γ's capital (or Bank τ in the Merger 2) on future GDP and, hence, in households' repayment rates. At the same time, loan supply increases, demand for credit also

increases considerably due to the repercussion of the higher value of Bank γ's equity (or Bank τ in the Merger 2) on expected GDP. This increase in demand explains the higher credit volumes in the loan market under these scenarios.

Next, the discount rates (r) are decreasing functions of t. This, in general, is a good signal in terms of financial stability since it reduces the presence of moral hazard in the credit market. If interest rates are smaller, this means that firms accept to borrow money to invest in 'good technologies' with increasing probability of loan repayment.

However, if no moral hazard is present in the country's credit market, this is a bad news in terms of financial stability, since lower interest rates reduce the spreads of the banks weakening the financial stability of the system. The reduction of bank spreads may imply a reduction in bank profits which may serve as a cushion for losses in periods of stress. Thus, a reduction in bank spreads may also be associated with higher default probability.

The effect of capital injection by the government on the other remaining variables can be understood by noting that banks maximise their utility by equating the marginal benefit from profits with the marginal cost from default and capital violation penalties. Hence, in trying to achieve maximal utility, banks face a trade-off. On one hand, higher profits increase banks' utility both directly and by raising banks' capital-to-asset ratios. On the other hand, to obtain higher profits, other things being equal, banks need to take more risk, i.e. to increase their default rates (equivalently to decrease their repayment rates). It is important to note, however, that the decisions made by banks may not be socially optimal. Banks internalise how their decisions matter for run risk and choose funding contracts optimally to maximize their own welfare. Governments can improve social welfare by regulating banking activities through their interventions. The context in which these interventions are decided, however, play a crucial role in determining their effectiveness.

4.4. Conclusion

The chapter's findings are in line with the empirical results from my previous chapter of this thesis. Namely, there is no 'one-size-fits-all' solution for an effective government intervention in the banking sector. The results based on the CGE model's calibration exercise I carry out in this chapter indicate some favourable implications of 'bad bank' approach towards banks'

future performance. This was also found under the previous chapter. Similarly, nationalisation seems to be the least preferable intervention in comparison to the other studied interventions. Moreover, due to the high contagion between the intervened and non-intervened banks, the net effects of the intervention may be less strong than initially planned by the governments. Other agents in the economy may be negatively impacted and this adds more pressure on the governments to consider all the likely trade-offs each of the interventions may produce before they launch their intervention into their banking sector. This is because there are certain trade-offs between the desirable as well as undesirable implications of interventions on banks' future performance. The effectiveness of the interventions depends on what the government is aiming to achieve, e.g. higher bank lending, stronger bank capitalisation). The objectives and, most importantly, priorities of the governments should be timely decided on and assessed due to the risk of the moral hazard which can emerge in the longer term.

My chapter suffers from several limitations which provide scope for further research. The applied model of Goodhart et al. (2004, 2005) suggests how financial variables are related to each other, indicating how these variables affect financial stability. Due to the strong sensitivity of the model to the choice of parameters and path used to calibrate this model, the analysis of financial stability has limited external validity. The model is based on a set of strong assumptions.

More specifically, several assumptions of the model can be challenged in further research. Firstly, the applied model assumes that households in the economy are constrained to a particular bank. This is unlikely to be the case in practice as there is often no restrictions as to from whom agents in the banking system can borrow. Secondly, the assumption that banks maximise their expected profits over a period of one year does not work in real life as banks often have a longer horizon than one year for their profit expectation. Thirdly, the assumption of the default rate for deposit and that for the interbank market for each bank being the same is chosen for simplicity. In reality, banks may not default on their deposit.

Next, the assumption that the size of the penalty is being proportional to how far the level of capital is from the minimum level set by the government is likely to be problematic. In real world, the further the banks deviate from their minimum capital requirement, the more severe the penalty and, so, the capital infringement penalty cannot be linear. There is also an opportunity for future research on some of the exogenous variables which were arbitrarily

chosen, in particular, the elasticities of the reduced form equations that could be calibrated against real data from the given country.

More practically, more issues arise in reality when banks operate across borders while government intervention is still limited by national borders. This is a real challenge faced by many governments and policy makers which adds a significant burden on the design and implementation of effective bailouts or even bail-ins. As stated earlier, contagion between banks is not constrained by country's boundaries whereas government interventions tend to focus on their domestic banks which often have a high foreign exposure in other countries. Future research could explore this in more depth.

Lastly, the model does not factor in the size of the country's banking sector nor its level of development which further restricts its validity. Countries with a large financial sector compared to their GDP, like Ireland or the United Kingdom, may benefit more from interventions than countries with a small banking sector, particularly in less advanced countries.

5

Conclusion

This thesis explores various topics in relation to bank performance and stability in the format of a collection of three core chapters. All of these chapters explore banks from different research perspectives and from a different context of bank analysis. The importance of studying banks' performance and effects on the rest of the economy is explained in the introduction of this thesis. Till today, banks around the world continue to play an important role in the many countries on different level of economic development. There is a breath of literature evidence which confirms high correlations between banks and the economic growth across the globe. Researchers have followed a wide range of approaches in their analyses of bank performance. My thesis' chapters follow a bottom-up approach of bank performance's assessment. Namely, I start by looking into the bank performance by analysing investment projects of a single bank under my first chapter of this thesis. Next, I move to the assessment of multiple, failing banks in a cross-country and cross-bank angle in the context of various government interventions into the banking sector. And, finally, I take this topic further by assessing it through an application of a financial stability model in order to draw further conclusions.

The findings behind my first chapter suggest that the probability of investment project success of a studied MDB is higher with larger scale investments. Also, my results indicate that investment project under framework is an important contributor towards investment success and its impact is mediated through project size. Lastly, I find that investment projects with state clients are less likely to be successful. Due to several data constraints at the time of drafting my thesis I was not able to tackle several additional and important aspects behind this research topic. For instance, there is already an exciting empirical evidence on the trade-offs between financial and non-financial performance of investment projects carried out by MBDs. I plan to look deeper into this trade-offs question as I deal with the data issues which are currently being resolved. I have also collected additional project- and client-level variables which could further enrich my initial findings presented in this thesis for an even larger number of projects reaching now over 2,000 investments. My research findings are already being used internally at EBRD

for shaping the institutional learning as well as externally in co-operation with other MDBs in order to share lessons learnt and exchange approaches cross-institutionally.

The findings behind my second chapter are based on a cross-bank, cross-country and cross-time empirical study into bank performance in the context of government interventions into failing banks during financial crises. Based on my empirical assessments in this chapter, I find no clear winner among the studied interventions with gains as well as potential losses under each of the interventions. I argue that a 'one-size-fits-all' intervention approach is suboptimal. I reach similar conclusions under the final chapter of my thesis. There, I look at the bank performance analysis in the context of financial stability by applying the model of financial stability by Goodhart et al. (2004, 2005). I place special attention on the bank's NPLs which I assign as a trigger for government intervention. I outline the importance of NPLs under the literature review of this chapter. The results of the calibration exercise indicate some favourable implications of 'bad bank' approach towards banks' future performance as it was also found under the previous chapter. Similarly, nationalisation seems to be the least preferable intervention in comparison to the other studied interventions. Due to the high contagion between the intervened and non-intervened banks, the net effects of the intervention may be less strong than initially planned by the governments which is an important take-away for the future policy actions by the governments. The results of my second and third chapters come timely as the world is currently faced an increasing threat to financial stability caused by the Covid-19 pandemic. This health crisis is quickly turning into an economic one and it is already contributing to a sharp increase in NPLs which may, with time, depress banks' performance and their overall health. In that event, banks may, once again, call in on governments for help.

6
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