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ESSAYS ON THE MONETARY ECONOMICS OF LOW INCOME COUNTRIES

HAROLD P.E. NGALAWA

Thesis Presented for the Degree of

DOCTOR OF PHILOSOPHY

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UNIVERSITY OF CAPE TOWN

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Supervisor: Professor Nicola Viegi

University Of Cape Town

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Harold P.E. Ngalawa

Declaration

This thesis is my original work. Where other people's work is used, acknowledgements have been made. I declare that it has not been previously submitted for the award of a degree at any university.

Candidate _____

Harold P.E. Ngalawa

Date _____

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Dedication

To Mum and Dad

"We are like dwarfs astride the shoulders of giants, so that we can see more than they, and things at a greater distance, not by virtue of any sharpness of sight on our part, or any physical distinction, but because we are carried high and raised up by their giant size," Bernard of Chartres, n.d.

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Acknowledgements

After many years of blood, sweat and tears, this intellectual work is finally complete. After countless revisions, rewrites, edits and re-edits, I am humbled to acknowledge the time, energy and scholarship of numerous persons, whose input into the project has been amazing. After everything is said and done, I cannot but single out the selfless contribution of my supervisor, Professor Nicola Viegi. Nicola did not only have the patience to see to it that I am equipped with the tools of the trade, but also tirelessly ensured that the product is of acceptable academic rigour. I feel proud and privileged to have worked with such a 'giant'. I am also heartily grateful to Dr. Fulbert Tchana Tchana, especially for his valuable suggestions when I was studying banking instability and deposit insurance.

Without the generous financial support from the African Economic Research Consortium (AERC), it would not have been possible to embark on this project. I acknowledge their generosity with appreciation. I am also thankful to the Bill and Melinda Gates Foundation for funding my DYNARE training in Paris, the University of Cape Town (UCT) for providing me with a research grant, and the Beit Trust Foundation for the 'money for food.' In addition, I acknowledge contributions by fellow researchers at the AERC biannual conferences in Entebbe (June, 2008) and Nairobi (December, 2008), the Annual DYNARE Conference in Oslo (September, 2009), and UCT's School of Economics weekly seminars where earlier versions of Chapters Two, Three and Four were presented.

I treasure the unfailing love, support and understanding that I received from my wife Alice and children, Zimatha and Nthanda. I am also grateful to my brothers Andy and Peter and my sisters Mada, Fany and Ndaona for their love and care. To my parents, Phillion and Flora, I fall short of words to describe their input. I am still at pains to reconcile with the fact that they did not live long enough to see the project they unreservedly supported at inception come to completion.

Furthermore, I am indebted to many of my colleagues in the Collaborative PhD Program for creating a conducive environment for success with expressions of cheer and hope. I owe the most to Martin Phangaphanga, Richard Mussa and Grace Kumchulesi for making my stay in the Mother City bearable. While an attempt has been made to mention names, this thesis has benefited from specialised essential contributions from many other people and organisations too many to mention. Their input is acknowledged with appreciation as well. I, nonetheless, take full responsibility for all errors, omissions and misrepresentations.

Everything else considered, not a stone could have been turned if it were not for the divine support from the Almighty God, who has been a constant source of strength and hope to me. **May His Name be glorified.**

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Abstract

Essays on the Monetary Economics of Low Income Countries

by

Harold P.E. Ngalawa

University of Cape Town, May 2010

This thesis sets out to investigate selected macro-monetary and financial phenomena in low income countries. The study is presented in three separate but related essays. The first essay (Chapter Two) examines the process through which monetary policy affects economic activity in Malawi using innovation accounting in a structural vector autoregressive model with short run restrictions. Employing monthly time series data covering the period 1988:1-2004:12, it is established that monetary authorities in Malawi employ hybrid operating procedures and pursue both price stability and high growth and employment objectives. Two operating targets of monetary policy are identified, namely bank rate and reserve money. It is demonstrated that the former is a more effective measure of monetary policy than the latter. It is also illustrated that bank lending, exchange rates and aggregate money supply contain important additional information in the transmission process of monetary policy shocks in Malawi. In addition, it is shown that the floatation of the Malawi Kwacha in February 1994 had considerable effects on the country's monetary transmission process. In the post-1994 period, the role of exchange rates became more conspicuous than before although its impact was weakened, and the importance of aggregate money supply and bank lending in transmitting monetary policy impulses was enhanced. Overall, the monetary transmission process evolved from a weak, blurred process to a somewhat strong, less ambiguous mechanism.

The second essay (Chapter Three) develops a four-sector dynamic stochastic general equilibrium (DSGE) model, with asymmetric information in the formal financial sector, to analyse the interaction of formal and informal financial markets and their impact on economic activity in low income countries. Calibrated on Malawi data, the model demonstrates that formal and informal financial sector loans are complementary in the aggregate, suggesting that an increase in the use of formal financial sector (FFS) credit creates additional productive capacity that requires more informal financial sector (IFS) credit to maintain equilibrium. The model also illustrates that the response of both formal and informal financial sector loans to either a positive production technology or a monetary policy shock is sensitive to the rates of success for both high and low risk borrowers. In addition, it is shown that the response of output, expected prices and lending in both formal and informal financial sectors to a shock on the risk factor (rate of succes) for high risk borrowers is sensitive to the rate of

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success for low risk borrowers. The behaviour of interest rates in the formal and informal financial sectors presents some further interesting results. The model demonstrates that interest rates in the IFS are not necessarily driven by FFS interest rates. While interest rates in the two sectors are observed to change together in the same direction following a positive production technology shock, the same is not observed with a monetary policy shock. The implication of this finding is that the IFS is likely to frustrate monetary policy in certain instances. In countries with a large IFS, therefore, the sector's negative impact on the transmission process of monetary policy is expected to be equally large. Accordingly, countries with a very large IFS may be associated with a relatively lower impact of monetary policy on economic activity.

The third essay (Chapter Four), attempts to find out if low income countries are prone to banking instability more than high income countries, whether or not deposit insurance explains the high prevalence of banking instability in low income countries and the relatively low incidence of banking instability in high income countries, and the effect of different designs of deposit insurance on banking instability. Using a new empirical framework that distinguishes banking instability triggered by bank runs from banking instability caused by insolvency of banks, logit models are estimated on sample sizes ranging from 33 to 109 countries in a pool of 118 countries. The sample size in each regression is dependent on data availability for the period 1980-2004. The study finds very weak evidence that low income countries are vulnerable to banking instability more than high income countries. Although not conclusive, the results show some evidence that African countries may be at greater risk of encountering bank runs than other countries. There is no evidence, though, that the African countries are vulnerable to insolvency more than other countries. Contrary to popular findings, it is shown than deposit insurance *per se* has no bearing on banking fragility, whether characterised by bank runs or insolvency of banks. Certain features in the design of deposit insurance are, nonetheless, observed to have a statistically significant effect on banking fragility. It is established that a country is more vulnerable to banking instability if it has a more generous deposit insurance scheme, if the deposit insurance agency has a legal mandate to cancel or revoke deposit insurance for any participating bank, if the deposit insurance scheme has a permanent fund, and if deposit insurance is funded jointly by the government and the private sector or solely by the government. We argue, therefore, that it is not whether or not a country has deposit insurance that matters; rather, it is the design of the insurance scheme that makes a difference.

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Chapter 1

Introduction

Challenges facing low income countries in the conduct of monetary policy are often different from those facing high income countries[1]. Unlike high income countries, a majority of low income countries have a relatively large non-monetised sector operating on an almost indigenous exchange mechanism. In these countries, the formal financial sector (FFS) coexists with a large informal financial sector (IFS), information is costly and incomplete, fiscal deficits and domestic public sector borrowing are high, prudential supervision of financial institutions is poor, the legal system is weak, and banks play a heightened role because capital markets are shallow or non-existent, *inter alia* (see Ghatak and Sanchez-Fung, 2007; Chipeta and Mkandawire, 1991; Montiel, 1991; Coats and KhatKhate, 1983). In contrast, high income countries usually have highly developed and broadly competitive financial markets (Bolnick, 1991), small budget deficits (Christiansen, Prati, Ricci and Tressel, 2009), a sound legal system characterised by constitutional guarantees and judicial independence (Klerman, 2006), a more effective prudential supervision of financial institutions (IMF, 2008) and a virtually non-existent IFS. Clearly, using models developed with more advanced economies in mind for any theoretical or empirical study of low income countries obscures an understanding of these countries' problems. This thesis, therefore, contributes

[1] According to World Bank's classification of countries based on the 2008 gross national income (GNI) per capita calculated using the Atlas method, countries with a GNI per capita of less than US$975 are low income while countries with a GNI per capita of US$976 or more are further classified as lower middle income (US$976-US$3,855), upper middle income (US$3,856-US$11,905) and high income (US$11,906 or more). For simplicity, we categorise countries into two broad income groups: low and high income countries, where high income countries include lower middle income, upper middle income and high income countries.

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to the literature by investigating selected macro-monetary and financial issues in the low income countries taking into account the institutional peculiarities in these countries. The investigations are presented in three separate but related essays.

The first essay (presented in Chapter 2) investigates the process through which monetary policy affects economic activity in Malawi. The central bank in Malawi is mandated through the Reserve Bank of Malawi (RBM) Act of 1989 'to implement measures designed to influence the money supply and the availability of credit, interest rates and exchange rates with the view to promoting economic growth, employment (and) stability in prices' (Government of Malawi, 1989, pp. 5). Clearly, this objective cannot be achieved unless the monetary authorities understand the mechanism through which monetary policy affects economic activity in the country. In the case of Malawi, however, there is no study that we are aware of that has quantitatively measured the monetary policy transmission process.

Chapter 2, therefore, contributes to the literature by filling this gap. Using a structural vector autoregressive model (SVAR) with short run restrictions, the study isolates monetary policy autonomous disturbances from other shocks, quantifies their dynamic behaviour and measures the impact of the shocks on macroeconomic variables that represent policy goals. Using this approach, the study unearths important channels of monetary policy transmission in the country. Cognisant that transmission linkages can be transformed by innovations in financial markets, revisions in policy procedures and changes in economic conditions (see Bolnick, 1991), the study also investigates how Malawi's monetary policy process was altered when the country migrated from using direct to using indirect tools of monetary control in the late 1980s and the 1990s.

Contrary to the official position that monetary policy in Malawi targets only reserve money, the study finds that monetary authorities in the country also target short term interest rates (specifically the bank rate), suggesting that the country employs hybrid operating procedures. The study further demonstrates that the bank rate is a more effective measure of monetary policy than reserve money. In addition, it is established that monetary authorities in the country pursue both price stability and high growth and employment

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objectives, in line with the country's central bank Act (Part III, Section 4(d) of the RBM Act of 1989). It is further shown that price stability is the principal objective of monetary policy in the country. With the exception of exchange rate shocks, however, consumer prices respond weakly to monetary impulses suggesting that inflation in Malawi may not be dominated by monetary factors. The fact that food costs have a preponderant weight (58.1 percent) in the all items national composite consumer price index reveals that structural rigidities in food production may be more important determinants of inflation than monetary considerations.

The study also illustrates that bank lending, exchange rates and aggregate money supply contain important additional information on the transmission process of monetary policy shocks in Malawi. Furthermore, truncating the study period to include only the flexible exchange rate period (post-1994) reveals two interesting issues. First, the role of the exchange rate becomes more conspicuous although its impact on economic activity is weakened. Second, the importance of aggregate money supply and bank lending in transmitting monetary policy impulses is enhanced. It is concluded, therefore, that following the country's migration from a fixed to a floating exchange rate regime in February 1994, the monetary transmission process evolved from a weak, blurred process to a somewhat strong, less ambiguous mechanism, consistent with theoretical expectations.

The second essay (presented in Chapter 3) explores the interaction of formal and informal financial markets and their impact on economic activity in low income countries. We generalise the low income countries as being characterised by weak monetary and fiscal institutions and an FFS that co-exists with a large IFS. Notwithstanding its sheer size and the likelihood that the IFS's response to monetary policy may be non-trivial, nearly all low income countries do not include informal financial transactions in official monetary data, effectively underestimating the volume of aggregate financial transactions and bringing into question the timing and effect of monetary policy on economic activity. Nonetheless, for monetary policy to be an effective tool for macroeconomic management, monetary authorities are still required to understand the process through which monetary policy affects

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economic activity, which necessitates understanding the interaction of formal and informal financial markets and their impact on economic activity.

While previous empirical studies provide evidence of interaction between formal and informal financial markets, there is no consensus on the nature of interaction between the two markets and how it affects economic activity. In a study of Thailand, Chandavarkar (1990) found that there were significant flows of savings from the FFS to the IFS from time to time because of higher rates of interest in the latter, leading to financial disintermediation in the FFS. The reverse was observed in a study of Korea where Cole and Park (1983) noted that an increase in interest rates in the FFS that accompanied the financial reforms of the 1950s and the 1960s induced an inflow of savings from the informal to the formal financial sector. Cole and Park (1983), however, did not explain the extent to which the flow of savings from the IFS to the FFS was induced by interest rates and not by the financial reforms. Cole and Park (1983) also observed that informal credit markets facilitated the monetary policy process in Korea by transmitting signals and funds, and contributed to the maintenance of high rates of economic growth by mitigating disruptive consequences of credit controls in the formal sector.

In the case of Malawi, Chipeta and Mkandawire (1991, 1992) concluded that there is a weak deposit link between formal and informal financial markets, which operates especially with moneylenders depositing their surplus funds in formal financial institutions. In this instance, the primary motivation for depositing funds in a formal financial institution (FFI) is security rather than interest income because commercial banks offer much lower rates of interest than what the moneylender would get by giving out more loans. Chipeta and Mkandawire (1991, 1992) also observed that credit links between the formal and informal financial markets in Malawi are significant. In the Philippines, Floro and Ray (1997) reported that formal sector banks are a major source of funds for informal lenders, particularly for those lenders involved in trading operations. Recently, in a case study of Ghana, Aryeetey (2008) stated that *susu* (savings) collectors are increasingly becoming an important channel of savings mobilisation by FFIs, particularly Barclays Bank Ghana, from the IFS. Contrary

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to what many analysts who perceive informal finance as a consequence of inadequate formal financial systems would expect, Aryeetey (2008) also reported that there are signs of formal institutions borrowing from the IFS in Ghana.

None of these empirical studies, however, is based on any analytical framework. In addition, the studies have no microfoundations and their place in a general equilibrium structure is not known. Chapter 3, therefore, contributes to the literature by developing a four-sector dynamic stochastic general equilibrium (DSGE) model with asymmetric information in the FFS to analyse the interaction of formal and informal financial markets and their impact on economic activity in low income countries. The model is calibrated to Malawi data. The chapter investigates whether informal financial markets are autonomous or reactive to formal financial markets, whether the two markets are complementary or competitive and whether their interaction frustrates or strengthens monetary policy.

Focusing on three experiments identified by a positive production technology shock, a monetary policy shock and a shock on the risk factor of high risk borrowers, we demonstrate that while formal and informal sector loans may be substitutes in a borrower's utility function, they are in the aggregate complementary. Thus, increasing the use of FFS credit increases the demand for credit in the IFS. The observed behaviour of formal and informal financial sector interest rates presents another important finding. The model demonstartes that interest rates in the IFS are not necessarily driven by FFS interest rates. When experimenting with a positive production technology shock, interest rates in the two sectors were observed to move together in the same direction while in the experiments involving a monetary policy shock and a risk factor shock, they were not. In the monetary policy shock experiment, the two interest rates were in fact moving in opposite directions. The implication of this finding is that the IFS has the potential to frustrate monetary policy and its impact is likely to be more pronounced in countries where the sector is very large. Finally, the study shows that the risk factor of borrowers is an important determinant of the extent to which macroeconomic indicators respond to various shocks. In all the three experiments demonstrating how selected macroeconomic indicators respond to a positive

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production technology shock, a monetary policy shock and a shock on the probability of success for high risk borrowers, the model shows that changing the risk factors of either low or high risk borrowers results in most macroeconomic indicators responding with different magnitudes.

The third essay (presented in Chapter 4) explores whether low income countries are prone to banking instability more than high income countries, whether deposit insurance explains the high prevalence of banking instability in low income countries relative to their high income counterparts, and the effect of different designs of deposit insurance in achieving banking stability. Recent studies show that more cases of banking instability have been recorded in low income countries than in high income countries (see Demirgüç-Kunt and Detragiache, 1998). While many countries have adopted deposit insurance as a way of minimising the risk of banking instability arising from self-fulfilling expectations, the available data shows that high income countries have been more receptive to the implementation of deposit insurance schemes than low income countries (see, for example Demirgüç-Kunt, Karakaovali and Laeven, 2005). Does the absence of deposit insurance explain the high prevalence of banking instability in low income countries? Or, are low income countries just prone to banking instability more than high income countries? This study sets out to answer these and other questions. Using a new empirical framework that distinguishes banking instability triggered by bank runs from banking instability caused by insolvency of banks, the study goes beyond the two questions to investigate the role of deposit insurance in achieving banking stability and the effect of different designs of deposit insurance on banking fragility.

The adoption of deposit insurance is rationalised by the desire to minimise the risk of banking instability arising from self-fulfilling expectations. Upon rumours that a bank is on the brink of failure, the absence of deposit insurance leads to fears that the bank may not be able to repay all depositors in full and on time because its funds are tied up in assets that cannot be easily converted into cash. These expectations, in turn, prompt depositors to simultaneously attempt to withdraw all their deposits before the bank runs

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out of cash, bringing about failure of the bank. Deposit insurance, however, also creates a moral hazard problem. With deposit insurance, depositors feel no longer obliged to assess the risk of depositing money in a particular bank and end up choosing a bank based on the attractiveness of interest rates on offer rather than the bank's financial standing. Similarly, deposit insurance makes it attractive for banks to pursue high-risk high-return projects more than they otherwise would, subjecting the banking system to a high risk of instability. On the balance, the theory is inconclusive on whether deposit insurance leads to banking system stability or instability. The few empirical studies that have been carried out (see, for example Demirgüç-Kunt and Detragiache, 2002; Wheelock and Wilson, 1995; Carapella and Di Giorgio, 2004; Cull, Senbet and Sorge, 2005) support the view that moral hazard, arising from the adoption of deposit insurance, is dominant in a general equilibrium framework. None of these studies, however, has distinguished between banking instability triggered by bank runs and banking instability caused by insolvency of banks. The distinction is an innovation of this study.

In this study, we develop a new empirical framework where we distinguish banking instability initiated by a bank run or panic withdrawals of deposits, and banking instability initiated by the insolvency problem of banks. Using a panel dataset with a pool of 118 countries, we estimate a baseline model to investigate the vulnerability of a country to banking instability given its income level, the susceptibility of African countries to banking instability relative to other countries and the role of deposit insurance in achieving banking system stability. The study also explores whether the generosity of payouts, coverage, legal environment and administration of deposit insurance affect banking fragility.

Our investigation shows very weak evidence that low income countries are more vulnerable to banking instability than high income countries. There is, however, some evidence, although not conclusive, that African countries may be at greater risk of encountering bank runs more than other countries. There is no evidence, though, that African countries are more vulnerable to insolvency than other countries. We conclude, therefore, that the banking system in African countries may have underlying characteristics that make it susceptible

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to bank runs more than banking systems in other countries.

Contrary to popular findings, we also find that deposit insurance *per se* has no bearing on banking fragility, whether characterised by bank runs or by insolvency of banks. While our results do not necessarily refute the findings in the earlier literature because of differences in measurement of the banking instability variable, we lay claim to having presented more expressive findings following our distinction of bank runs and insolvency of banks as identifiers of banking instability. Certain features in the design of deposit insurance are, nonetheless, observed to have a statistically significant effect on banking fragility. We establish that a country is more vulnerable to banking instability when it has a more generous deposit insurance scheme, when the deposit insurance agency has a legal mandate to cancel or revoke deposit insurance for any participating bank, when the deposit insurance has a permanent fund, and when the scheme is funded jointly by the government and the private sector or solely by the government. We argue, therefore, that it is not whether or not a country has deposit insurance that matters; rather, it is the design of the insurance scheme that makes a difference.

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Chapter 2

Dynamic Effects of Monetary Policy Shocks in Malawi

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2.1 Introduction

While it is generally agreed that monetary policy can significantly affect economic activity and prices in the short to medium run and only prices in the long run, considerable debate remains about how monetary policy shocks are transmitted (see, for example Bernanke and Gertler, 1995; Meltzer, 1995; Thornton and Wheelock, 1995; Ghatak and Sanchez-Fung, 2007). There are many different views of the monetary transmission mechanism and different studies put emphasis on different mechanisms (see, for example Mohanty and Turner, 2008; Dabla-Norris and Floerkemeier, 2006; Kamin, Turner and Van't dack, 1998; Taylor, 1995)[1,2]. Many of these studies mostly deal with monetary policy in industrialised countries where financial systems are highly developed, markets are broadly competitive and macroeconomic relationships have been studied for decades (Bolnick, 1991). The views differ with regard to the emphasis placed on money, credit, interest rates, exchange rates, asset prices and the role of commercial banks and other financial institutions (Taylor, 1995).

[1] There are, nonetheless, some channels of monetary policy transmission that are considered standard in the literature. These include the credit channel, the exchange rate channel, the interest rate channel and the other asset price effects channel. A concise outline of these channels is found in Mishkin (1995).

[2] The term 'transmission mechanism ' refers to the chain of cause-and-effect linkages that connect monetary policy tools to the macroeconomic variables that represent policy goals (see Bolnick, 1991)

The differences are prevalent even in the individual industrialised countries where the topic has been a subject of research for many years. In low income countries, the process is even more uncertain (Kamin et al., 1998). In spite of the prominence given to monetary policy in the low income country setting, the monetary policy transmission process in a typical low income country is not well understood (Montiel, 1991).

In Malawi, monetary policy plays an important role in the management of the economy. As outlined in the Reserve Bank of Malawi (RBM) Act of 1989, one of the principal objectives of the central bank is to influence money supply, credit availability, interest rates and exchange rates in order to ultimately promote economic growth, employment and price stability (Government of Malawi, 1989). Achieving this objective clearly requires an understanding of the process through which monetary policy affects economic activity. There is, however, no study that we are aware of that has quantitatively measured the transmission process of monetary policy in Malawi. This chapter, therefore, contributes to the literature by filling this gap. The study isolates monetary policy autonomous disturbances from other shocks, quantifies their dynamic behaviour and measures the consequent macroeconomic implications using a structural vector autoregressive model (SVAR) with short run restrictions. Within the same framework, the study also assesses how the country's monetary policy transmission process was altered by the RBM's migration from direct to indirect tools of monetary control in the late 1980s and the 1990s.

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Since Sims's (1980) pioneering work, vector autoregression models (VARs) are considered benchmarks in econometric modelling of monetary policy transmission (Borys and Hovarth, 2007). While natural experiments would be ideal, the real world does not provide for this option and SVARs are the only other way experiments can be performed (Christiano, Eichenbaum and Evans, 1998). SVAR experiments aimed at measuring the effect of monetary policy on economic activity have traditionally involved setting apart monetary policy shocks and tracking the response of macroeconomic variables to the monetary policy impulses.

Most studies that have applied SVARs to study the dynamic behaviour of monetary

policy shocks have used developed market economies as case studies (see, for example Karame and Olmedo, 2002; Bernanke and Mihov, 1998; Sims and Zha, 2006; Bernanke and Mihov, 1997; Piffanelli, 2001)). In recent years, there has been growing attention given to emerging market economies (EMEs) of Latin America, Asia and Eastern Europe (see, for example Borys and Hovarth, 2007; Vonnak, 2005; Disyatat and Vongsinsirikul, 2003; Dabla-Norris and Floerkemeier, 2006) and to Australia (see, for example Becklemans, 2005; Brischetto and Voss, 1999). In contrast, low income countries, particularly in Sub-Saharan Africa (SSA), have attracted very little attention.

Among the few studies undertaken on low income countries, Mutoti (2006) employed a cointegrated structural VAR identified with short run and long run restrictions to model the monetary transmission process of post-liberalisation Zambia. Using monthly data for the period 1992-2003, he found that much of the output volatility in the country was attributable to aggregate supply shocks, with IS shocks turning out to be the most important demand factors for the business cycle. He also noted that money demand shocks modestly boosted short run output. He further established that in the short run, changes in consumer prices were accounted for by aggregate supply, money demand and exchange rate shocks whilst at longer horizons, they were mainly underlined by aggregate supply shocks and modestly by foreign price shocks. The study concluded that a very small proportion of output variance was due to monetary policy shocks.

In a study of Kenya, Maturu (2007) used a structural VAR to argue that interest rate and exchange rate channels are unambiguously important channels of monetary policy transmission in the country besides the traditional money channel. On this basis, he pointed out that there was potential for signalling monetary policy using the REPO interest rate. In another study of Kenya, Cheng (2006) also used a structural VAR to examine the impact of monetary policy shocks on output, prices and the nominal effective exchange rate for the country during the period 1977-2005. Cheng found that an exogenous increase in the short term interest rate was followed by a decline in prices and an appreciation of the nominal exchange rate, but the impact on output was insignificant. He further showed that

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variations in short term interest rates accounted for significant fluctuations in the nominal exchange rate and prices, while only marginally influencing output fluctuations.

In the case of Malawi, there are two theoretical studies, one by Bolnick (1991) and another by Phiri (2002), and no empirical analysis on the country's monetary transmission process. The Bolnick study was carried out at the time the RBM was converting from direct to indirect tools of monetary management. The study investigated how the changing conditions would weaken or alter links in the country's monetary transmission process. Unfortunately, Bolnick was unable to predict the emergence of a reasonably competitive financial sector within the foreseeable future and consequently concluded erroneously that after the RBM's implementation of indirect monetary controls, the transmission of monetary policy shocks in Malawi would be stage-managed by the central bank through informal consultations with commercial bank managers. Phiri's (2002) study, on the other hand, is not very useful as it does not go beyond a theoretical exposition of textbook transmission channels of monetary policy. For instance, he presented the other asset price effects channel operating through an efficient stock market as one of Malawi's monetary transmission channels. However, with only eight listed companies at the time of the study, it is common knowledge that the Malawi Stock Exchange (MSE) was still is in its infancy with regard to acting like a conduit of monetary transmission. As at January 2010, the MSE had 15 listed companies and was still classified as 'infant.'

Following this introduction, the rest of the chapter is organised as follows. Section 2.2 is an overview of monetary policy in Malawi since independence in 1964. A methodological framework characterising structural VARs, identification of the structural shocks, data sources, variable definitions and measurement of variables are presented in Section 2.3. Estimation results and inferences are discussed in Section 2.4. Section 2.5 presents a summary and conclusions.

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2.2 Overview of Monetary Policy in Malawi Since 1964

Monetary policy in Malawi since independence can be outlined in three broadly distinct monetary policy regimes. This includes a period of financial repression (1964-86), a period of financial reforms (1987-1994) and a period of financial liberalisation (post-1994). At independence in 1964, the formal banking system which the country adopted from the colonial government was perceived to be primarily interested in serving the needs of an expatriate community, to have little interest in direct lending to local entrepreneurs, and to impose unreasonably high charges on routine banking services (Gondwe, 2001). To get rid of these distortions, direct controls on credit and interest rates were imposed. The agricultural sector, in particular, was accorded preferential lending rates and quota credit allocations in line with the government's policy of promoting agricultural production. Besides these controls, the government also adopted a fixed exchange rate system and imposed price ceilings on selected commodities.

In the late 1970s, a hostile external environment forced the economy into a deep recession, which persisted through the 1980s. Intensification of civil war in neighbouring Mozambique with the subsequent flooding of refugees into the country and disruption of a cost effective rail route to the sea ports of Beira and Nacala, the 1979 oil crisis, and drought in 1980, were some of the factors that triggered the recession. Failure of the economy to adjust to these shocks revealed structural weaknesses in the design of the country's macroeconomic framework. The government was forced, therefore, to implement a policy change from the mid 1980s to the 1990s, moving away from direct to indirect tools of monetary control, among others. A phased financial liberalisation program targeted at enhancing competition and efficiency in the financial sector was adopted.

The reforms commenced with partial deregulation of lending rates in July 1987 and deposit rates in April 1988. The partial deregulation allowed commercial banks to determine their own lending and deposit rates but not to effect any adjustment without prior consultation with the central bank. Credit ceilings were abolished in 1988. In January 1990, the authorities announced the abolition of preferential lending rates to the agricultural sector.

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Complete deregulation of interest rates was effected in May 1990.

The reform program also overhauled the legal and regulatory framework of the banking system, which involved revision of the RBM Act of 1964 and Banking Act of 1965 in May and December 1989, respectively. While the central bank previously supervised commercial banks only, the revised Banking Act extended its coverage to include non-bank financial institutions (NBFIs), a function that was previously in the hands of the Treasury. In addition, inspection of financial institutions was broadened to include monitoring of adherence to prudential requirements besides compliance to exchange control regulations.

In line with the revised RBM Act, the central bank introduced two new instruments of monetary policy, namely liquidity reserve requirement (LRR) and a discount window facility. The discount window facility led to the introduction of the bank rate, which has since become a very powerful indicator of monetary policy. A change in the bank rate is usually followed by near instantaneous corresponding changes in both lending and deposit rates. Average yields on government securities also follow the same direction (see Figure 2-1).

The country's financial reforms reached near-completion with the floatation of the Malawi Kwacha on February 7, 1994. Thereafter, the monetary authorities removed exchange control regulations, allowed for the establishment of foreign exchange bureaux, introduced foreign currency denominated accounts, established a forward foreign exchange market and started the trading of foreign exchange options and currency swaps. Ten new commercial banks (one of which has since been liquidated) entered the commercial banking sector between 1994 and January 2010, changing the structure of the market from a duopoly to a fairly competitive sector. The country's first discount house started operations in 1998 followed by a second one in 2002.

The official position of the RBM is that monetary policy in the country utilises reserve money, a quantitative operating target defined as the sum of currency in circulation, vault cash and bank deposits with the central bank (Banda, 2004). On the sources side, reserve money is defined as net domestic assets (NDA) plus net foreign assets (NFA). In this frame-

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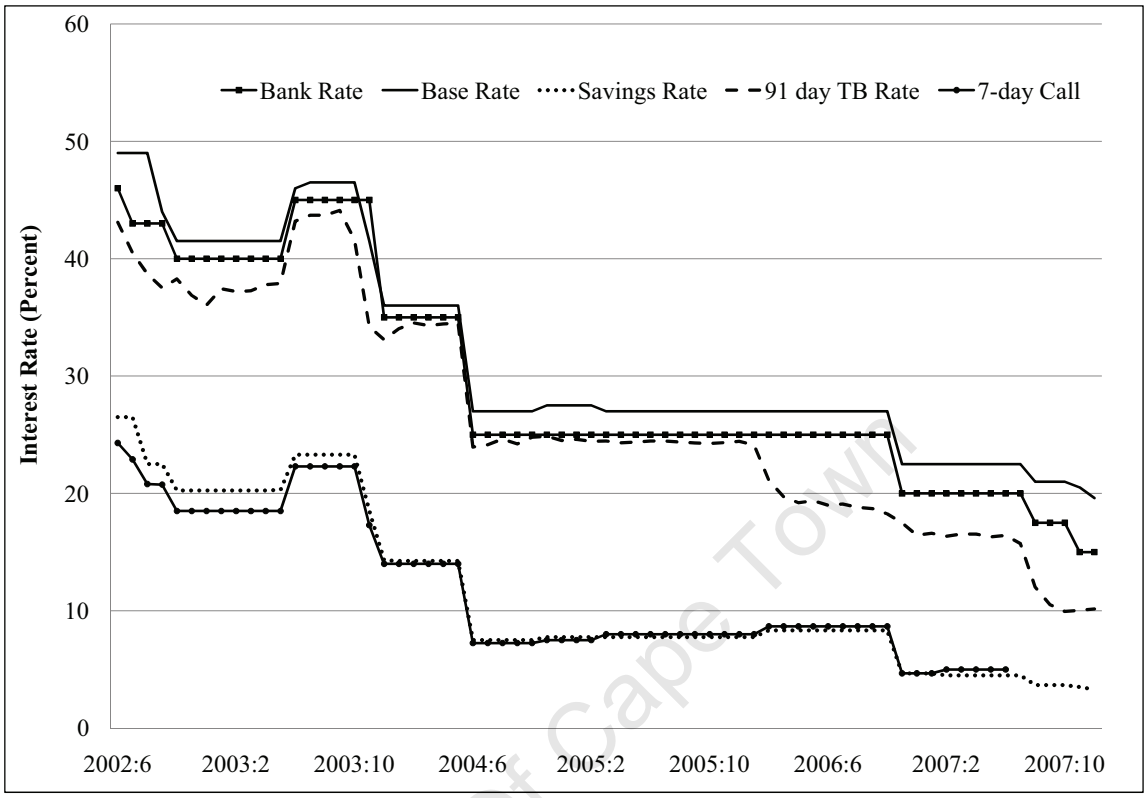
Figure 2-1: Interest Rates in Malawi (2002-2007)



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work, the foreign exchange market operates on the supply side of reserve money through the effect of foreign exchange transactions on NFA. The rationale for reserve money targeting by the central bank is to balance supply and demand conditions of the monetary aggregate in the money market so as to achieve price stability (Banda, 2004).

As an instrument target of monetary policy, reserve money is used to reflect open market operations (OMO) and foreign exchange transactions. In Malawi's OMO, the central bank undertakes weekly trading of RBM Bills and Malawi Government Treasury Bills (TBs) in a competitive bidding system. The former are short-term financial instruments issued by the central bank for monetary policy purposes while the latter are short-term financial instruments issued by the government through the RBM to borrow funds from the general public for the financing of the current fiscal deficit and maturing government debt. In addition to the regular trading, the RBM also sells extra securities on an ad hoc basis to

discount houses and commercial banks, referred to as 'tap sales'.

While the monetary policy framework in Malawi is officially designated as reserve money targeting with OMO playing an important role, the system operates as if the central bank also targets short term interest rates through adjustments in the bank rate. To avoid prejudice, this study assumes the central bank targets both the bank rate and reserve money and goes on to empirically determine which of the two is a more effective measure of monetary policy.

2.3 Methodology

2.3.1 Structural VAR Framework

To draw the SVAR mainframe, suppose Malawi's monetary transmission process is described by a dynamic system whose structural form equation is given by:

$$Ay_t = \Omega + \Phi(L)\, y_{t-i} + B\mu_t \tag{2.1}$$

where A is an invertible $(n \times n)$ matrix describing contemporaneous relations among the variables; y_t is an $(n \times 1)$ vector of endogenous variables such that $y_t = (y_{1t}, y_{2t}, ..., y_{nt})$; Ω is a vector of constants; $\Phi(L)$ is an $(n \times n)$ finite order matrix polynomial in the lag operator L i.e. Φ_i is an $(n \times n)$ matrix of coefficients of lagged endogenous variables $(\forall i = 1, 2, 3, \ldots, p)$; B is an $(n \times n)$ matrix whose non-zero off-diagonal elements allow for direct effects of some shocks on more than one endogenous variable in the system; and μ_t are uncorrelated or orthogonal white-noise structural disturbances i.e. the covariance matrix of μ_t is an identity matrix $E\left(\mu_t, \mu_t^{'}\right) = 1$.

At the centre of analysis in similar vector autoregression models are monetary policy shocks and their dynamic behaviour in the system. The SVAR presented in the primitive system of equations (2.1) cannot be estimated directly due to the feedback inherent in a VAR process (Enders, 2004). Nonetheless, the information in the system can be recovered by estimating a reduced form VAR implicit in the two equations. Pre-multiplying equation (2.1) by A^{-1} yields a reduced form VAR of order p, which in standard matrix form is written

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as:

$$y_t = \Psi_0 + \Sigma_{i=1}^{p} \Psi_i y_{t-i} + \varepsilon_t \tag{2.2}$$

where $\Psi_0 = A^{-1}\Omega$; $\Psi_i = A^{-1}\Phi_i$; and $\varepsilon_t = A^{-1}B\mu_t$ is an $(n \times 1)$ vector of error terms assumed to have zero means, constant variances and to be serially uncorrelated with all the right hand side variables as well as their own lagged values though they may be contemporaneously correlated across equations. The variance-covariance matrix of the regression residuals in equation (2.2) is defined as $\Sigma = E\left(\varepsilon_t, \varepsilon_t^{'}\right)$. Given the estimates of the reduced form VAR in equation (2.2), the structural economic shocks are separated from the estimated reduced form residuals by imposing restrictions on the parameters of matrices A and B in equation (2.3):

$$A\varepsilon_t = B\mu_t \tag{2.3}$$

which derives from equation (2.2). The orthogonality assumption of the structural innovations i.e. $E(\mu_t, \mu_t^{'}) = 1$ and the constant variance-covariance matrix of the reduced-form equation residuals i.e. $\Sigma = E\left(\varepsilon_t, \varepsilon_t^{'}\right)$ impose identifying restrictions on A and B as presented in equation (2.4):

$$A\Sigma A^{'} = BB^{'} \tag{2.4}$$

Since matrices A and B are both $(n \times n)$, a total of $2n^2$ unknown elements can be identified upon which $n\left(n+1\right)/2$ restrictions are imposed by equation (2.4). To identify A and B, therefore, at least $2n^2 - n\left(n+1\right)/2$ or $n\left(3n-1\right)/2$ additional restrictions are required. These restrictions can be imposed in a number of ways. One approach is to use Sims's (1980) recursive factorisation based on Cholesky decomposition of matrix A. The approach assumes that elements of matrix A are recursively related and are, therefore, lower triangular. The implication of this relationship is that identification of the structural shocks is dependent on the ordering of variables, with the most endogenous variable ordered last (Favero, 2001). Thus, with a given ordering, the first variable has no contemporaneous relationships with all other variables in the model, indicating that its reduced form shock is identical to its structural shock; the second variable has contemporaneous interactions only with its own and the first structural shock; the third variable is contemporaneously affected

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by its own and the first two structural shocks; and so on. In this framework, the system is just (exactly) identified.

While there are many models that are consistent with the recursiveness assumption, the approach is nonetheless controversial (Christiano et al., 1998). The assumptions rationalising the ordering of variables are often different in different studies using the same variables, and since estimation results in a VAR identified by Cholesky factorisation differ with ordering of variables, these studies tend to be incomparable. Changing the order changes the VAR equations, coefficients and residuals, and there are $n!$ recursive VARs, representing all possible orderings (Stock and Watson, 2001). The validity of Cholesky factorisation is also questioned in cases where a simultaneity problem among monetary or macroeconomic variables exists. Following the apparent shortfalls in the approach, many authors have adopted alternative approaches to the identification of structural shocks (see, for example Sims and Zha, 2006; Bernanke and Mihov, 1998; Leeper, Sims and Zha, 1996; Sims, 1986; Bernanke, 1986).

Another approach for identifying structural shocks is the sign restriction technique. This approach formally incorporates criteria based on economic knowledge of empirical reactions in the economy, such as that output will rise in the face of a government expenditure shock, but fall with a positive taxation revenue shock (Dungey and Fry, 2009). The problem with this approach is that as the dimension of the SVAR increases, the number of sign restrictions increases dramatically if all shocks in the system are to be identified (ibid). Accordingly, some studies have opted to identify only a selected number of shocks, leaving the rest unconstrained (see, for example Mountford and Uhlig, 2008).

More recent literature has used structural factorisation, an approach which uses relevant economic theory to impose restrictions on the elements of matrices A and B (Sims and Zha, 2006; Bernanke and Mihov, 1998; Sims, 1986; Bernanke, 1986). This study adopts a similar approach. The underlying structural model is identified by assuming orthogonality of the structural disturbances, μ_t; imposing that macroeconomic variables do not simultaneously react to monetary variables, while the simultaneous feedback in the reverse direction is

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allowed for; and imposing restrictions on the monetary block of the model reflecting the operational procedures implemented by the monetary policy-maker (Favero, 2001, pp. 166).

Seven variables are included in our SVAR namely, output (GY_t), consumer price level (CP_t), commercial bank loans (BL_t), exchange rates (XR_t), aggregate money supply ($M2_t$), bank rate (BR_t) and reserve money (RM_t). Output and consumer prices enter the SVAR as policy goals; bank rate and reserve money as operating targets; and commercial bank loans, exchange rates and monetary aggregates as intermediate targets. The structural shocks in equation (2.3) are identified according to the following scheme:

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} \\ a_{41} & a_{42} & 0 & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & 0 & 0 & 1 & a_{56} & 0 \\ 0 & 0 & 0 & a_{64} & 0 & 1 & 0 \\ 0 & 0 & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{pmatrix} \qquad \varepsilon_t = \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{BL} \\ \varepsilon_t^{XR} \\ \varepsilon_t^{M2} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix}$$

$$B = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{pmatrix} \qquad \mu_t = \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{BL} \\ \mu_t^{XR} \\ \mu_t^{M2} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{2.5}$$

The non-zero coefficients a_{ij} and b_{ij} in matrices A and B, respectively, show that any residual j in matrices ε_t and μ_t, in that order, has an instantaneous impact on variable i. The first two equations suggest that output and consumer prices are sluggish in responding to shocks to monetary variables in the economy. This scheme is based on the observation that most types of real economic activity may respond only with a lag to monetary variables

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because of inherent inertia and planning delays (Karame and Olmedo, 2002). Proposed by Bernanke and Mihov (1997), the validity of this argument has been supported by a number of studies (see, for example Cheng, 2006; Becklemans, 2005; Vonnak, 2005; Karame and Olmedo, 2002).

Commercial bank loans are postulated to be contemporaneously affected by all variables in the system. Blundell-Wignall and Gizycki (1992) argue that expectations of future activity form an important determinant of credit demand. Assuming current output, price level, exchange rates, interest rates, and money supply give some indication of what is expected in the future (Becklemans, 2005) and because economic agents are indeed forward looking, bank lending may respond contemporaneously to all variables in the system.

Modelling contemporaneous responses of exchange rates to other variables in an SVAR is relatively standard across studies. Since the exchange rate is a forward-looking asset price, most studies assume that all variables have contemporaneous effects on the exchange rate (Kim and Roubini, 2000). Becklemans (2005) uses a real trade-weighted exchange rate index in a study of Australia and assumes that the index responds instantaneously to all variables in the system. In a study of Kenya, Cheng (2006) employs a nominal effective exchange rate and maintains that the exchange rate responds contemporaneously to all variables in the SVAR. Similarly, Borys and Hovarth (2007) in a study of the Czech Republic and Piffanelli (2001) in a study of Germany assume all variables in the system affect exchange rates instantaneously. This study takes a departure from these studies and postulates that exchange rates respond contemporaneously to changes in the level of output and consumer prices only and with a lag to movements in interest rates, bank loans and monetary aggregates. This is motivated by the nature of the financial sector in Malawi.

The financial sector in Malawi lacks depth and is weakly integrated into global markets. In contrast, most financial markets that have been studied extensively in the literature are either emerging or highly developed and broadly competitive. For this reason, it would be erroneous to model the financial sector in Malawi in the same way as in the emerging and developed economies. Given the structure of Malawi's financial markets, therefore, we assume

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that information delays will be prevalent, forcing players on the foreign exchange market to respond with a lag to changes in interest rates, bank loans and monetary aggregates.

Besides being an asset price, exchange rates are expected to account for movements in external factors such as oil prices and interest rates on the international market. Given the large dimensionality of our problem, therefore, we resist the temptation to add more variables to the SVAR to capture external factors. The complete SVAR analysed in this study has seven variables, which is already large by SVAR standards and increasing the number of variables without proper justification would only decrease the power of the model without making meaningful additions to the output.

The fifth equation is a standard money demand function. The equation postulates that demand for money in the country makes aggregate money supply respond contemporaneously to changes in consumer prices, output and interest rates but not to changes to other variables in the system, akin to Sims and Zha (2006). The last two equations constitute the monetary policy feedback rule. While Malawi's official position is that it targets reserve money, there is reason to believe that the monetary authorities also target short term interest rates. The study, therefore, assumes that the country employs hybrid operating procedures, with the bank rate and reserve money as operating targets. In this framework, both interest rates and reserves are expected to contain information about monetary policy (Bernanke and Mihov, 1997). The country's effective operating target, accordingly, is determined empirically.

The monetary policy feedback rule is drawn on the assumption that information delays impede policymakers' ability to react immediately to economic activity and price level developments (Karame and Olmedo, 2002). Both the bank rate and reserve money, therefore, do not respond immediately to output and consumer prices. The bank rate, specifically, responds contemporaneously to changes in the exchange rates only. While exchange rate data is available real-time, data on other variables including bank loans and monetary aggregates is usually available to the monetary authorities with a lag. Reserve money, on the other hand, is assumed to respond contemporaneously to all monetary variables because by

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its definition, this information is inherent in the monetary aggregate.

While SVARs are superior to the more complex traditional simultaneous equation models, especially in their forecasting power, the approach has been criticised for a number of reasons[3]. First, individual coefficients in SVARs are often difficult to interpret. Accordingly, most studies do not go beyond analysis of impulse response functions. Second, there is no uniform approach in choosing the appropriate lag length. Different studies justify their chosen lag lengths differently, rendering what has been referred to as the standard criteria (Akaike, Hannan-Quinn and Schwartz Information Criteria) in the determination of lag length non-standard. Third, there is still controversy on whether the correct approach is to estimate SVARs in levels or in first differences. Our analysis shows that the literature is to a large extent in favour of estimation in levels. Nonetheless, the debate is outstanding. Fourth, unlike simulataneous equation modelsSVARs are *a-theoretic* because they use less prior information, (Gujarati, 2003). While inclusion or exclusion of certain variables play an important role in the identification of simultaneous equation models, the same does not apply in SVARs (ibid).

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2.3.2 Analysis

Analysis of the SVAR is carried out in three modular experiments. First, a generic model comprising the country's monetary policy goals and operating targets is estimated. Output and price level enter the model as policy goals while bank rate and reserve money go in as operating targets. The rationale for estimating the generic model is to establish how the two monetary policy goals respond to each of the operating targets and to find out if monetary authorities react to changes in the policy goals. In addition, the estimated generic model is used to determine which of the two monetary policy operating targets has a greater impact on the policy goals.

At the second level of analysis, bank lending, exchange rates and M2, representing three different transmission processes, are separately appended to the generic model and

[3]see Gujarati (2003)

estimated. Following Disyatat and Vongsinsirikul (2003) and Morsink and Bayoumi (2001), two sets of impulse responses are calculated in each case: one with the variable of interest endogenised and the other with the variable exogenised. The latter procedure generates an SVAR identical to the former, except that it blocks off any responses within the SVAR that pass through the variable of interest (Disyatat and Vongsinsirikul, 2003). The two sets of impulse responses are later compared. The size of the difference in the impulse responses is an indicator of the level of information contained in the variable of interest associated with a particular transmission channel. Large differences denote more information in the variable of interest and suggest greater importance of the related transmission channel.

At the third and final level of analysis, all variables found to hold important information in the country's monetary transmission process are pooled and a composite SVAR is estimated. A general identification scheme based on short run restrictions developed in system of equations 2.5 is used for identifying structural shocks in each of the models. Analysis in the study is carried out only for the short run to conform with the subject matter under investigation. Since economists generally agree that monetary policy affects only the price level in the long run, there is little value in extending investigation of the monetary transmission process to cover the long run.

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2.3.3 Data, Data Sources and Measurement of Variables

The study employs monthly time series data for the period 1988:1 to 2005:12. The starting date was been chosen to capture the period when monetary authorities in Malawi migrated from using direct measures of monetary control to using indirect measures. The cut-off date corresponds to the date when the latest data on all variables of interest was available. Major sources of data include the RBM, the National Statistical Office (NSO) of Malawi, the Malawi Meteorological Department and the University of Malawi.

Bank rate (BR_t) is defined as the rate at which the central bank provides short term loans to commercial banks and discount houses in its function as a lender of last resort. The variable enters the SVAR as an instrument target of monetary policy. Reserve money

(RM_t) is also employed as an instrument target of monetary policy in the SVAR. Components of RM_t are identified as total cash reserves held by the central bank, vault cash in commercial banks and currency held by the non-bank public. The variable BL_t captures commercial bank loans and advances and it enters the SVAR as an intermediate target of monetary policy. Similarly, exchange rate (XR_t) enters the SVAR as an intermediate target of monetary policy. Middle nominal exchange rates of the Malawi Kwacha vis-à-vis the United States Dollar (USD) are used as a proxy for XR_t. Aggregate money supply (M2) is measured by the sum of currency in circulation, demand deposits and time deposits. The variable also enters the SVAR as an intermediate target of monetary policy.

Consumer prices (CP_t) are measured by the all items national composite consumer price index with base year 2000. The variable enters the SVAR as a monetary policy goal. A measure of output (GY_t) enters the SVAR as a monetary policy goal as well. GDP data (used as a proxy for GY_t) for Malawi is, however, only available in annual frequency. This presents a case for interpolation. Several studies have used interpolated monthly GDP series in SVARs. Among them, Cheng (2006) used monthly production data of key sectors in Kenya to interpolate the country's annual GDP to monthly frequency and Borys and Hovarth (2007) used the quadratic-match average procedure to interpolate GDP from quarterly to monthly frequency in the Czech Republic. This study employs the Friedman method of interpolating time series by related series to compute the required monthly GDP series from annual data (see Appendix A, Section A.1 for a detailed outline of the GDP interpolation).

All variables, with the exception of interest rates, are expressed in natural logarithms. They are also seasonally adjusted using TRAMO (Time Series Regression with Autoregressive Moving Average (ARIMA) Noise, Missing Observations, and Outliers) and SEATS (Signal Extraction in ARIMA Time Series) with a forecast horizon of 12 months. While the former performs estimation, forecasting, and interpolation of regression models with missing observations and ARIMA errors in the presence of possibly several types of outliers, the latter performs an ARIMA-based decomposition of an observed time series into unobserved

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components (Quantitative Micro Software, 2007). Seasonal adjustment removes cyclical seasonal movements that are common in time series observed at quarterly and monthly frequency. The underlying trend component of the series, however, is retained after the data has been seasonally adjusted.

The variables are further subjected to a test for stationarity, which reveals that they are all I(1) (See Table A.2 in Appendix A, Section A.2). The study, however, proceeds with estimation of the SVAR in levels consistent with standard practice anchored on the canonical paper of Sims, Stock and Watson (1990). The Sims et al. (1990) paper demonstrates in part that the common practice of attempting to transform models to stationary form by difference or cointegration operators whenever it appears likely that the data are integrated is unnecessary because statistics of interest often have distributions that are unaffected by nonstationarity, which suggests that hypotheses can be tested without first transforming to stationary regressors. The issue, according to the study, is not whether the data are integrated, but rather whether the estimated coefficients or test statistics of interest have a distribution which is nonstandard if in fact the regressors are integrated.

The Sims et al. (1990) findings have been generally accepted and widely adopted in the SVAR literature. In a study of the German Bundesbank, Bernanke and Mihov (1997, p. 1037) maintain that 'we include the output, price, and reserves measures in levels despite their nonstationarity, as has become standard practice in VAR studies.' They further point out that the levels specification yields consistent estimates whether cointegration exists or not, whereas a differences specification is inconsistent if some variables are cointegrated. Other studies that have followed this approach of estimating SVARs in levels even when the variables are I(1) include Piffanelli (2001), Dungey and Pagan (2000), Kim (1999), Brischetto and Voss (1999), Bernanke and Mihov (1998), Ramaswamy and Sloek (1998), and Sims (1992), among many others. The preference of SVARs in levels, according to Kim and Roubini (2000) and Becklemans (2005), can be explained, at least in part, by a reluctance to impose possibly incorrect restrictions on the model. Kim and Roubini (2000) stress that if false restrictions are imposed, the resulting inferences will be incorrect as well.

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Some studies, however, have opted to transform non-stationary data prior to estimating SVARs. A common element in a large number of these studies is the focus on prevalent relationships in the variables of interest beyond the short run. A standard approach in this case is to explicitly model I(1) variables and co-integrating relationships present in the data by imposing cointegrating restrictions on a VAR in levels. Rationalising the approach, Haug, Karagedikli and Ranchhodd (2005) argue that for the long run, a vector error correction model (VECM) estimation produces more precise and efficient parameter estimates than a VAR in levels. Haug et al. (2005) nonetheless concede that for the short run, the VAR parameters are estimated consistently by least-squares if the VAR is estimated in levels without imposing co-integrating restrictions present in the data. Davidson (1998) and Johansen (1988) further add that when supplemented with cointegration analysis, the VAR technique allows for a rigorous modelling of the long-run relationship of non-stationary variables. Among many others, Garratt, Lee, Pesaran and Shin (2003), Ehrmann (1998), Lutkepohl and Wolters (1998) and King, Plosser, Stock and Watson (1991) are some of the studies that have used cointegration analysis to identify long-run relationships in a linear cointegrating model with I(1) variables.

While the debate concerning whether or not to transform models to stationary form by difference or cointegration operators when dealing with I(1) variables appears to lean towards the conclusion arrived at by Sims et al. (1990), there are other authors that support the traditional approach of transforming the data to stationary regressors prior to estimation regardless of whether the point of focus is long run or short run relationships (see, for example Enders, 2004). To illustrate that results obtained from the two methodologies are not diametrically opposed to each other, we also estimate the composite model using a cointegrated SVAR (see Appendix A, Section A.2 for details). It is demonstrated in the appendix that while there may be some differences, as expected, estimation results from the cointegrated SVAR are on the whole similar to what we obtain from estimation in levels.

An exploratory analysis of the data aimed at getting insights into the movements, structures and multivariate relations between variables used in the model is summarised in Fig-

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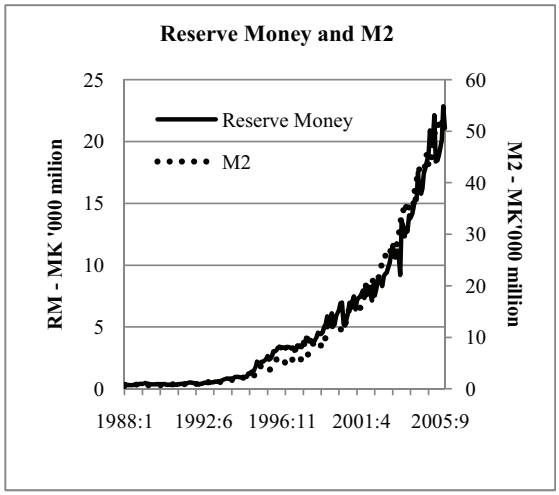
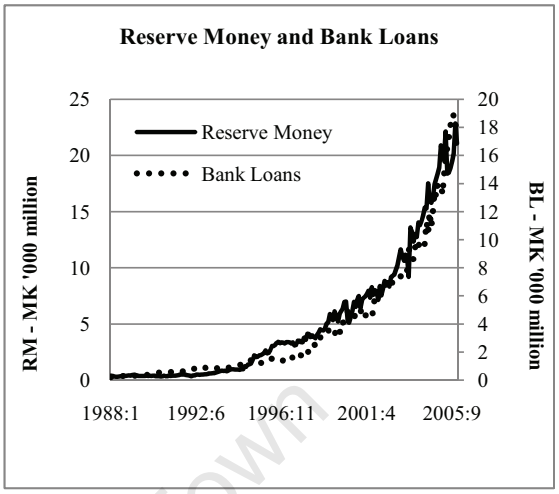
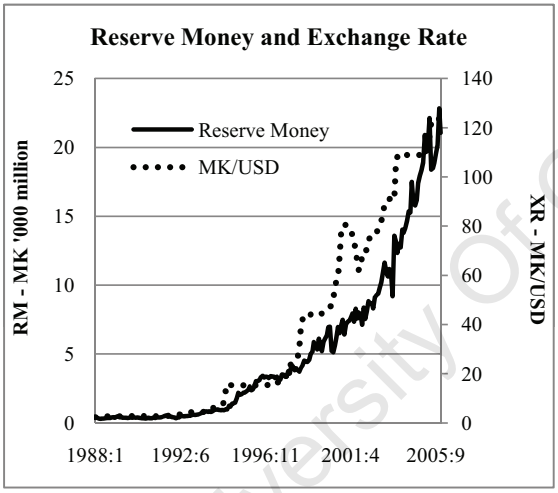
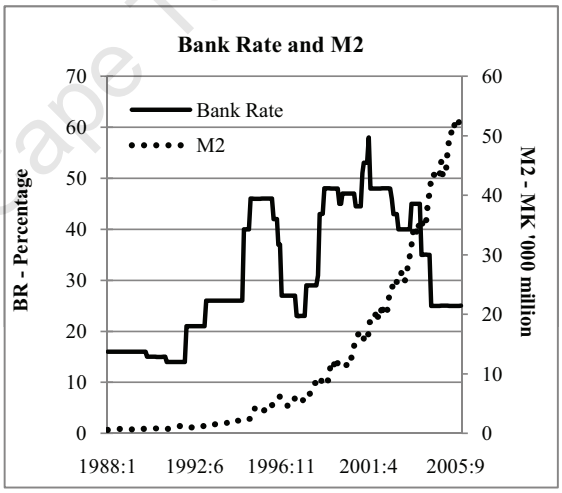
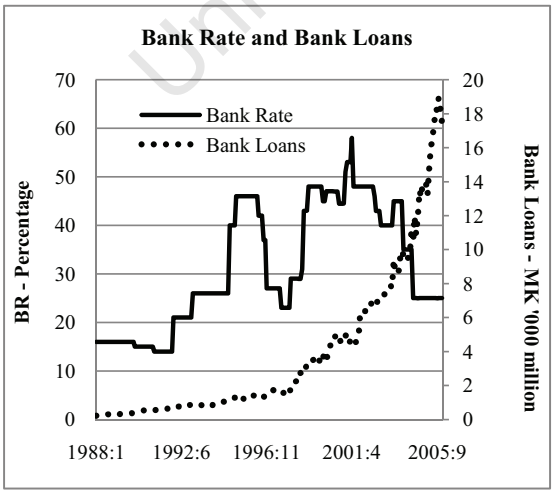
Figure 2-2: Behaviour of Selected Macroeconomic Indicators for Malawi (1988:1-2005:12)











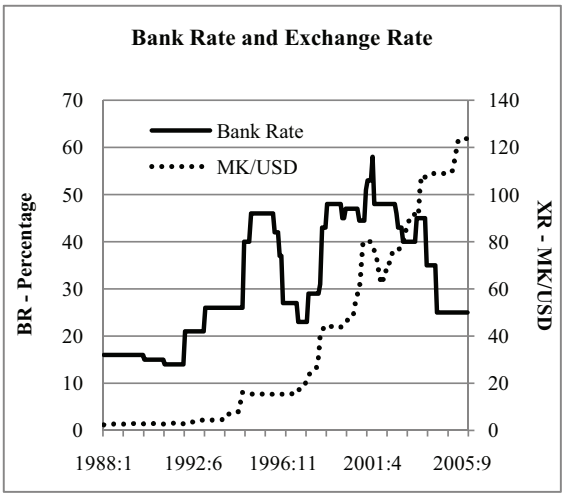


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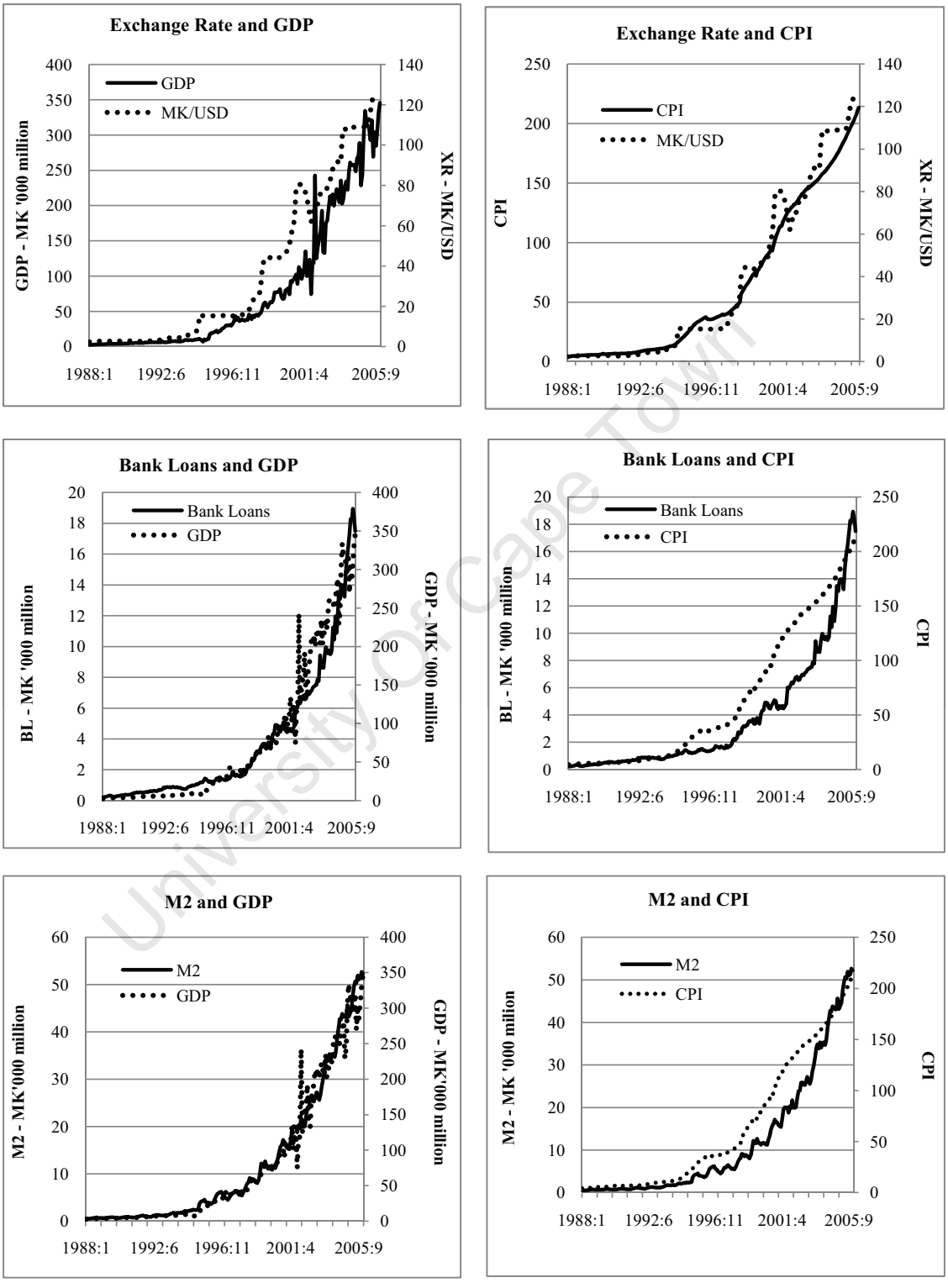
Figure 2-3: Behaviour of Selected Macroeconomic Indicators for Malawi (1988:1-2005:12)



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ures 2-2 and 2-3. Malawi had credit ceilings until 1988, interest rate controls until 1990 and a fixed exchange rate peg until 1994. Accordingly, free movement of monetary variables was not allowed until the mid 1990s (See Figures 2-2 and 2-3). Consistent with the country's official position of targeting reserve money to influence M2, a positive correlation shows up in a graphical representation of reserve money and M2 (see Figure 2-2). Reserve money is also seen to change together in the same direction with bank lending and exchange rates, in line with theoretical postulations. An expected negative correlation between the bank rate and M2, bank lending and exchange rates is also observed in the data. Exchange rates, bank lending and M2, the intermediate targets of monetary policy, depict a positive correlation with GDP and CPI, the policy goals, again in agreement with theoretical expectations (see Figure 2-3).

2.4 Estimates and Inferences

2.4.1 Generic Model

Investigation of the monetary transmission process commences with a simple four variable generic model. The vector of endogenous variables included in the model is presented as:

$$y_t^{'} = [GY_t, CP_t, BR_t, RM_t] \tag{2.6}$$

Following the identification scheme in system of equations (2.5), the equation separating structural economic shocks from the estimated reduced form residuals for the generic model is presented as:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & a_{43} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{pmatrix} \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{2.7}$$

Selection of the optimal lag length is guided by established criteria, which suggest a

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lag length of two[4]. At the chosen lag length (of order two), all the eight inverse roots of the characteristic autoregressive (AR) polynomial have modulus less than one and lie inside the unit circle, indicating that the estimated VAR is stationary or stable (see Table A.5 in Appendix A, Section A.3). A VAR lag exclusion Wald test further reveals that all endogenous variables in the model are jointly significant at each lag length for all equations collectively. Separately, at lag length of order one, all equations are significant while at lag length of order two, only consumer price and output equations are significant (see Table A.6 in Appendix A, Section A.3).

Before making inferences on the structural shocks in the model, we analyse correlations between movements in the bank rate and reserve money and their corresponding recovered structural shocks to ascertain if the monetary policy shocks are reasonable. Figures 2-4 and 2-5 present plots of recovered bank rate and reserve money structural innovations against month-on-month growth rates of the bank rate and the logarithm of reserve money, respectively, with the recovered structural shocks plotted on the primary vertical axis and the monetary policy operating targets on the secondary vertical axis. Positive structural innovations of the bank rate and negative structural innovations of reserve money are associated with monetary policy tightening while negative structural innovations of the bank rate and positive structural innovations of reserve money are associated with monetary policy loosening.

The charts reveal that there is some correlation in the movements of the monetary policy operating targets and their respective recovered innovations. The correlations are, however, more pronounced between the bank rate and its recovered structural shocks compared to reserve money and its recovered structural shocks. Reliability of the structural shocks is also ascertained by assessing the efficiency of the structural coefficients estimated in the SVAR. Table A.7 in Appendix A, Section A.3 shows that all structural estimates of the coefficients in matrices A and B of the generic model have standard errors that are less

[4] Akaike, Hannan-Quinn and Schwartz Information Criteria. This approach is applied in all subsequent models.

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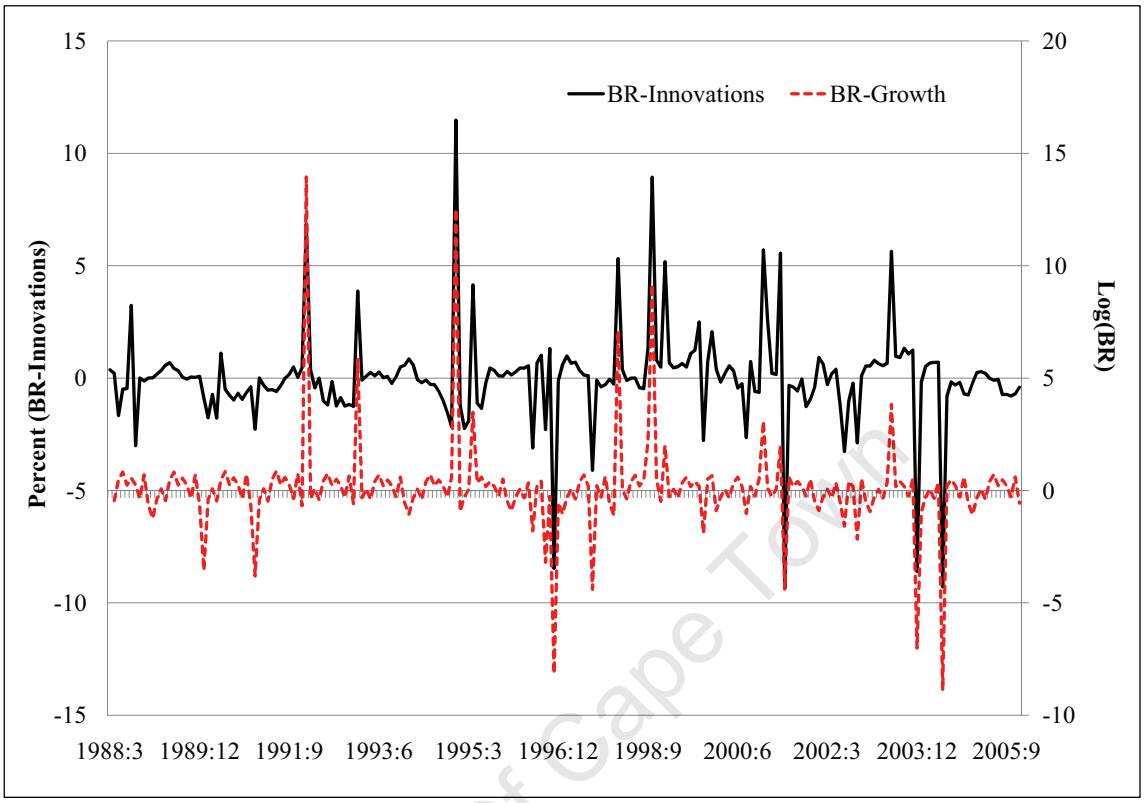
Figure 2-4: Bank Rate Movements and Related Recovered Structural Innovations



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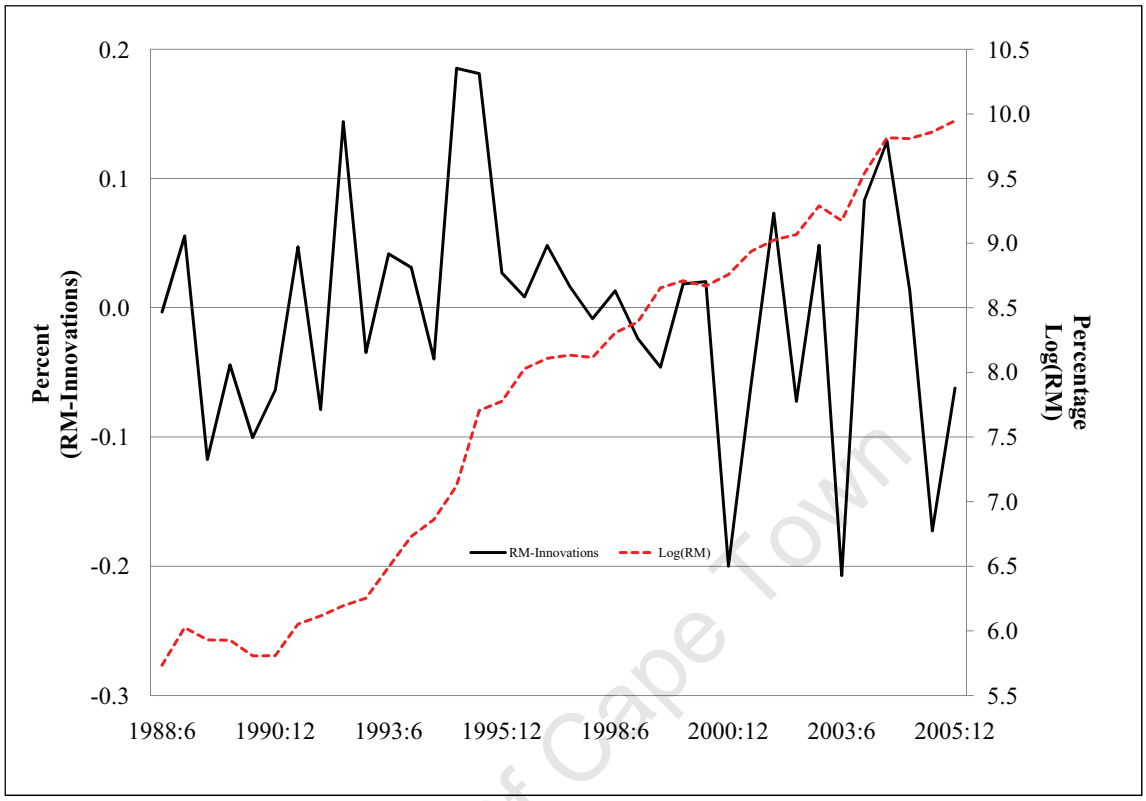
than one, implying that the coefficients are efficient. Accordingly, the measured structural shocks can be relied upon as being a true reflection of reality.

Next we analyse the response of the central bank to shocks in the policy goals. Figure 2-6 presents impulse responses of the bank rate and reserve money to structural one standard deviation innovations in output and consumer prices over a five-year horizon. Impulse responses of output and consumer prices to own shocks are also presented in the same figure. The time scale measured on the primary horizontal axis is in months and the dashed lines represent analytic confidence intervals obtained from variance-covariance matrices after the final iteration. In the literature, there are three alternatives to the computation of confidence intervals, namely, the Monte Carlo approach, the analytical method, and bootstrapping. Roa, Ernst and Tapia (1999) assessed the performance of the three approaches and concluded that on the whole, they perform equally well. Presently, a Monte Carlo

Figure 2-5: Reserve Money Movements and Related Recovered Structural Innovations



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algorithm is not available for SVARs. Bootstrapping, on the other hand, is not appropriate for dependence structures like time series models because it is based on the independence assumption (see Sahinler and Topuz, 2007). This leaves us with the analytic approach, which we have adopted.

Both an output shock corresponding to an unanticipated 11 percent increase in output and a supply shock equivalent to an unexpected 2.2 percent rise in consumer prices trigger significant responses by the central bank, illustrating that monetary authorities in Malawi are concerned with both inflation and economic growth in line with the RBM Act of 1989. The bank responds to the output shock by loosening monetary policy through a decrease in the bank rate to further buoy the output growth. In response to the supply shock, monetary policy is tightened by raising the bank rate to arrest the increase in the consumer prices. The central bank's response with regard to reserve money, however, is surprising.

Following the sudden increase in output, reserve money declines while the unexpected rise in consumer prices triggers an increase in reserve money.

To analyse how monetary policy goals are affected by shocks to the operating targets, we plot impulse responses of output and consumer prices to structural one standard deviation shocks in the bank rate and reserve money. Figure 2-7 reveals that a monetary policy shock corresponding to an unanticipated increase in the bank rate of about 2.2 percent leads to a decline in output, which bottoms out after 5 months at 1.4 percent below baseline. The price level, however, responds to the monetary tightening with an increase, although insignificant, which is maintained even after five years. This finding, referred to as the 'price puzzle,' is common in the literature. Some of the studies that have reported this finding include Weitong (2007), Kugler, Jordan, Lenz and Savios (2004), Disyatat and Vongsinsirikul (2003), Piffanelli (2001), Mihira and Sugihara (2000), Clarida and Gertler (1996), Bernanke and Mihov (1997) and Sims (1992).

Several explanations to the price puzzle have been suggested. Disyatat and Vongsinsirikul (2003) argue that failure to include a rich enough specification of the information available to policy makers is what causes the puzzle to show up. They maintain that if policy makers are able to observe variables that contain useful information about future prices, but those variables are left out of the model, a monetary tightening may be associated with higher prices because they partly reflect systematic policy responses to information indicating that inflation is on the way. Empirical evidence, however, does not support the Disyatat and Vongsinsirikul (2003) hypothesis. In a study of this phenomenon in Germany, Sims (1992) added a number of variables, including commodity prices and exchange rates in his system of equations to control for unanticipated future inflation after he had encountered the price puzzle. However, the perverse price response persisted. Piffanelli (2001) argues that the price puzzle may occur if an incorrect operating target is used in the analysis. In her study of Germany, Piffanelli (2001) showed that the price puzzle appears when the call rate is used and it disappears when the Lombard rate is used. A similar finding is reported by Bernanke and Mihov (1997).

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Figure 2-6: Impulse Responses of Bank Rate and Reserve Money: The Generic Model

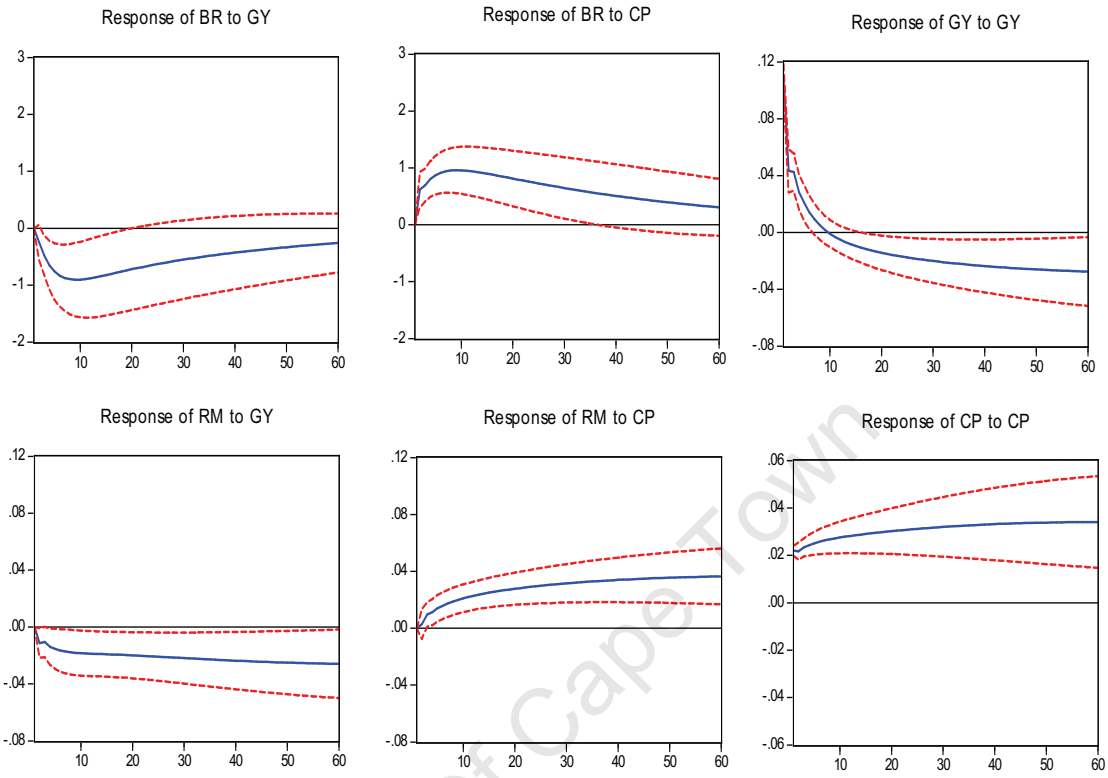

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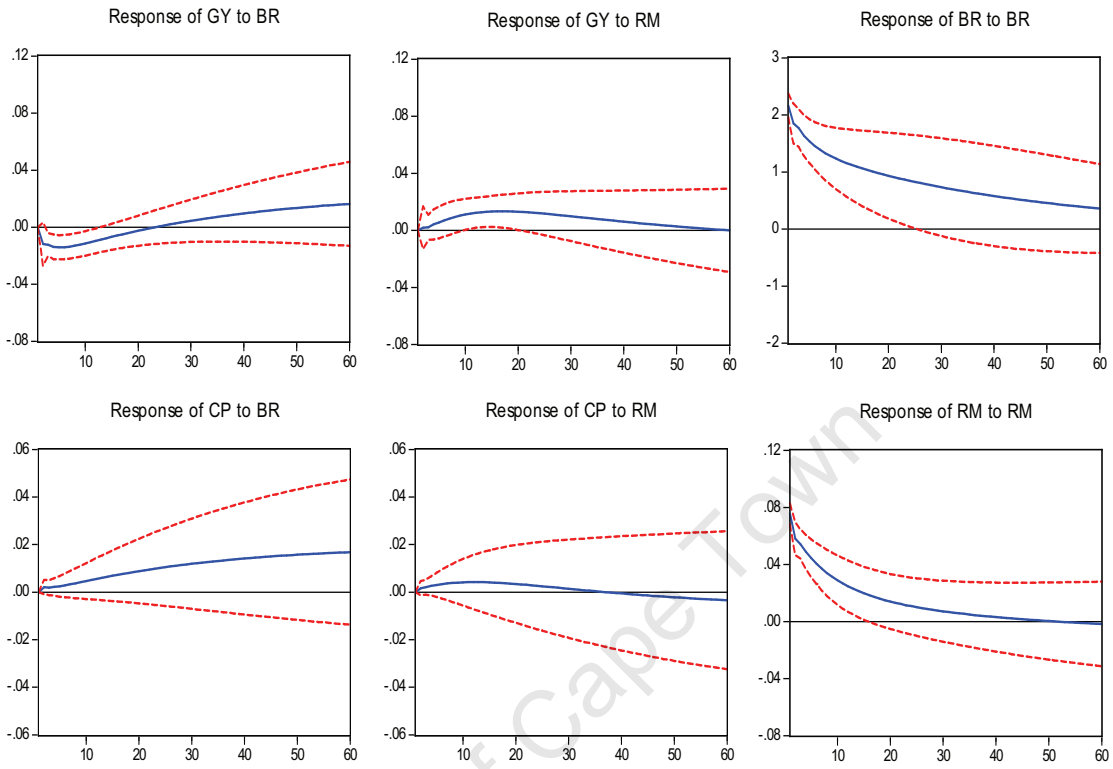
Figure 2-7 also shows that an expansionary monetary shock equivalent to a 7.6 percent sudden increase in reserve money causes an increase in output, peaking at 1.4 percent above baseline after 15 months. The price puzzle, however, disappears with reserve money as an operating target. Consumer prices respond to the unexpected increase in reserve money with an increase which peaks at 0.4 percent above baseline after 10 months.

Overall, shocks to either of the monetary policy operating targets attract significant output responses and insignificant consumer price responses, suggesting that monetary factors may not be primary determinants of inflation in Malawi. This finding is supported by the preponderant weight of food costs (58.1 percent) in the representative basket of commodities used for measuring national consumer price indices, which indicates that structural rigidities in food production may be a more important cause of inflation than monetary variables.

Figure 2-7: Impulse Responses of Output and Consumer Prices: The Generic Model



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To determine the relative importance of each structural innovation in explaining fluctuations of the variables in the generic model, Table 2.1 presents variance decompositions for each variable in the model over a five-year forecast horizon. Given the two policy goals, fluctuations in both the bank rate and reserve money are dominated by consumer prices, connoting that the principal objective of monetary policy in the country is price stability. While shocks to consumer prices account for 13.1 percent of the bank rate fluctuations after 6 months, 18.6 percent after a year and 21.9 percent after 2 years, output shocks account for 8.2 percent of the bank rate fluctuations after 6 months, 14.7 percent after a year and 17.4 percent after 2 years. Shocks to consumer prices also account for 3.4 percent of the reserve money fluctuations after 6 months, 10.7 percent after a year and 25.5 percent after 2 years while shocks to output account for 4.8 percent of the reserve money fluctuations after 6 months, 9.8 percent after a year and 16.3 percent after two years.

Table 2.1: Variance Decomposition for the Generic Model

Variance Decomposition of GY				
Month	GY	CP	BR	RM
1	100	0	0	0
6	92.3109	2.2698	4.8520	0.5673
12	76.8961	11.7495	7.8319	3.5225
24	55.1723	30.9392	5.8431	8.0455
36	45.2397	42.9679	4.3865	7.4060
48	40.2602	49.4123	4.7945	5.5331
60	37.3931	52.5810	5.9678	4.0581

Variance Decomposition of CP				
Month	GY	CP	BR	RM
1	0.0043	99.9957	0	0
6	8.8384	89.5588	0.7021	0.9007
12	17.2802	79.9114	1.4836	1.3247
24	23.9426	71.2309	3.7321	1.0945
36	26.3566	67.0872	5.8799	0.6763
48	27.4080	64.4648	7.6509	0.4764
60	27.9006	62.5823	9.0639	0.4532

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Table 2.1 (cont..): Variance Decomposition for the Generic Model

Variance Decomposition of BR				
Month	GY	CP	BR	RM
1	0	0	100	0
6	8.2201	13.0522	76.6691	2.0586
12	14.6781	18.6407	60.9944	5.6867
24	17.4205	21.8650	50.6677	10.0468
36	17.7836	22.7513	47.3985	12.0666
48	17.8461	23.0723	46.0195	13.0622
60	17.8509	23.1937	45.3665	13.5889

Variance Decomposition of RM				
Month	GY	CP	BR	RM
1	0	0	0.6211	99.3789
6	4.8283	3.4247	0.2510	91.4960
12	9.8319	10.6703	0.1705	79.3273
24	16.3189	25.4689	0.5049	57.7074
36	20.3133	36.1984	1.7809	41.7074
48	22.8209	42.7248	3.5098	30.9445
60	24.3806	46.4778	5.2263	23.9154

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Table 2.1 also reveals that the difference in the proportion of fluctuations in output attributed separately to the bank rate and reserve money is not pronounced. The bank rate, however, accounts for a notably larger proportion of the fluctuations in consumer prices than reserve money. On the whole, the preliminary indication is that the bank rate is a more effective tool of monetary policy than reserve money. While bank rate shocks account for 4.8 percent of the fluctuations in output after 6 months, 7.8 percent after a year, 5.8 percent after 2 years and 6 percent after five years, reserve money shocks account for 0.6 percent of the output fluctuations after 6 months, 3.5 percent after a year, 8 percent after 2 years and 4.1 percent after five years. This shows that interest rate shocks account for a larger proportion of the fluctuations in output up to a year and, thereafter, reserve money shocks are responsible for most of the variations in output. Reserve money shocks account for only 0.9 percent of the fluctuations in consumer prices after 6 months, 1.1 percent after two years and 0.5 percent after 4 years while bank rate shocks account for 0.7 percent of the fluctuations in consumer prices after 6 months, 3.7 percent after 2 years and 7.7 percent after 4 years, illustrating that the bank rate accounts for most of the consumer price variations given the two operating targets.

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2.4.2 Channels of Monetary Transmission

In order to unfold the monetary transmission process, analysis moves away from the generic model to an examination of more specific transmission channels. Three channels are investigated. These include bank lending channel, exchange rate channel and money effect channel. In the course of identifying major monetary transmission channels for Malawi, we concentrate on measuring the importance of each channel in the transmission process.

The Bank Lending Model

The bank lending model is a component of the credit channel of monetary transmission. The underlying argument in the credit channel is that asymmetric information and costly enforcement of contracts create agency problems in financial markets (Bernanke and Gertler,

1995). Two mechanisms explain this process: the balance sheet and bank lending. The balance sheet model operates through the net worth of business firms (Mishkin, 1995) and transmission occurs either through equity prices or interest rates and firms' cash-flows. These affect the severity of adverse selection and moral hazard problems, which in turn impact on lending, investment and output. Owing to data constraints, the balance sheet channel is not pursued further in this study.

The bank lending model, on the other hand, operates through quantity rather than price of credit. A monetary policy shock is assumed to be transmitted through changes in bank reserves, the total amount of available bank credit, and bank lending. The channel presumes that firms facing informational frictions in financial markets rely on bank loans for external finance because it is prohibitively expensive for them to issue securities in the open market (Disyatat and Vongsinsirikul, 2003). A decline in available bank credit, therefore, adversely affects investments and output. Appending commercial bank loans to equation (2.6) transforms the generic model to a bank lending model and the corresponding vector of endogenous variables becomes:

$$y_t^{'} = [GY_t, CP_t, BL_t, BR_t, RM_t] \tag{2.8}$$

The SVAR under investigation in equation (2.8) comprises five variables, which include output, consumer prices, bank loans, the bank rate and reserve money. In line with the identification scheme in the system of equations (2.5), the bank lending model is identified according to the following scheme:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & a_{55} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{BL} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{pmatrix} \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{BL} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{2.9}$$

Figure 2-8 presents impulse responses of output, consumer prices and bank loans to

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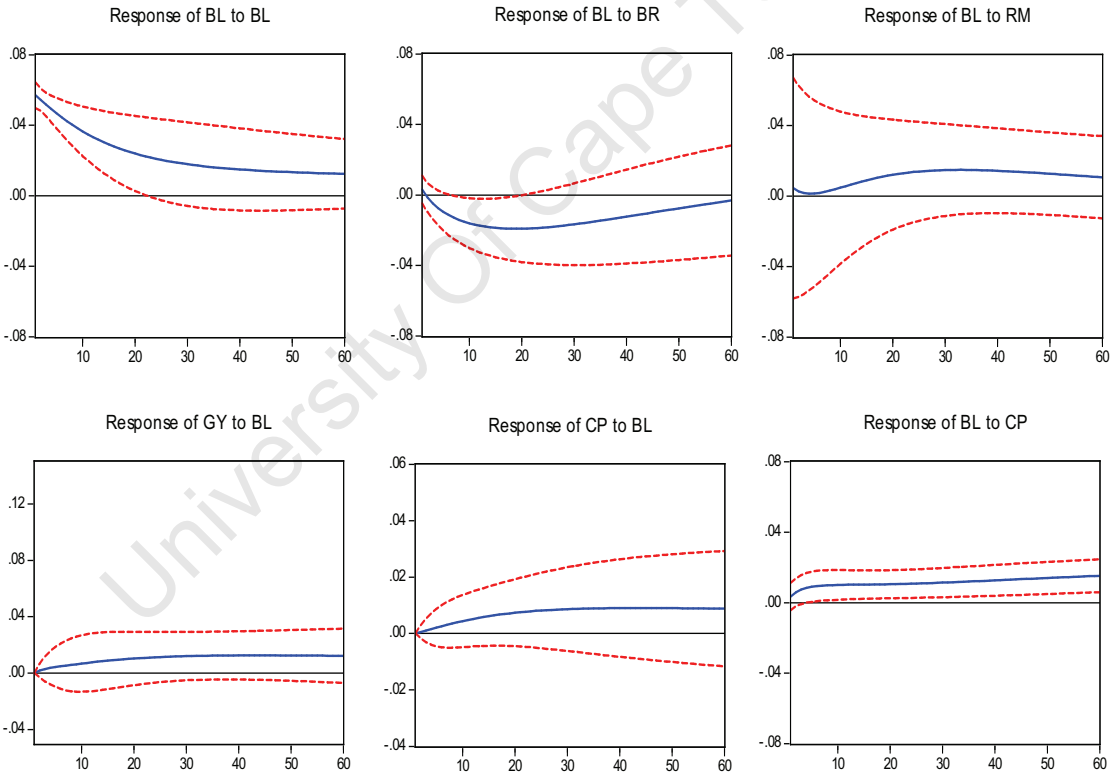
innovations in the bank rate, reserve money and bank lending. The figure shows that a bank rate shock equivalent to an unanticipated increase in the bank rate of about 2.2 percent causes bank lending to decline, bottoming out at 2 percent below baseline after 18 months. This response is significant between 6 and 24 months. A reserve money shock, on the other hand, corresponding to a 7.2 percent sudden increase in reserve money leads to an increase in bank loans, peaking at 1.5 percent above baseline after 3 years. This response, however, is not significant. An unexpected 5.5 percent rise in bank loans, on the other hand, leads to an increase in both output and consumer prices.

Figure 2-8: Impulse Responses for the Bank Lending Model



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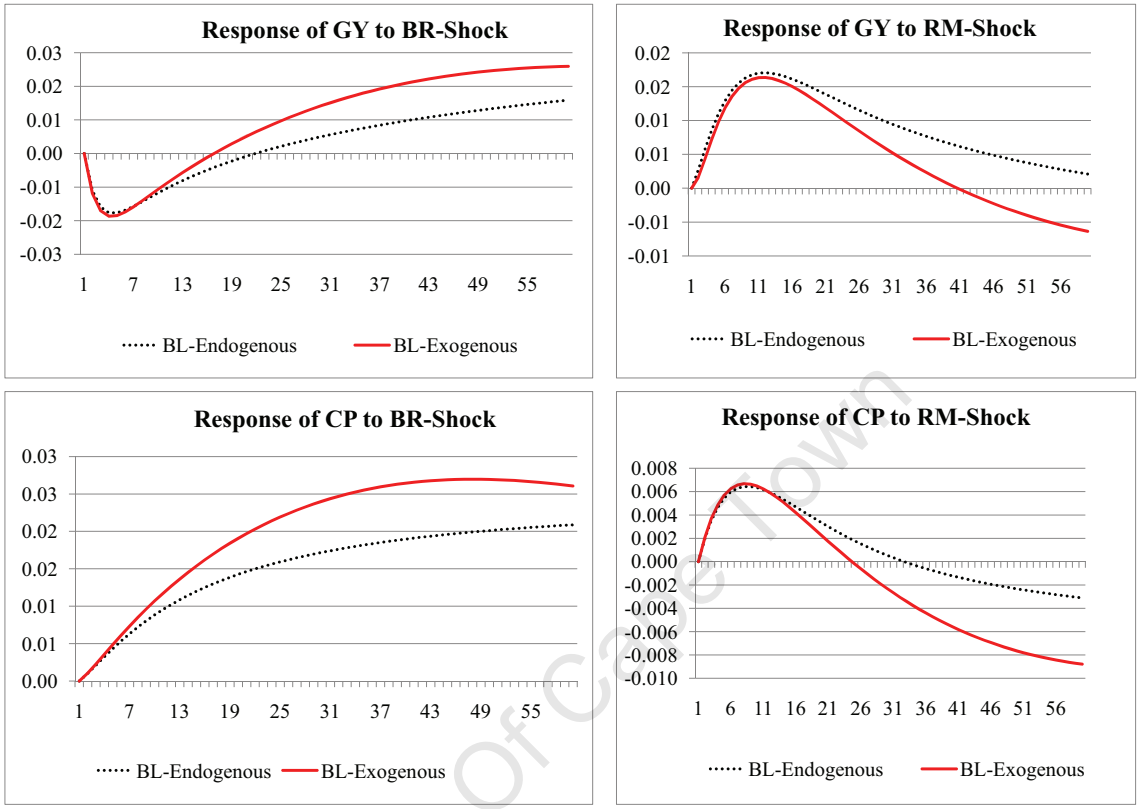
To determine the importance of the bank lending channel, impulse responses of consumer prices and output to bank rate and reserve money shocks are plotted in each case with two scenarios: endogenous and exogenous bank lending. The case of exogenous bank lending

Figure 2-9: Impulse Responses of Output and Consumer prices to Bank Rate and Reserve Money Shocks with Endogenous and Exogenous Bank Lending



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blocks off responses that pass through bank loans while the case of endogenous bank loans allows bank lending to transmit the monetary policy shocks. Figure 2-9 shows that, in all four instances, there is a considerable difference in the size of impulse responses when bank lending is exogenous and when it is endogenous. This provides preliminary evidence that bank lending contains important additional information in the country's monetary transmission process. In line with theoretical expectations, output decreases following a sudden increase in the bank rate and increases following an unexpected increase in reserve money while consumer prices go up in response to an unanticipated increase in reserve money. The response of consumer prices to an unexpected rise in the bank rate continues to show the price puzzle, dissipating faster though when bank lending is endogenous.

Exchange Rate Model

Taylor (1995), Obstefield and Gertler (1995) and others have drawn attention to monetary policy operating through exchange rates and net exports. Monetary policy can influence the exchange rate through interest rates, direct intervention in the foreign exchange market or inflationary expectations. The changes in the exchange rate, in turn, affect aggregate demand through the cost of imported goods, the cost of production and investment, international competitiveness and firms' balance sheets in the case of high liability dollarisation (Dabla-Norris and Floerkemeier, 2006). We investigate the importance of the channel in Malawi's monetary transmission process by appending the exchange rate variable XR_t, to the generic model. The vector of endogenous variables in the exchange rate model is, accordingly, presented as follows:

$$y_t^{'} = [GY_t, CP_t, XR_t, BR_t, RM_t] \tag{2.10}$$

The five variables in the model are output, consumer prices, exchange rates, bank rate and reserve money. In line with the system of equations (2.5), the model is identified according to the following scheme:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ 0 & 0 & a_{33} & 1 & 0 \\ 0 & 0 & a_{53} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{XR} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{pmatrix} \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{XR} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{2.11}$$

Figure 2-10 presents impulse responses of exchange rates to own, bank rate and reserve money shocks and responses of output and consumer prices to innovations in exchange rates. A monetary tightening corresponding to an unexpected 2.2 percent increase in the bank rate causes the domestic currency to appreciate, moving 1.5 percent below baseline after 3 years. The response, however, is insignificant. Contrary to theoretical expectations, the exchange rate responds to a reserve money shock equivalent to a 7.6 percent sudden increase

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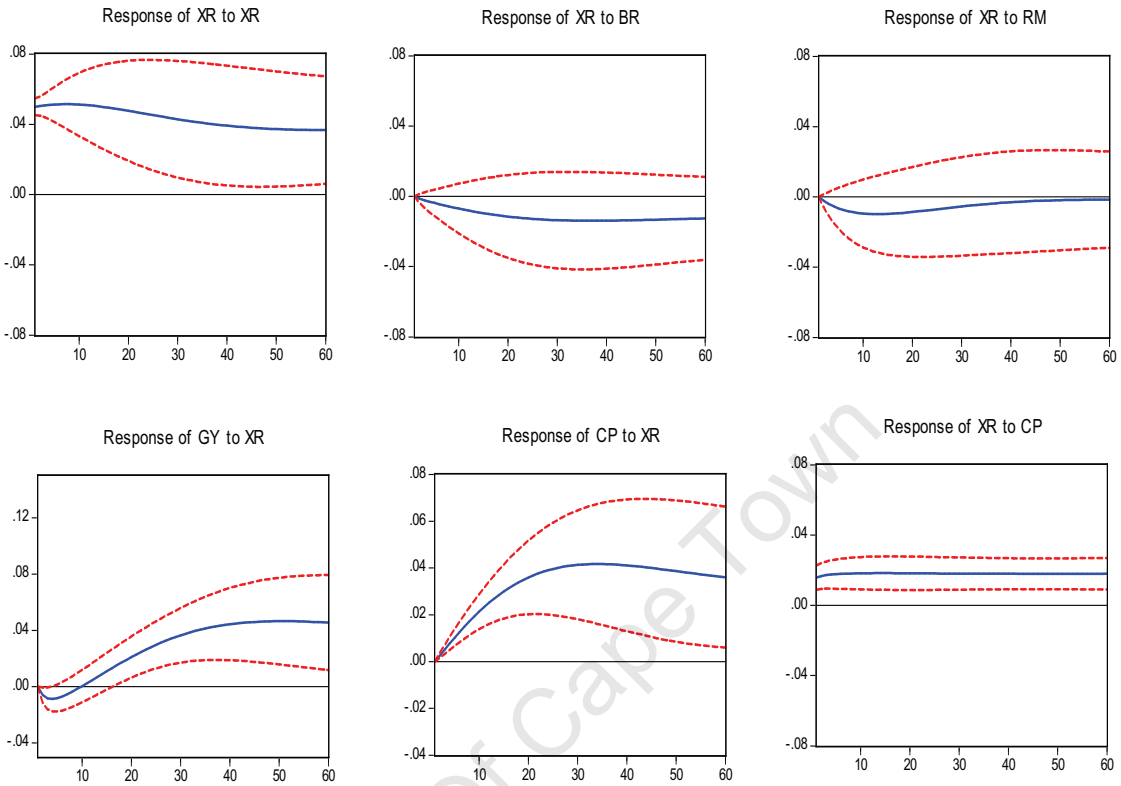
Figure 2-10: Impulse Responses for the Exchange Rate Model



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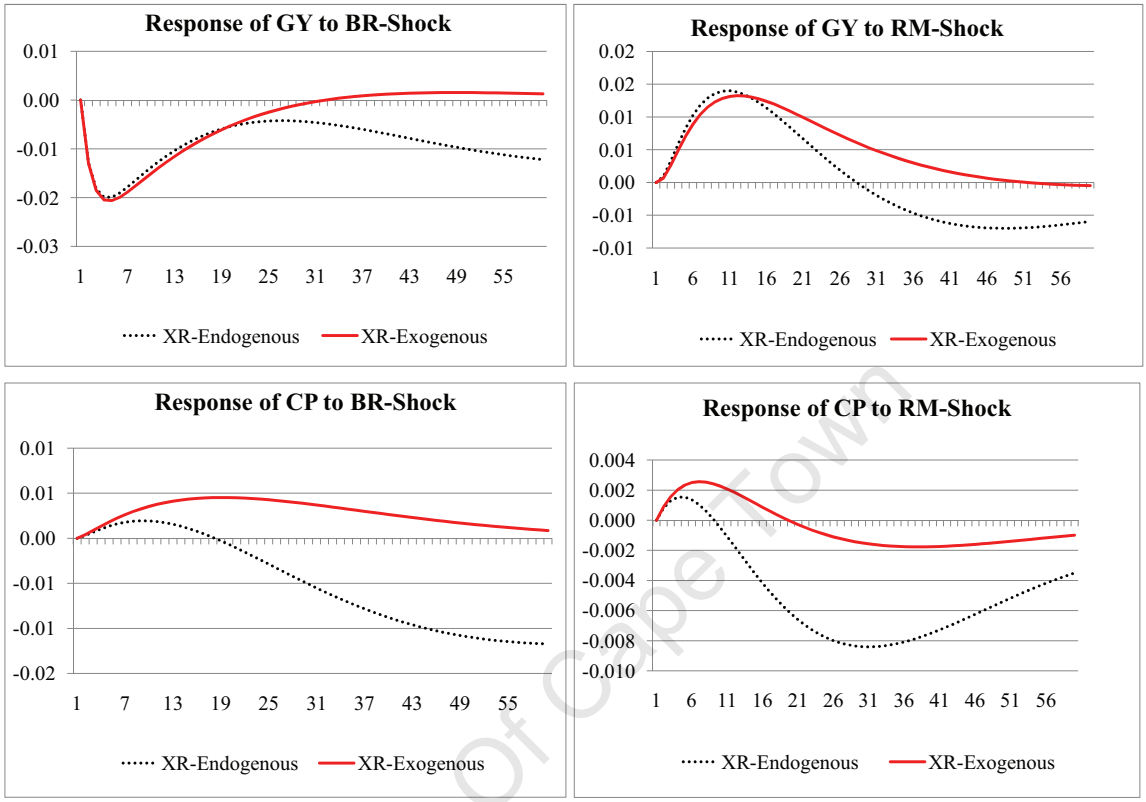
in reserve money with an appreciation, moving 1 percent below baseline after a year. This response is also insignificant. An exchange rate shock equivalent to a depreciation of the domestic currency by 5.5 percent, however, attracts significant responses in both consumer prices and output. Consumer prices rise, peaking at 4 percent above baseline after 3 years while output declines in the first 4 months and rises thereafter, peaking at 4.3 percent above baseline after 4 years.

In spite of the weak responses of exchange rates to innovations in monetary policy operating targets, Figure 2-11 demonstrates that impulse responses of output and consumer prices to bank rate and reserve money shocks are different when exchange rates are exogenous compared to when they are endogenous, indicating that inclusion of the exchange rate provides important additional information to the monetary transmission process.

Figure 2-11: Impulse Responses of Output and Consumer Prices to Bank Rate and Reserve Money Shocks with Endogenous and Exogenous Exchange Rates



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The Money Effect Model

An alternative channel of monetary transmission is the monetarist view. The channel downplays the role of interest rates and liquid asset adjustment in the transmission mechanism, reducing the process to a direct link between changes in aggregate money supply and absorption (Bolnick, 1991). According to this view, prices and output respond to monetary impulses because households and businesses fail to anticipate or perceive correctly all of the future implications of past and current actions (Meltzer, 1995). These misperceptions occur primarily because of the existence of a time lag between observing the impulses and being able to distinguish between permanent and transitory impulses and real and nominal shocks. A monetary shock, therefore, drives a wedge between money supply and money

demand, which triggers adjustments in portfolio holdings that in turn alter spending decisions. We use aggregate money supply (M2) as an indicator of the money effect. Appending $M2_t$ to the generic model, the vector of endogenous variables in the money effect model is presented as:

$$y_t^{'} = [GY_t, CP_t, M2_t, BR_t, RM_t] \tag{2.12}$$

where the five variables in the model are output, consumer prices, M2, bank rate and reserve money. Following the identification scheme in system of equations (2.5), the model is identified as:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & a_{53} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{M2} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{pmatrix} \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{M2} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{2.13}$$

Figure 2-12 presents impulse responses of M2 to own, bank rate and reserve money shocks and responses of output and consumer prices to M2 shocks. A monetary tightening equivalent to a 2.2 percent unexpected increase in the bank rate leads to a significant increase in M2. A reserve money shock corresponding to a sudden 7.2 percent increase in reserve money, however, triggers no response in M2. A possible explanation for this occurrence is the dominance of commercial banks in the trading of government securities. A sudden change in reserve money arising from OMO transactions changes bank reserves proportionately without significantly affecting currency and term and demand deposits, except for the interest component in maturing securities. Accordingly, aggregate money supply is insignificantly affected by the reserve money shock.

Both output and consumer prices respond significantly to unexpected changes in M2. An unanticipated 6.1 percent increase in M2 is followed by a rise in output, which peaks at 2.4 percent above baseline after 10 months and is significant up to 2 years. Consumer prices

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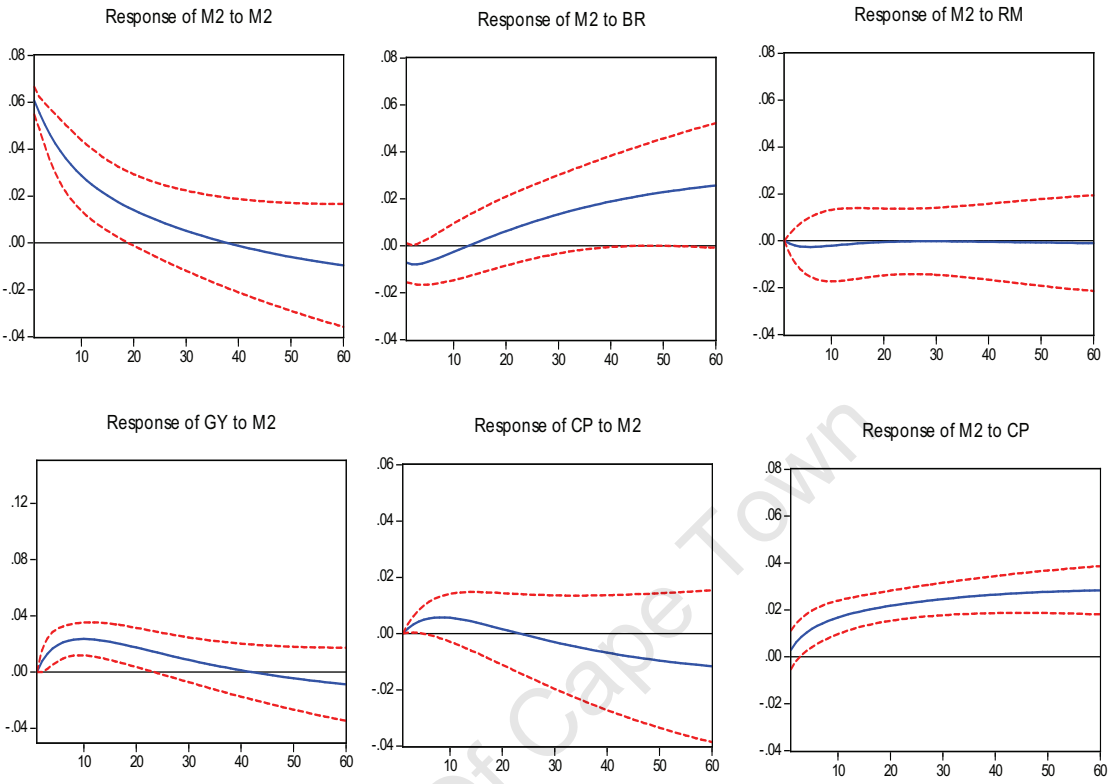
Figure 2-12: Impulse Responses for the Money Effect Model



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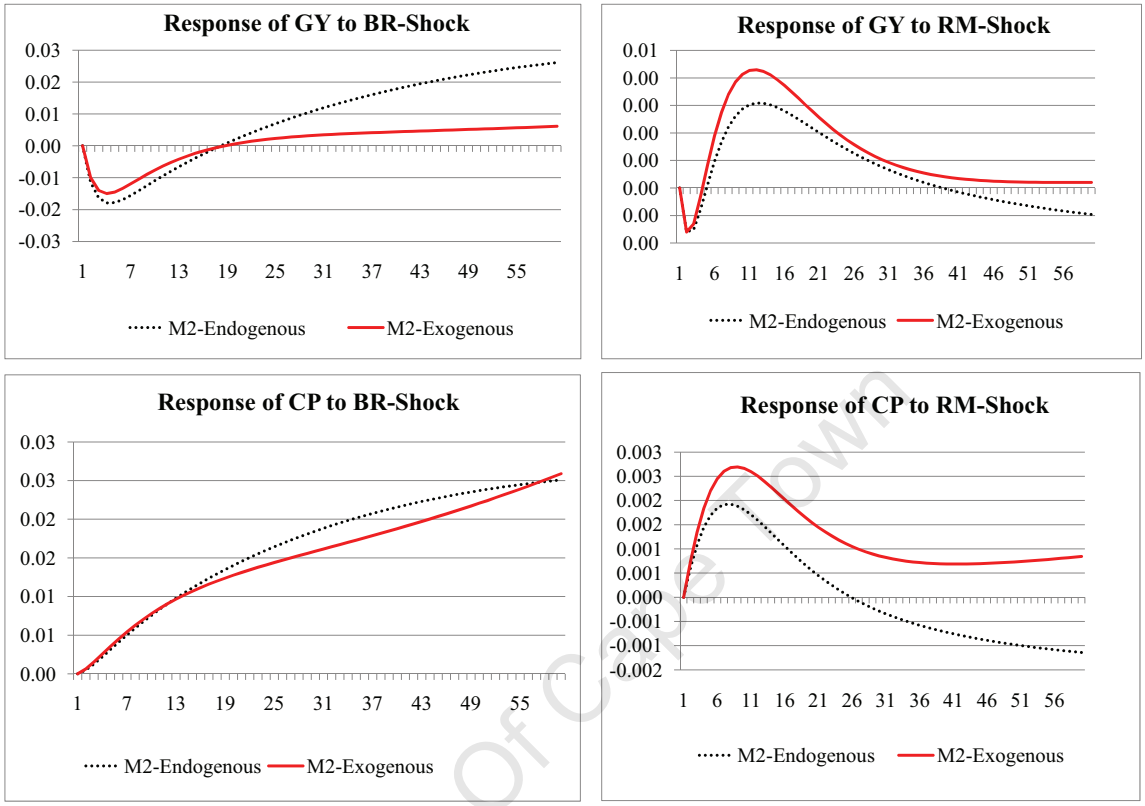
respond to the monetary expansion with an initial price increase, peaking at 0.6 percent above baseline after 8 months. The response is significant up to five months.

To determine the importance of the money effect model, Figure 2-13 presents impulse responses of consumer prices and output to bank rate and reserve money shocks in two scenarios: endogenous and exogenous M2. The figure confirms that M2 contains important additional information in the monetary transmission process, which is more pronounced in the responses of output to bank rate shocks and consumer prices to reserve money shocks.

Figure 2-13: Impulse Responses of Output and Consumer Prices to Bank Rate and Reserve Money Shocks with Endogenous and Exogenous M2



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2.4.3 The Composite Model

Preliminary indications from the preceding section suggest that bank lending, the exchange rate and money effect channels contain important additional information for the monetary transmission process in Malawi. Putting everything together, a composite model of monetary transmission in Malawi can be drawn with the following vector of endogenous variables:

$$y_t^{'} = [GY_t, CP_t, BL_t, XR_t, M2_t, BR_t, RM_t] \tag{2.14}$$

which is identified according to system of equations (2.5). Impulse responses for the consolidated model over a five year period are presented in Figure A-5 in Appendix A,

Section A.3. The figure illustrates that bank lending and money effect are important channels of monetary transmission in Malawi but the transmission process is somewhat weak. Among the three intermediate policy targets, none responds significantly to reserve money shocks while only bank lending and M2 respond significantly to bank rate shocks, although the M2 response is only marginally significant. Bank lending responds to a 2.2 percent sudden increase in the bank rate with a decline, bottoming at 1.7 percent below baseline after 2 years. The response is significant between 12 and 30 months. M2 responds to the shock with an instantaneous decline of 0.8 percent, before rising in the next 6 months and declining thereafter. The response is marginally significant between 16 and 24 months.

Output responds significantly to unexpected changes in both bank lending and M2. An unanticipated 5.7 percent increase in bank lending causes output to rise, peaking at 1.3 percent above baseline after 15 months. A sudden 5.8 percent increase in M2 also causes output to rise, peaking at 1.6 percent above baseline after 5 months. Consumer prices, however, respond insignificantly to shocks emanating from both bank lending and M2, consistent with earlier findings.

The money effect channel is strengthened by significant responses of M2 to bank lending and exchange rate shocks. In contrast, the exchange rate channel is not well established. Exchange rates respond insignificantly to all monetary variables in the model but they prompt significant responses in both output and consumer prices. Thus, while there is no evidence that they are driven by monetary policy shocks, exchange rates are an important determinant of output and consumer prices. On this basis, it is probable that exchange rates are exogenously determined in the model. To confirm this claim, the composite model is re-estimated with the exchange rate treated as an exogenous variable and similar results are obtained (see Figure A-6 in Appendix A, Section A.3).

Historical events in Malawi suggest that financial sector operations during the pre-1994 period were considerably different to the post-1994 period. The country had credit ceilings until 1988, direct interest rate controls until May 1990 and a fixed exchange rate peg until February 1994. In the post-1994 period, numerous financial innovations emerged,

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the number of commercial banks increased considerably (from two in 1993 to 11 in January 2010) and the financial sector became reasonably competitive. Cognisant of the fact that the impact of financial sector operations on economic activity may have also changed in the post-1994 period, the composite model (with endogenous exchange rates) is re-estimated with the sample period truncated, starting instead from 1994:03. The truncation date is chosen to separate the periods of fixed exchange rate peg (pre-1994:03) and floating exchange rates (post-1994:02). Impulse responses for the model with a truncated sample are presented in Figure 2-14. While the patterns are broadly similar to the full sample patterns, there are notable differences as well.

First, the response of exchange rates to unexpected changes in the bank rate is significant in the truncated sample. This is not surprising since the exchange rate was flexible during the entire post-1994 period, which allowed the Malawi Kwacha to respond freely to monetary variables. The response of output to exchange rate shocks, while still significant, is now less pronounced compared to the full sample. Thus, the impact of exchange rate shocks on policy goals is weaker in the truncated model although the exchange rate as a monetary policy transmission channel is now apparent. Second, the significant response of M2 to bank rate shocks is more pronounced in the truncated sample. This underlines the importance of monetary policy in the flexible exchange rate regime. Third, the significant output response to unexpected changes in bank lending is more pronounced in the truncated model, highlighting the importance of bank lending as a standalone channel of monetary transmission.

To determine the proportion of fluctuations in a given variable caused by different shocks, variance decompositions of each variable in the composite model with a truncated sample are computed at forecast horizons of 1 to 5 years (see Table 2.2). The table shows that, besides own shocks, output fluctuations are largely attributed to M2 up to about a year, exchange rates at about 2 years and bank lending from about 3 years and beyond. Collectively, bank lending, exchange rates and M2 account for 8.12 percent of the fluctuations in output after a year, 19.4 percent after 2 years, 28 percent after three years and 36.9 percent after 5 years.

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Figure 2-14: Impulse Responses for the Composite Model with a Truncated Sample

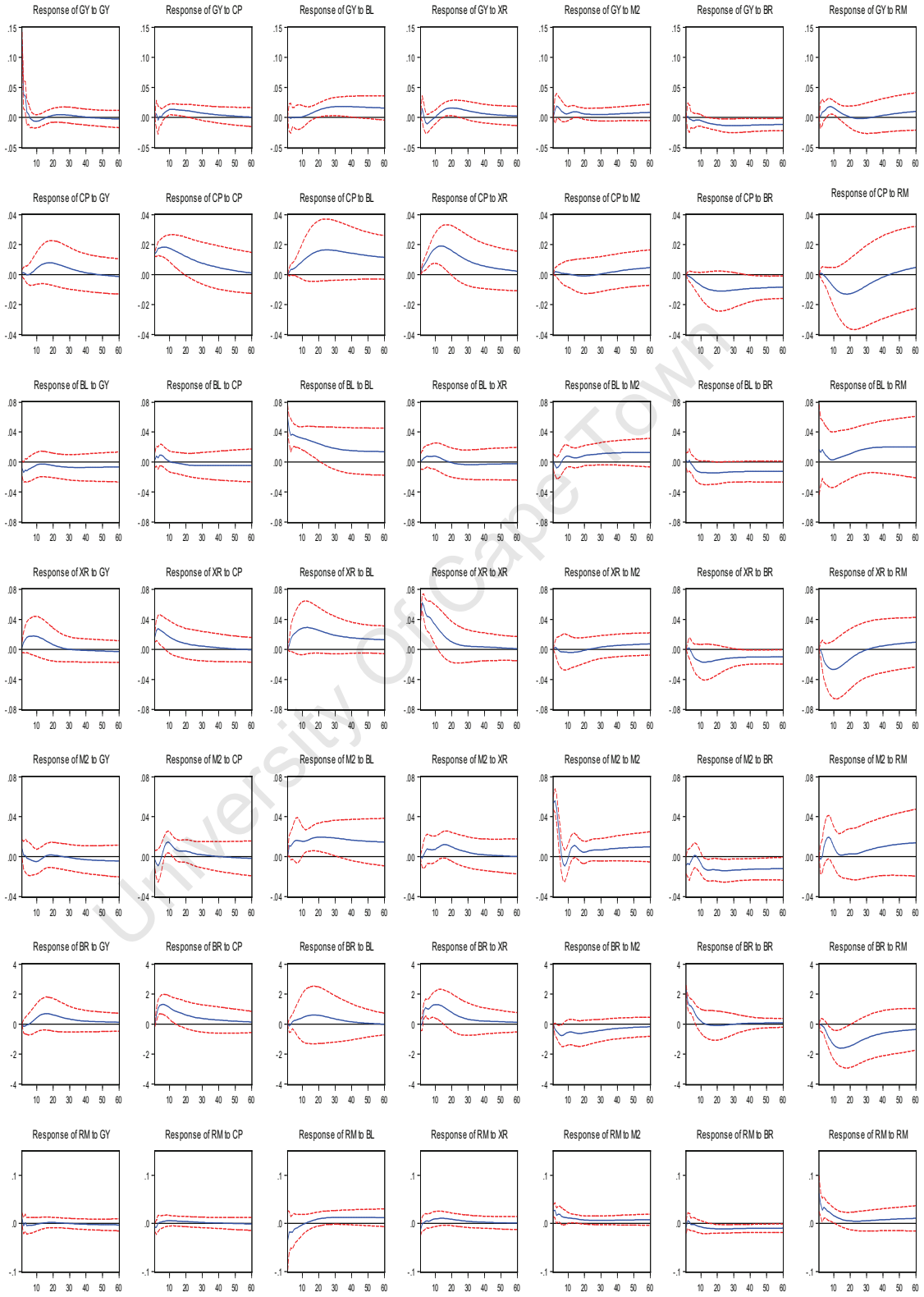

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Table 2.2: Variance Decomposition for the Composite Model with a Truncated Sample

Responses of GY							
Month	GY	CP	BL	XR	M2	BR	RM
1	100	0	0	0	0	0	0
6	88.9972	0.4038	0.0177	2.3901	4.9986	0.4072	2.7855
12	78.4499	3.6822	0.0578	2.5118	5.5537	1.2000	8.5447
24	59.7092	7.7282	4.3302	9.0110	6.0529	5.9602	7.2085
36	47.5531	7.5615	12.5306	10.5965	5.4659	10.5178	5.7747
48	40.6831	6.7650	18.4448	9.7991	5.5879	13.3136	5.4067
60	35.8408	5.9716	21.9176	8.7884	6.1403	15.0565	6.2848
Responses of CP							
Month	GY	CP	BL	XR	M2	BR	RM
1	0.4792	99.5208	0	0	0	0	0
6	0.1269	78.5446	3.1477	15.6286	0.5097	1.4660	0.5766
12	1.4681	51.4900	7.1739	29.3745	0.1799	4.6270	5.6866
24	3.9681	29.8407	16.7095	28.7400	0.1051	8.7683	11.8684
36	3.7172	24.4680	23.9787	25.1090	0.1053	11.3679	11.2539
48	3.2648	21.9025	28.5072	22.8361	0.3744	13.2559	9.8592
60	2.9776	19.9325	31.0985	20.9767	0.9715	14.6828	9.3603
Responses of BL							
Month	GY	CP	BL	XR	M2	BR	RM
1	2.2583	0.1986	90.2722	0.0140	0.0307	0.0930	7.1333
6	5.5229	2.5329	80.5760	1.5127	1.1358	0.8496	7.8701
12	4.1039	1.7816	78.8282	2.4896	2.0008	5.5770	5.2190
24	3.1966	1.4451	72.3613	1.7959	3.3429	10.8788	6.9795
36	3.6208	1.6487	61.5861	1.6212	5.6537	12.4880	13.3816
48	3.9139	1.7806	53.2470	1.4590	7.6008	13.2090	18.7898
60	4.0358	1.8533	47.5869	1.3146	8.9958	13.7526	22.4611

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Table 2.2 (cont...): Variance Decomposition for the Composite Model with a Truncated Sample

Responses of XR							
Month	GY	CP	BL	XR	M2	BR	RM
1	0.4143	14.0718	0	85.5139	0	0	0
6	4.9664	15.4216	6.5576	66.8150	0.1397	0.8939	5.2057
12	6.5994	12.2794	13.7981	51.0453	0.2760	3.8684	12.1333
24	6.1850	10.1437	22.9385	39.6472	0.3166	7.0914	13.6776
36	5.6241	9.5043	26.9406	36.2663	0.4574	8.6822	12.5252
48	5.2983	8.9223	28.815	33.9814	0.9202	9.8839	12.1790
60	5.0737	8.3708	29.7261	31.9085	1.5614	10.8526	12.5069
Responses of M2							
Month	GY	CP	BL	XR	M2	BR	RM
1	1.9264	0.2874	0	0.0035	95.4028	2.3799	0
6	0.6548	1.8160	7.5246	1.2160	81.1561	1.7130	5.9195
12	1.1910	7.0872	14.4188	3.0670	60.4929	3.1334	10.6076
24	0.8558	6.1143	25.9479	6.9906	42.1039	10.7904	7.1972
36	0.7346	4.8195	32.2545	6.0773	34.0857	15.0220	7.0065
48	0.9330	3.9270	34.1127	5.0182	29.8880	16.9727	9.1484
60	1.2192	3.3383	34.0998	4.2060	27.2372	17.9386	11.9608
Response of BR							
Month	GY	CP	BL	XR	M2	BR	RM
1	0.0007	0.0243	0	0.1477	0	99.8273	0
6	0.1695	25.4735	0.6292	15.7219	7.2024	47.9679	2.8357
12	1.8011	24.6725	2.0438	23.2621	6.9985	22.3638	18.8581
24	5.0952	17.5419	4.5163	20.9502	7.2595	11.4689	33.1680
36	5.3944	16.3351	4.9589	19.0360	7.8321	9.8491	36.5944
48	5.4258	16.0741	4.8605	18.4364	8.1086	9.4006	37.6940
60	5.4569	15.9262	4.7515	18.1548	8.2638	9.2190	38.2279

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Table 2.2 (cont...): Variance Decomposition for the Composite Model with a Truncated Sample

Response of RM							
Month	GY	CP	BL	XR	M2	BR	RM
1	1.1951	1.2239	20.7566	3.1205	11.4659	0.8413	61.3968
6	1.0974	1.1211	17.1994	1.7811	18.0151	0.7655	60.0205
12	1.0686	1.8004	14.4123	3.7263	18.6833	2.1861	58.1230
24	0.9749	2.3032	14.8494	7.2198	18.1430	7.9062	48.6036
36	0.8454	2.1047	19.0743	6.9160	16.9618	11.9046	42.1932
48	0.8928	1.8168	22.1946	6.0937	16.2624	14.1667	38.5730
60	1.0566	1.5922	24.0020	5.3260	15.8866	15.5339	36.6028

Excluding own shocks, variations in consumer prices are mostly accounted for by exchange rates up to about 3 years and by bank lending thereafter. M2 accounts for less than 1 percent of the fluctuations in consumer prices across the forecast horizon, implying that shocks in aggregate money supply are not responsible for inflation in Malawi. Consistent with earlier findings, consumer prices account for a larger proportion of the fluctuations in both bank rate and reserve money fluctuations, given the two policy goals, reconfirming that the primary goal of monetary policy in Malawi is price stability, though the output goal is also pursued.

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2.4.4 Robustness Check

While all models are subjected to robustness checks, we report here results of the estimated composite model from the truncated sample only. Structural estimates of the coefficients in matrices A and B of the model are presented in Table A.8 in Appendix A, Section A.3. The table shows that nearly all coefficients in the model have standard errors with values of less than one, implying that they are efficient and hence form a solid basis for measuring monetary policy shocks. In addition, 12 of the 17 structural coefficients have

correct signs. Inverse roots of the characteristic AR polynomial for the determination of stability (stationarity) of the model are reported in Table A.9 (Appendix A, Section A.3). The table shows that all inverse roots of the characteristic AR polynomial have modulus less than one and they lie inside the unit circle, indicating that at the chosen lag length (of order three), the estimated model is stationary or stable. We also experimented with lag length. While the model uses a lag length of order two, we tested the robustness of the model with a lag length of order 6. The estimation results indicate that the impulse responses are generally similar to what we get with a lag length of order 2. Finally, serial correlation test results reported in Table A.10 (Appendix A, Section A.3) show no evidence of serious serial correlation in the model. Thus, the composite model with a truncated sample is robust and its inferences can be relied upon.

2.5 Summary and Conclusions

This chapter set out to investigate the process through which monetary policy affects consumer prices and output in Malawi. Using innovation accounting in a structural vector autoregressive model, it is established that contrary to the official position that monetary policy in the country targets reserve money only, monetary authorities in Malawi also target short term interest rates. Effectively, the country employs hybrid operating procedures and it is demonstrated that the bank rate is a more effective measure of monetary policy than reserve money. In line with Part III, Section 4(d) of the RBM Act of 1989, it is also established that monetary authorities in the country pursue both price stability and high growth and employment objectives. It is further shown that price stability is the principal objective of monetary policy in the country. With the exception of exchange rate shocks, however, consumer prices respond weakly to monetary impulses suggesting that inflation in Malawi may not be dominated by monetary factors. The fact that food costs have a preponderant weight (58.1 percent) in the all items national composite consumer price index reveals that structural rigidities in food production may be more important determinants of inflation than monetary considerations.

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The study also illustrates that bank lending, exchange rates and aggregate money supply contain important additional information on the transmission process of monetary policy shocks in Malawi. Besides own shocks, output fluctuations are largely attributed to M2 up to about a year, exchange rates at about 2 years and bank lending from about 3 years and beyond. Excluding own shocks, variations in consumer prices are mostly accounted for by exchange rates up to about 3 years and bank lending thereafter. M2 accounts for less than 1 percent of the consumer price fluctuations across the five-year forecast horizon.

Truncating the study period to include only the flexible exchange rate period (post-1994) reveals two interesting issues. First, the role of the exchange rate becomes more conspicuous although its impact on economic activity is weakened. Second, the importance of aggregate money supply and bank lending in transmitting monetary policy impulses is enhanced. It is concluded, therefore, that with the floatation of the Malawi Kwacha in 1994, the monetary transmission process evolved from a weak, blurred process to a somewhat strong, less ambiguous mechanism, consistent with theoretical expectations.

One shortfall of the findings in this Chapter is that we do not explicitly take into account the co-existence of the formal financial sector (FFS) with a large informal financial sector (IFS). It is common knowledge that Malawi, like other low income countries, has a segmented financial system. In a survey carried out in 1989, Chipeta and Mkandawire (1991) found that the IFS in Malawi was larger than the FFS both in terms of credit extended to the private sector and savings mobilised by each sector. The second Integrated Household Survey (IHS2) for Malawi carried out in 2005 also revealed that at the time of the survey, the IFS was larger than the FFS in terms of credit to the private sector. The large size of the IFS suggests that official monetary data grossly underestimates the size of the financial sector, indicating that monetary policy is based on incomplete information and targeted at only a portion of the whole financial sector. It is, therefore, important to understand how the IFS responds to monetary policy, how developments in the commercial banking sector affect activities in the IFS, the impact of informal financial transactions on formal banking activities, and the role of the IFS in influencing economic activity. This

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is the subject of the next chapter. In Chapter 3, we develop a dynamic stochastic general equilibrium model for low income countries that investigates these issues.

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Chapter 3

Interaction of Formal and Informal Financial Markets in Low Income Countries

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3.1 Introduction

In the previous chapter, we investigated dynamic effects of monetary policy shocks in a typical low income country, Malawi, using innovation accounting in a structural vector autoregressive model. We isolated monetary policy autonomous disturbances from other shocks, quantified their dynamic behaviour and measured the consequent macroeconomic implications. The study demonstrated that Malawi employs hybrid operating procedures and pursues both price stabilisation and high growth and employment objectives. With reserve money and short-term interest rates identified as instrument targets, we illustrated that the latter is a more effective tool of monetary policy in the country. We further showed that bank lending, exchange rates and aggregate money supply contain important additional information in the transmission process of monetary policy shocks in the country. A key shortfall in the study was the failure to account for the existence of the IFS.

One of the fundamental distinguishing features of low income countries is the co-existence of the FFS with a large IFS. Several studies have shown that the IFS in low income countries is large (see for example African Development Bank, 1994; Chipeta and Mkandawire, 1991) and growing (see for example Chipeta, 1998; Soyibo, 1997; Bagachwa, 1995; Aryeetey, 1994;

Chipeta and Mkandawire, 1991). According to the African Development Bank (1994), 70 percent of the total population in Cameroon and 80 percent in Zambia take part in informal financial activities. The African Development Bank (1994) study also showed that 85 percent of rural households in Niger and over 80 percent of smallholder farmers in Zimbabwe have access to informal credit, and 60 percent of the population in Ethiopia and 52 percent in Senegal participate in rotating savings and credit associations (ROSCAs). In Malawi, Chipeta and Mkandawire (1991) observed that in 1989, the IFS was larger than the FFS when measured in terms of credit extended to the private sector. They arrived at the same result by comparing savings mobilised by the formal and informal financial sectors. Field surveys carried out in Nigeria by Soyibo (1997), in Ghana by Aryeetey (1994), in Malawi by Chipeta and Mkandawire (1991) and in Tanzania by Bagachwa (1995) established that the IFS grew faster than the FFS in the reform years 1990-1992 (Chipeta, 1998).

Given its sheer size, the IFS's response to policy is expected to be non-trivial and the consequent effect on economic policy may not be obvious - it is likely to vary depending on whether informal financial markets are autonomous or reactive to formal financial markets (See Rahman, 1992; Acharya and Madhura, 1983; Sundaram and Pandit, 1984); whether the two markets are competitive or complementary; and whether the nature of their interaction frustrates or strengthens monetary policy. Unfortunately, nearly all low income countries leave out informal financial transactions in official monetary data, effectively underestimating the volume of financial transactions and bringing into question the timing and effect of monetary policy on economic activity. This chapter contributes to the literature by investigating these and other issues. Using a macromonetary model with microeconomic foundations, we study the interaction of formal and informal financial markets and analyse the resulting impact on economic activity in low income countries.

For many years, informal financial markets have been perceived as an economic ill that has only succeeded in exploiting impoverished peasants in low income countries (Bolnick, 1992). The policy prescription, as expected, has been to integrate the IFS in the FFS (see Aryeetey, 2008; Bolnick, 1992; Bell, 1990). Recent research, however, has shown an

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emerging change in opinion with the sector now being regarded more positively as an integral component of the whole financial sector. Chipeta and Mkandawire (1991), for instance, report that the IFS in Malawi plays an important role in alleviating economic hardships among low-income groups by enabling these groups to mobilise resources (savings effect), use the resources to earn income (investment effect) and obtain loans (credit effect). An account of similar findings is presented by Steel, Aryeetey, Hettige and Nissanke (1997) in a study of Ghana, Malawi, Nigeria and Tanzania. Steel et al. (1997) stress that informal financial institutions (IFIs) in the three countries are an important vehicle for mobilising household savings and financing small businesses, a function that is carried out using specialized techniques that address the problems of information, transaction costs and risks, which prevent banks from serving these market segments. In Kenya, Atieno (2001) observes that unlike commercial banks, informal credit sources provide easier access to credit facilities for small and micro-enterprises.

Against this background, it is clear that official monetary data grossly underestimates the volume of financial transactions in low income countries; and that operating tools of monetary policy are targeted at only a portion of the financial sector though their impact may spread to the whole sector. On this point, important questions with profound policy implications ought to be asked. How do formal and informal financial markets interact? How does this interaction affect economic activity? How do informal financial markets respond to monetary policy and what is the impact on economic activity? This study contributes to the literature by providing answers to these and related questions using a four-sector dynamic stochastic general equilibrium (DSGE) model incorporating asymmetric information in the FFS.

The choice of a DSGE framework for analysis is motivated by a number of factors. First, DSGE models are derived from microeconomic foundations of constrained decision-making. That is, they describe the general equilibrium allocations and prices in the economy where all agents dynamically maximise their objectives subject to budget or resource constraints (Tovar, 2008). Following the estimation of deep parameters, therefore, it is possible to

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avoid the Lucas Critique, where only models in which the parameters that do not vary with policy interventions are suited to evaluate the impact of policy change (Ibid, 2008). Indeed, according to Woodford (2003), DSGE models should not, at least in principle, be vulnerable to the Lucas Critique, unlike the more traditional macroeconomic forecasting models. Second, DSGE models are structural, implying that each equation has an economic interpretation which allows clear identification of policy interventions and their transmission mechanisms (Peiris and Saxegaard, 2007). Third, DSGE models are forward looking in the sense that agents optimise model-consistent forecasts about the future evolution of the economy (Ibid, 2007). Fourth, DSGE models allow for a precise and an unambiguous examination of random disturbances. This is facilitated by the stochastic design of the models. To the best of our knowledge, there is no study that has examined the interaction of formal and informal financial sectors and their impacts on economic activities in low income countries using a macromonetary model developed within the context of a microfounded DSGE representation.

Following this introduction, the rest of the chapter is structured as follows. A DSGE model for low income countries is developed in Section 3.2. The model aims at building a quantitative macroeconomic representation from explicit optimising behaviour while allowing for a minimum amount possible of imperfections. Thus, the model is similar in many aspects to the Real Business Cycle (RBC) approach except on the monetary side (see Tovar, 2008; Mankiw, 2006). Calibrations of parameter and steady state values are presented in Section 3.3. Section 3.4 interprets simulation results of the model from three experiments, each illustrating impulse responses of selected macroeconomic indicators to a particular shock. The three shocks in the experiments include a positive production technology shock, a monetary policy shock and a risk factor shock. A summary and conclusions are presented in Section 3.5.

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3.2 A DSGE Model for Low Income Countries

3.2.1 Basic Design

There are four sectors in the economy: households, firms, financial intermediaries and monetary authorities. The household maximises an intertemporal utility function separable in consumption, leisure, and real cash balances; and its financial resources are used for consumption or held as cash balances with the excess deposited in commercial banks or lent out to firms in the informal credit market. The financial system is segmented into formal and informal financial sectors. We generalise service providers in the FFS as commercial banks and in the IFS as moneylenders. While commercial banks are corporate institutions, moneylenders are usually individuals, each person operating as a business unit. In rare cases, moneylenders have been observed to hire agents (Bolnick, 1992).

Besides the fact that the business is run by individual persons, moneylending usually has no formal accounts and is often run without official registration. It is, therefore, difficult to isolate moneylending from the household as a completely separate institution. Accordingly, we consolidate the household and moneylending activities and assume that the behaviour of moneylenders is decribed within the household's utility maximisation problem. Nonetheless, we allow the moneylending function to operate distinctly within the household framework. We describe the household's credit function as 'moneylending' and we reserve the term 'moneylenders' for credit institutions in the IFS.

The firm produces its own capital by converting loans obtained from the formal or informal financial sectors, which are assumed to be perfect substitutes (see Dasgupta, 2004). Using capital and labour as the only factors of production, the firm produces final output using technology described by a Cobb Douglas production function. In the financial market, firms self-selectively seek loans either in the formal or informal credit markets.

While lenders in the IFS deal with local communities for which they are able to identify risk levels of individual potential borrowers, the same does not apply to commercial banks in the FFS. Commercial banks are unable to distinguish between high and low risk borrowers

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ex-ante because high risk borrowers disguise themselves as low risk borrowers in order to enhance their chances of obtaining credit in the FFS. We assume the commercial banks have a preference for low risk borrowers emmanating from the view that low risk borrowers are associated with a relatively higher rate of loan repayment, which translates into higher expected profits for the banks than is the case with high risk borrowers. At this point, we invoke the Stiglitz and Weiss (1981) hypothesis that banks may ration credit in equilibrium. The residual demand that is rationed out of the formal loan market spills over to the informal credit market. Accordingly, the IFS provides credit to this demand as well as the component of total credit demand which self selectively seeks loans in the IFS only. Finally, we assume that the population is constant so there is no aggregation bias with treating average quantities as aggregate quantities (see Dasgupta, 2004).

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3.2.2 Household Sector

There is a continuum of identical households (with identical endowments and preferences). The objective of a representative household of constant size with a constant amount of time per period and an infinite planning horizon is to maximise the expected sum of a discounted stream of instantaneous utilities U_t given by[1]:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U_t \tag{3.1}$$

where $\beta \epsilon (0,1)$ is the consumer subjective intertemporal discount factor. The utility function is assumed to be separable in consumption (C_t), leisure $(1 - N_t)$ and real cash balances $\left(\frac{M_t}{P_t}\right)$:

$$U_t = \ln C_t + \Phi \ln (1 - N_t) + \Gamma \ln \left(\frac{M_t}{P_t}\right) \tag{3.2}$$

where N_t is time t labour (the amount of time worked) and $\Phi, \Gamma > 0$ represent the importance of leisure and real cash balances, respectively, in utility. The utility function $U_t(.,.,.)$ satisfies $U_{t,C_t} > 0, U_{t,(1-N_t)} > 0, U_{t,\left(\frac{M_t}{P_t}\right)} > 0, U_{t,C_t,C_t} < 0, U_{t,(1-N_t),(1-N_t)} < 0$ and

[1] A summary of parameters and variable definitions is presented in Table 3.1.

$U_{t,\left(\frac{M_t}{P_t}\right),\left(\frac{M_t}{P_t}\right)} < 0$.[2] The household's financial resources are used for consumption, deposited in commercial banks, held in cash or lent out to firms. We assume the household lends money to firms or deposits funds in commercial banks from its own earnings. Maximisation of the household's objective function, therefore, is subject to the following intertemporal budget constraint:

$$C_t + L_t^i + D_t + \frac{M_t}{P_t} = \left(1 + R_{t-1}^{li}\right) qL_{t-1}^i + (1 + R_{t-1}^{df})D_{t-1} + \frac{M_{t-1}}{P_{t-1}} + W_t N_t \tag{3.3}$$

where L_t^i are loans to firms given by households (informal finance), which we generalise as moneylending, D_t are the household's deposits in commercial banks, R_t^{li} are interest rates on credit given by the households, q_t is the probability of repayment on loans given by the moneylenders, R_t^{df} are interest rates on deposits in commercial banks and W_t is the wage rate. Maximising the objective function given in equation (3.1) subject to the budget constraint in equation (3.3) with respect to consumption, labour, cash balances, and the household's loans to firms and deposits in commercial banks, yields the following first order conditions:

$$\frac{1}{C_t} = \beta \left(1 + R_t^{df}\right) E_t \left(\frac{1}{C_{t+1}}\right) \tag{3.4}$$

$$N_t = 1 - \frac{\Phi C_t}{W_t} \tag{3.5}$$

$$\frac{M_t}{P_t} = \Gamma \beta E_t \left(\frac{C_{t+1}}{R_t^{df}}\right) \tag{3.6}$$

$$1 + R_t^{df} = \left(1 + R_t^{li}\right) q \tag{3.7}$$

Equation (3.4) is the Euler equation[3]. Equation (3.5) is a labour supply equation. It illustrates that consumption and labour supply are inversely related due to decreasing

[2] U_{t,C_t,C_t}, $U_{t,(1-N_t),(1-N_t)}$, and $U_{t,\left(\frac{M_t}{P_t}\right),\left(\frac{M_t}{P_t}\right)}$ stand for the second order derivatives of U_{t,C_t}, $U_{t,(1-N_t)}$, and $U_{t,\left(\frac{M_t}{P_t}\right)}$, respectively.

[3] This is also referred to in the literature as the intertemporal consumption function. We can replace $\left(1 + R_t^{df}\right)$ with $\left(1 + R_t^{li}\right) q$ for the same result.

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marginal utility of consumption. Equation (3.6) is a money demand equation. It states that the demand for real cash balances is negatively related to interest rates and positively related to future consumption. Equation (3.7) states that for the household in equilibrium, the effective return on deposits in commercial banks is equal to the return on loans given out on the informal financial market, taking into account the risk of default.

3.2.3 The Firm

Agriculture in low income countries often accounts for at least half of GDP and 60 to 80 percent of total employment (International Finance Corporation, 2009). In Malawi, the sector is responsible for nearly 80 percent (2006 estimate) of the country's exports, employs an estimated 84.5 percent of the labour force and generates 82.5 percent of foreign exchange earnings (Malawi Government, 2004). Smallholder agriculture in the country accounts for nearly 75 percent of total agricultural production (average for the period 1994-2006) while estate agriculture caters for the rest. For generality, therefore, it is safe to assume that a representative firm in a low income countries is small and engaged in agricultural activities. The firm owns land and requires working capital, which it borrows at the beginning of the period from either the formal or informal financial sector and repays at the end of the period after selling its harvest[4]. We assume there are no adjustment costs and that the working capital is predetermined at time t (Ambler and Paquet, 1994). The equation of motion for the capital stock is given by:

$$K_{t+1} = (1 - \delta) K_t + I_t \tag{3.8}$$

where K_t is capital, I_t is investment and δ is depreciation. Since the working capital is used up in a single period, it is equivalent to $\delta = 1$, which reduces equation (3.8) to $K_{t+1} = I_t$. We assume the loan is converted into current investment (change in capital) using a linear function described as:

$$I_t = \vartheta_{\tau,t} \left(L_t^f + L_t^i \right) \tag{3.9}$$

[4]For simplicity, we assume that a firm cannot borrow from both sectors at any given time.

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where ϑ_τ is a risk factor or probability of success ($\forall \tau = hr, lr$, where hr denotes high risk (low probability of success) and lr stands for low risk (high probability of success)); and L_t^f and L_t^i are formal and informal financial sector loans, respectively[5]. This is a case of a generic firm. A proportion (ρ) of all firms are high risk borrowers and the remaining proportion $(1-\rho)$ are low risk. Total lending, therefore, is described as:

$$I_t = \rho\vartheta_{hr,t}\left(L_t^f + L_t^i\right) + (1-\rho)\,\vartheta_{lr,t}\left(L_t^f + L_t^i\right)$$

$$I_t = \left[\rho\vartheta_{hr,t} + (1-\rho)\,\vartheta_{lr,t}\right]\left(L_t^f + L_t^i\right) \tag{3.10}$$

The firm's production technology is assumed to be given by a Cobb-Douglas formulation of the following form:

$$Y_t = e^{A_t} K_t^\alpha N_t^{1-\alpha} \tag{3.11}$$

where Y_t is output and $A_t > 0$ captures technology. The technology factor is assumed to evolve according to a first order autoregressive process given by:

$$A_t = \eta A_{t-1} + \varepsilon_t^A \tag{3.12}$$

where ε_t^A is independently and identically distributed (iid) with a standard deviation of σ_{ε^A}. The firm's cost minimisation problem subject to satisfying market demand, therefore, is given by:

$$\min_{K_t,\, N_t} W_t N_t + \left(1 + R_t^{lf}\right) L_t^f + \left(1 + R_t^{li}\right) q L_t^i + \phi_t\left(Y_t - e^{A_t} K_t^\alpha N_t^{1-\alpha}\right) \tag{3.13}$$

where ϕ_t is a Lagrangian multiplier. First order conditions with respect to labour, FFS loans and IFS loans yield demand functions for labour and formal and informal financial

[5] We define high risk firms as those firms that have a lower probability of success in converting the loans into capital while low risk firms are defined analogously as those firms with a higher probability of success in converting their loans into capital (see Dasgupta, 2004)

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sector loans, in that order, given by:

$$W_t = \phi_t (1-\alpha) \frac{Y_t}{N_t} \tag{3.14}$$

$$L_t^{df} = \frac{1}{\vartheta_{\tau t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{\tau t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \tag{3.15}$$

$$L_t^{di} = \frac{1}{\vartheta_{\tau t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{li}\right) q K_{t+1}^{\alpha}}{\alpha \vartheta_{\tau t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \tag{3.16}$$

Equation (3.14) shows that wages increase with output but are inversely related to labour supply. Equations (3.15) and (3.16) show the self-selection of firms in seeking loans. While some firms approach the FFS first, others self-selectively approach the IFS for credit. Both demand functions show that the demand for loans increases with higher expected wages and employment, given that $\alpha < 0$.

3.2.4 Financial Intermediaries

An important distinguishing feature of low income economies is the segmentation of the financial system into formal and informal financial sectors. Within the two broad segments, there are several different types of operators that usually have very little contact with one another and whose clients often do not overlap; and even when they overlap, they are able to sort out clearly which aspects of their financial business will be handled by which financial arrangement (Aryeetey, 2008). To model the two sectors, we build on the ideas of Dasgupta (2004).

Formal Financial Sector

Base lending rates are set as a mark-up (ζ) over the bank rate i.e. $R_t^{lf} = R_t^{nr} + \zeta$, where R_t^{nr} is the bank rate. The size of the mark-up depends on a commercial bank's market power, reflecting its estimate of the interest elasticity of the demand for credit (King, 2003). For simplicity, we assume the mark-up is fixed. Aggregate self-selection demand for loans in the

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FFS is given by:

$$L_t^{adf} = \frac{\rho}{\vartheta_{hr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha \vartheta_{hr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \quad (3.17)$$

We assume commercial banks are not keen to give out loans to high risk borrowers as these are associated with a high rate of default in loan repayment, which reduces the banks' expected profits. The banks, however, are not able to distinguish between the two types of borrowers *a priori* because high risk borrowers have the incentive to mimic the behaviour of low risk borrowers in order to enhance their chances of accessing the FFS loans. Against this behaviour among potential borrowers, therefore, total revealed demand for loans in the FFS is given by:

$$L_t^{rdf} = \frac{\rho}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}}$$

$$L_t^{rdf} = \frac{1}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \quad (3.18)$$

In the absence of information that distinguishes the types, banks resort to credit rationing, turning down some loan applicants even if they are willing to pay a relatively high price (Stiglitz and Weiss, 1981). Indeed when formal credit markets are imperfect due to asymmetric information, credit rationing is the most common practice to minimise banks' exposure to risk (Dasgupta, 2004). We assume the commercial banks can only supply a fraction ϖ of the revealed demand for FFS loans. We further assume ϖ_t is endogenously determined within the banks' profit maximisation framework. Following the absence of information that identifies the types of potential borrowers, commercial banks decide to take

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a safe position by assuming the worst case scenario in which all potential borrowers are high risk. The supply function for FFS loans, therefore, is given by:

$$L_t^{sf} = \frac{\varpi_t}{\vartheta_{hr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{hr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \tag{3.19}$$

The loans given out by commercial banks to firms in the formal credit market $\left(L_t^f\right)$ are converted from household deposits (D_t) and borrowing from the central bank $\left(L_t^{cb}\right)$. For simplicity, we assume there is no liquidity reserve requirement (LRR) i.e. all the deposits can be converted into loans. The intermediation technology, therefore, is assumed to be given by[6]:

$$L_t^{sf} = D_t + L_t^{cb} \tag{3.20}$$

The commercial banks' profit maximisation problem is described by:

$$\max_{L_t^{adf},\, \varpi_t} \varpi_t \left(1+R_t^{lf}\right) L_t^{adf} + D_t + L_t^{cb} - \varpi_t L_t^{adf} - \left(1+R_t^{df}\right) D_t - \left(1+R_t^{nr}\right) L_t^{cb}$$

subject to $L_t^{adf} \leq D_t + L_t^{cb}$, which reduces to:

$$\max_{L_t^{adf},\, \varpi_t} \varpi_t R_t^{lf} L_t^{adf} - R_t^{df} D_t - R_t^{nr} L_t^{cb} \text{ subject to } L_t^{adf} \leq D_t + L_t^{cb} \tag{3.21}$$

Taking FOCs with respect to L_t^{adf}, D_t and L_t^{cb} and solving for ϖ_t, we obtain:

$$\ell_t = \varpi_t R_t^{lf} = R_t^{nr} = R_t^{df} \tag{3.22}$$

$$\varpi_t = \frac{R_t^{df}}{R_t^{lf}} = \frac{R_t^{nr}}{R_t^{lf}} \tag{3.23}$$

where ℓ_t is a Lagrangian multiplier. Equation (3.22) states that in equilibrium, the cost of funds from the different sources (household deposits and borrowing from the central bank) will be equal $\left(\text{i.e. } R_t^{nr} = R_t^{df}\right)$ and they will be proportional to the return on loans $\left(\varpi R_t^{lf}\right)$. Alternatively, it can be inferred from equation (3.23) that the ratio of the cost of funds from the two identified sources defines the proportion of total demand for FFS loans that is satisfied by the commercial banks.

[6] This can also be seen as a simplified representation of the banks' balance sheets with assets on the left hand side and liabilities on the right.

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Informal Financial Sector

Loans in the IFS are provided by moneylenders[7]. The self selection demand for IFS credit is given by:

$$L_t^{adi} = \frac{\rho}{\vartheta_{hr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{li}\right) qK_{t+1}^{\alpha}}{\alpha \vartheta_{hr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{li}\right) qK_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \tag{3.24}$$

Like commercial banks, moneylenders also face a pool of high and low risk borrowers. However, unlike the banks, the moneylenders are able to identify the risk levels of individual borrowers. Achievement of this feat owes to the localisation of moneylending to communities within the neighbourhood of the lenders, which makes risk-level information readily available.

The residual demand for credit in the FFS is defined by equation (3.25) as equal to the total self-selection demand for loans in the FFS (equation (3.17)) less the proportion of revealed demand for FFS loans that succeeds in getting loans from the commercial banks (equation (3.19)). This residual demand spills over to the IFS. Assuming moneylenders are able to correctly identify the risk level of each potential borrower, the FFS residual demand seeking loans in the IFS is given by:

$$\begin{aligned} L_t^{rf} \quad = \quad & \frac{\rho}{\vartheta_{hr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{hr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} - \\ & \frac{\varpi_t \rho}{\vartheta_{hr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{hr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} - \frac{\varpi_t (1-\rho)}{\vartheta_{lr,t}} E_t \left[\frac{(1-\alpha)\left(1+R_t^{lf}\right) K_{t+1}^{\alpha}}{\alpha \vartheta_{lr,t} W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \end{aligned}$$

[7] We emphasize that the term 'moneylenders' is not used to distinctly refer to the usury market, but rather as a blanket reference to all creditors in the IFS, including the moneylenders themselves, traders, landlords, estate owners and grain millers, inter alia.

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$$L_t^{rf} = \left[\frac{\rho}{\vartheta_{hr,t}}\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}}\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}} - \frac{\varpi_t\rho}{\vartheta_{hr,t}}\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}} - \frac{\varpi_t(1-\rho)}{\vartheta_{lr,t}}\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}}\right]$$

$$E_t\left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}}$$

$$L_t^{rf} = \left[\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{\rho(1-\varpi_t)}{\vartheta_{hr,t}}\right) + E_t\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{(1-\rho)(1-\varpi_t)}{\vartheta_{lr,t}}\right)\right]$$

$$\left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}} \tag{3.25}$$

Aggregate demand for loans in the IFS, therefore, is given by the sum of equations (3.24) and (3.25):

$$L_t^{adi} = \frac{\rho}{\vartheta_{hr,t}}E_t\left[\frac{(1-\alpha)\left(1+R_t^{li}\right)qK_{t+1}^{\alpha}}{\alpha\vartheta_{hr,t}W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}}E_t\left[\frac{(1-\alpha)\left(1+R_t^{li}\right)qK_{t+1}^{\alpha}}{\alpha\vartheta_{lr,t}W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}} +$$

$$\left[\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{\rho(1-\varpi_t)}{\vartheta_{hr,t}}\right) + \left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{(1-\rho)(1-\varpi_t)}{\vartheta_{lr,t}}\right)\right]$$

$$\left[\frac{(1-\alpha)\left(1+R_t^{lf}\right)K_{t+1}^{\alpha}}{\alpha W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}}$$

$$L_t^{adi} = \left[\frac{(1-\alpha)\left(1+R_t^{li}\right)qK_{t+1}^{\alpha}}{\alpha W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}}\left[\frac{\rho}{\vartheta_{hr,t}}\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}} + \frac{(1-\rho)}{\vartheta_{lr,t}}\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}} + \right.$$

$$\left.\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{\rho(1-\varpi_t)}{\vartheta_{hr,t}}\right) + \left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}}\left(\frac{(1-\rho)(1-\varpi_t)}{\vartheta_{lr,t}}\right)\right]$$

$$L_t^{adi} = E_t\left[\frac{(1-\alpha)\left(1+R_t^{li}\right)qK_{t+1}^{\alpha}}{\alpha W_{t+1}N_{t+1}}\right]^{\frac{1}{\alpha-1}}\left[\left(\frac{\rho}{\vartheta_{hr,t}}\right)\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}}(2-\varpi) + \right.$$

$$\left.\left(\frac{(1-\rho)}{\vartheta_{lr,t}}\right)\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}}(2-\varpi)\right]$$

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$$L_t^{adi} = (2-\varpi_t)\, E_t \left[\frac{(1-\alpha)\left(1+R_t^{li}\right) q K_{t+1}^{\alpha}}{\alpha W_{t+1} N_{t+1}} \right]^{\frac{1}{\alpha-1}} \left[\left(\frac{\rho}{\vartheta_{hr,t}}\right)\left(\frac{1}{\vartheta_{hr,t}}\right)^{\frac{1}{\alpha-1}} + \left(\frac{(1-\rho)}{\vartheta_{lr,t}}\right)\left(\frac{1}{\vartheta_{lr,t}}\right)^{\frac{1}{\alpha-1}} \right] \tag{3.26}$$

3.2.5 Monetary Authorities

Monetary authorities in low income countries generally have a choice among three different operating targets of monetary policy: money supply, interest rate and exchange rate targets[8]. With the wave of liberalisation in the 1980s and the 1990s, exchange rate targeting has become less popular, leaving money supply and interest rates in the fold of common monetary policy operating targets for low income countries. Countries may target one or both instruments. Our earlier findings in Chapter 2 show that monetary authorities in Malawi employ hybrid operating procedures where they target both money supply and interest rates. We further demonstrated that between the two targets, interest rates are a more effective measure of monetary policy in the country. Following this finding, we experiment with a forward-looking monetary policy rule that treats the bank rate (R_t^{nr}) as an operating tool of monetary policy to characterise how monetary authorities conduct policy in low income countries. The forward-looking specification allows the central bank to consider a broad array of information to form beliefs about the future condition of the economy (Clarida, Gali and Gertler, 2000). The rule calls for adjustment of the bank rate based on the return on investment, the expected change in output and expected inflation:

$$R_t^{nr} = \chi_1 R_t^{rr} + \chi_2 \Delta Y^e + (1-\chi_2)\,\pi^e + \mu_t \tag{3.27}$$

[8] While inflation targeting is an alternative, it is an outside option for a majority of low income countries. Most studies, for example Masson, Savastano and Sharma (1998; 1997), point out that preconditions for adopting an inflation targeting framework in low income countries are not yet present. Very few low income countries have so far adopted inflation targeting as a monetary policy operating strategy. In a recent study of developing countries that have adopted the strategy, Lin and Ye (2009) use a pool of 13 countries, of which only the Philippines is low income.

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where R_t^{rr} is the real rate of interest or return on investment, ΔY^e is expected change in output i.e. $\Delta Y^e = E(Y_{t+1}) - Y_t$, π^e is expected rate of inflation defined as the expected difference between real and nominal interest rates in the next period and μ_t is a disturbance term assumed to be iid[9]. Since our model is in discreet time, we postulate that the marginal productivity of capital in the next period is equal to the real rate of interest (see Carlstrom and Fuerst, 2003; Benhabib, Carlstrom and Fuerst, 2005) as given by:

$$R_t^{rr} = \alpha e^{A_{t+1}} K_{t+1}^{\alpha-1} N_{t+1}^{1-\alpha} \tag{3.28}$$

3.2.6 Market Equilibrium

In equilibrium, clearing of the final goods market implies that aggregate production is equal to demand for household consumption and private investment:

$$Y_t = C_t + I_t \tag{3.29}$$

where $I_t = K_{t+1}$. We assume that money is required for all transactions in the goods market. In equilibrium, therefore, the following equality will hold:

$$P_t C_t = M_t \tag{3.30}$$

Equation (3.30) is an identity illustrating an ex-post equilibrium position connoting that prices operate only on the real side of the market. Since we have used N_t to represent labour supply by the household as well as labour demand by the firm, we have implicitly assumed clearing of the labour market. The equilibrium wage is determined by the market according to equations (3.5) and (3.14). The bank rate is determined by the monetary policy reaction function in equation (3.27). Commercial bank deposit and IFS interest rates are endogenously determined. Base lending rates are determined by loading a fixed mark-up over the bank rate. Self-selection demand for FFS and IFS loans is given by equations (3.15) and (3.16), in that order. Equations (3.19) and (3.26) represent loans supplied by the formal and informal financial sectors, respectively. Equilibrium in the two

[9] We have used the bank rate as an indicator of nominal interest rates.

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markets follow the simultaneous equation solution of the two equations, which takes into account the spill-over of demand from the FFS satisfied by the supply in the IFS. The sum of equations (3.19) and (3.26) determines the level of capital accumulation in the economy.

We assume prices adjust to equate supply and demand in every market simultaneously (see Mankiw, 1989). We further assume that money supply is exogenous. Interest rates and the price level adjust to equate supply and demand in the money market.

3.3 Calibrations

Several parameter estimates are adopted from the literature where their values are fairly standard. Following Liu and Gupta (2007), Hartley, Salyer and Sheffrin (1997) and Hansen (1985), the share of labour in output is set at 0.63, implying a value of 0.37 for α; economic agents are assumed to spend an estimated 21 percent of their time on work activities, suggesting a value of Φ equal to 3^{10}; the autoregressive process for the technology factor, η, is approximated at 0.91; the consumer discount factor β is assumed to be 0.99; and the depreciation rate, δ is 1 (see Table 3.1). Other parameter estimates and initial values are obtained directly from quarterly data for Malawi covering the period 1988:1-2005:4. These include parameter estimate for the mark-up over the bank rate to obtain base lending rate (ζ) and initial value for commercial bank deposit rates $\left(R^{df}\right)$.

More parameter estimates are obtained from equilibrium relations within the framework of the model. These are consumption parameter characterising weight of real money balances in the utility function (Γ), the lagrangian multiplier in a firm's cost minimisation function (ϕ), the factor of inertia in the base lending rate (χ_1) and weight of expected change in output in the monetary policy rule (χ_2). Initial values of some parameters are also obtained from the model's equilibrium relations. These include initial values of employment (N), capital stock (K), consumption (C), wage rate (W) and proportion of FFS

[10] According to Hartley et al. (1997), evidence from many countries shows that the time spent working (which determines Φ) and capital's share in output (α), while different, do not vary dramatically.

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loan demand that is satisfied (ϖ). From our knowledge of low income countries, the probability of loan repayment in the IFS (q) is estimated at 0.85 and the proportion of high risk borrowers (ρ) is approximated at 0.15. The risk factor (probability of success) for high risk borrowers (ϑ_{hr}) and the risk factor (probability of success) for low risk borrowers (ϑ_{lr}) are adjusted in the model with the experiments.

3.4 Simulation Results and Inferences

The model is solved using DYNARE in MATLAB (see Juilliard, 1996). We focus our attention on three shocks namely, a positive production technology shock characterised by an unexpected improvement in production technology; a monetary policy shock identified by an unanticipated increase in the bank rate; and a risk factor shock represented by a sudden increase in the probability of success for high risk borrowers. Figure 3-1 shows the impact of a positive production technology shock on various macroeconomic indicators when the success rate for high risk borrowers is low ($\vartheta_{hr} = 0.275$) and when it is relatively high ($\vartheta_{hr} = 0.8$). Figure 3-2 repeats the experiment but for a monetary policy shock. Impulse responses of selected macroeconomic indicators following a shock on the probability of success for high risk borrowers with high and low probabilities of success for low risk borrowers ($\vartheta_{lr} = 0.95$ and $\vartheta_{lr} = 0.3$, respectively) are presented in Figure 3-3.

3.4.1 Production Technology Shock

Figure 3-1 shows the impact of a production technology shock when the rate of success for high risk borrowers is low (i.e. $\vartheta_{hr} = 0.275$) and when it is high (i.e. $\vartheta_{hr} = 0.8$). An unanticipated improvement in production technology when the rate of success for high risk borrowers is low (i.e. $\vartheta_{hr} = 0.275$), as illustrated in the figure, causes a decline in marginal costs across all firms leading to a jump in output and a decline in expected prices. Since the shock causes an improvement in the marginal productivity of capital, which is equal to the instantaneous interest rate (see Carlstrom and Fuerst, 2003; Benhabib et al., 2005), we observe that our measure of the real interest rate goes up together with all nominal

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Table 3.1: Calibrated Parameter and Steady State Values

Parameter	Description	Value
α	Output elasticity of capital	0.37
β	Consumer subjective intertemporal discount factor	0.99
δ	Depreciation rate	1
η	Autoregressive process for the technology factor	0.91
Γ	Weight of real money balances in the utility function	3
q	Probability of loan repayment in the IFS	0.85
Φ	Leisure parameter	3
ϕ	Lagrangian multiplier in a firm's cost minimisation function	0.8
ρ	Proportion of high risk borrowers	0.15
ϑ_{hr}	Risk factor (rate of success) for high risk borrowers	0.275/0.8
ϑ_{lr}	Risk factor (rate of success) for low risk borrowers	0.3/0.95
ζ	Mark-up over the bank rate to obtain base lending rate	0.1
χ_1	Factor of inertia in the base lending rate	0.98
χ_2	Weight of expected change in output in the monetary policy rule	0.3
C	Initial value of consumption	0.8
K	Initial value of capital stock	0.2
N	Initial value of employment	0.3
ϖ	Initial value of proportion of FFS loan demand that is satisfied	0.7
W	Initial value of wage rate	0.3
R^{df}	Initial value of commercial bank deposit rates	0.075

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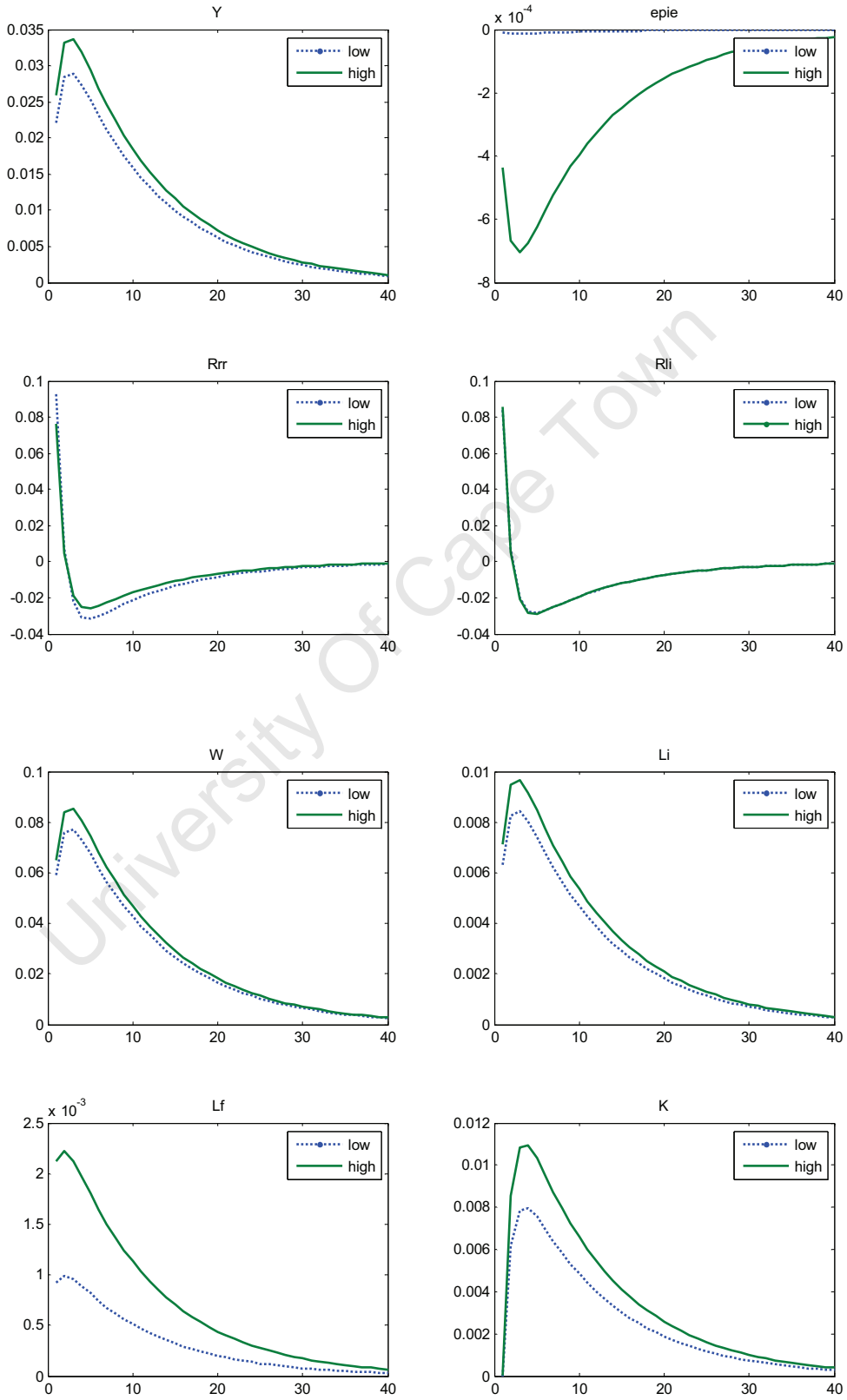
interest rates in the FFS. Holding the risk of default constant, interest rates in the IFS adjust upwards as well, in line with the lenders' risk hypothesis (see Basu, 1997). Thus, it is observed that in this instance, interest rates in both the formal and informal financial sectors change together in the same direction.

As a direct consequence of the improvement in technology, labour productivity increases,

Figure 3-1: Impulse Responses of a Production Technology Shock with High and Low Probabilities of Success for High Risk Borrowers



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consequently pushing wage rates upwards. Coupled with the increase in employment, the higher wage rates lead to a rise in households' financial resources, resulting in an increase in loans supplied by moneylenders in the IFS. Commercial banks respond to the higher output by expanding their customer base, leading to a rise in FFS loans, albeit marginally. Formal and informal financial sector loans, therefore, respond as complements. Since capital stock depends on the sum of formal and informal financial sector loans, *inter alia*, the increase in lending by commercial banks and moneylenders is followed by a rise in capital stock.

When the rate of success for high risk borrowers is increased to 0.8, a positive production technology shock causes a larger increase in loans extended by both formal and informal financial sectors as entrepreneurs are now encouraged to venture into new business establishments and expand existing ones to take advantage of the improvement in the success rate. Accordingly, capital stock and output increase by larger proportions and expected prices also decline by a larger margin. With larger amounts of capital and output, firms demand more labour and offer larger increases in wages than when the rate of success for high risk borrowers was low. The response of interest rates in both formal and informal financial sectors, however, does not change markedly.

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3.4.2 Monetary Policy Shock

Figure 3-2 shows the impact of a monetary policy shock when the rate of success for high risk borrowers is low (i.e. $\vartheta_{hr} = 0.275$) and when it is high ($\vartheta_{hr} = 0.8$). When the rate of success for high risk borrowers is low (i.e. $\vartheta_{hr} = 0.275$), an unanticipated increase in interest rates (monetary policy shock) causes an increase in base lending rates and expected inflation. Facing higher expected prices, households smooth their consumption by reducing their consumption expenditures. Firms respond to the expected lower sales by cutting down on production, employment and wage rates. Accordingly, capital formation and subsequently demand for both formal and informal financial sector loans decline. Thus, lending in the two sectors is complementary. The decline in IFS loans is reinforced by the lower wages and employment, which reduce households' financial resources, consequently lowering loanable

funds for moneylenders.

Moneylenders initially reduce their lending rates, possibly because the reduction in their capacity to give out loans is proportionately lower than the decline in demand for IFS loans. Thus, at the pre-shock lending rates, moneylenders have excess supply of loans, *ceteris paribus*. Since IFS loans and commercial bank deposits are substitutes to households, the excess IFS loanable funds are deposited in commercial banks, leading to a decline in commercial bank deposit rates and a gradual increase in IFS interest rates until equilibrium is attained. In this instance, it is observed that formal and informal financial sector interest rates are changing in opposite directions unlike the case in Section 3-1.

When the rate of success for high risk borrowers is increased to 0.8, an unexpected increase in the bank rate causes a larger decline in the demand for loans, both in the formal and informal financial sectors, leading to a larger drop in capital stock and a correspondingly larger decline in employment and output. Expected forward prices also go up by a larger margin causing a larger decline in consumption, output, employment, wages rates, lending (in both formal and informal financial sectors) and capital formation. There is, however, no marked change in the response of interest rates in both formal and informal financial sectors.

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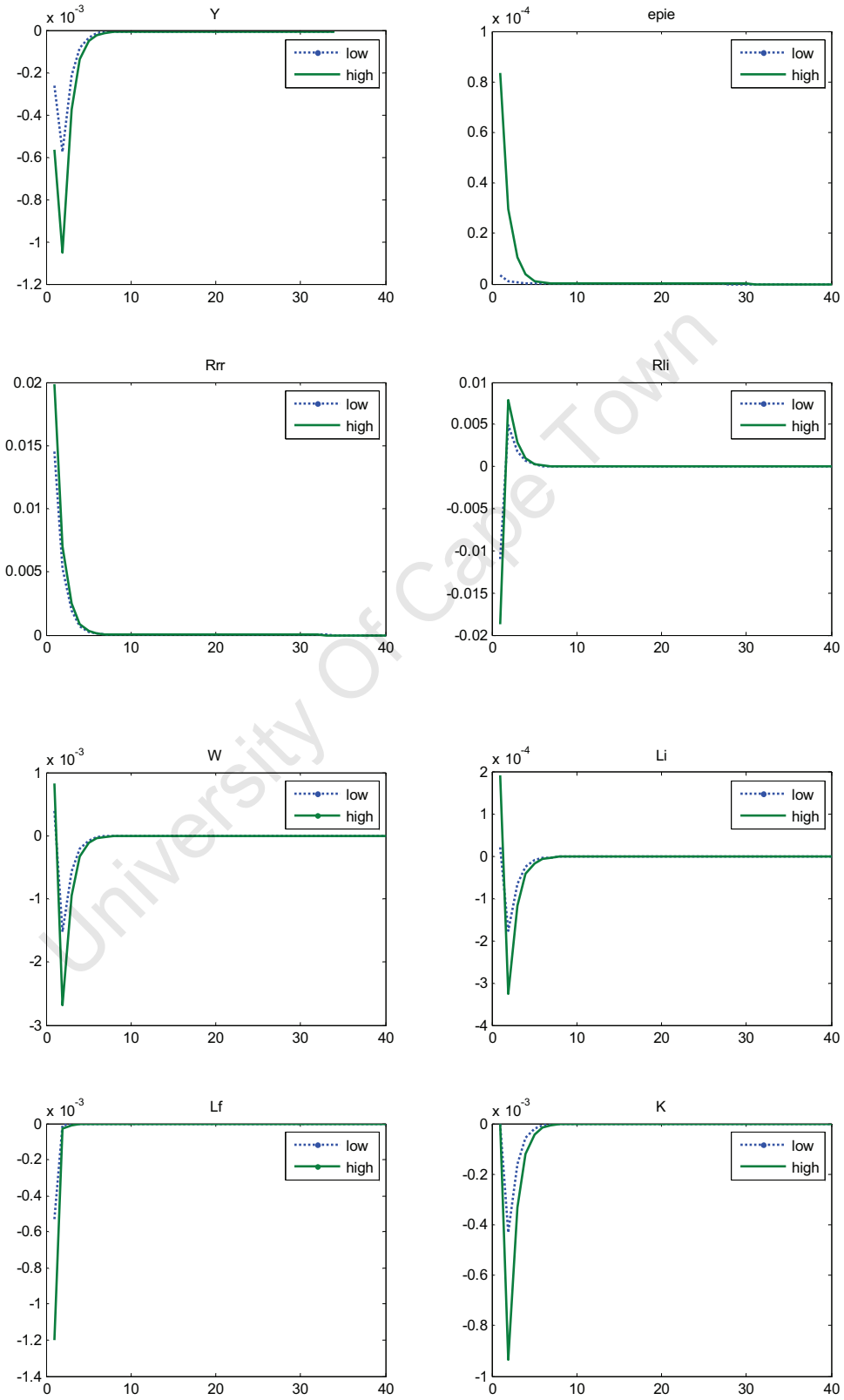
3.4.3 Risk Factor Shock

Figure 3-3 presents impulse response functions illustrating how various macroeconomic indicators respond to a shock on the probability of success (risk factor) for high risk borrowers. This experiment is evaluated against two scenarios: a high probability of success for low risk borrowers ($\vartheta_{lr} = 0.95$) in one instance and a low probability of success for the low risk borrowers ($\vartheta_{lr} = 0.3$) in another. Everything else remaining the same, an unexpected increase in the probability of success for high risk borrowers results in a rise in the proportion of borrowed funds that is turned into productive capital (see equations (3.9) and (3.10)). Consequently, capital, demand for labour, wage rates and output go up (see Figure 3-3). The expected higher wages translate into expected high costs of production, leading

Figure 3-2: Impulse Responses of a Monetary Policy Shock with High and Low Probabilities of Success for High Risk Borrowers



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consumers to expect higher prices.

Banks perceive the unanticipated increase in the probability of success for high risk borrowers as a reduction in the risk of loans extended to this type of borrowers. Everything else being equal, overall risk on loans decreases and the banks respond by increasing their lending leading to further increases in capital, output, demand for labour, wage rates and expected prices. With the rise in employment and wage rates, households now have a larger capacity to lend. IFS lending, therefore, goes up as well. Thus, consistent with previous findings, formal and informal financial sector lending remain complementary.

Following the shock, high risk borrowers' capacity to repay their loans goes up, which motivates banks to reduce the risk premium on base lending rates as a way of attracting more borrowers. As a result, FFS interest rates decline. In the IFS, on the other hand, interest rates initially go up, reflecting the profit-sharing element that is typical in low income countries. With higher anticipated output, the moneylender raises interest rates as a way of sharing the borrower's expected higher profits. The impact of the profit sharing element, however, is later offset by a reduction in the risk premium on lending rates necessitated by the increase in the probability of success for the high risk borrowers, causing IFS interest rates to decline. Thus, unlike the outcome in Section 3-1 and in agreement with findings in Section 3-2, we observe that interest rates in the formal and informal financial sectors are not changing together in the same direction.

Changing the risk factor (probability of success) for low risk borrowers (from 0.3 to 0.95 or vice versa), we observe that the impulse responses follow the same pattern with differences only in magnitudes. When the probability of success for low risk borrowers is increased from 0.3 to 0.95, the shock on the probability of success for high risk borrowers (characterised by an unexpected increase in the probability of success for the high risk borrowers) causes a larger increase in formal and informal financial sector loans and consequently a larger increase in capital and output. This result lends further support to previous findings that loans in the formal and informal financial sectors are complementary. A larger increase in FFS loans is followed by a larger increase in IFS loans. This occurence may be attributed

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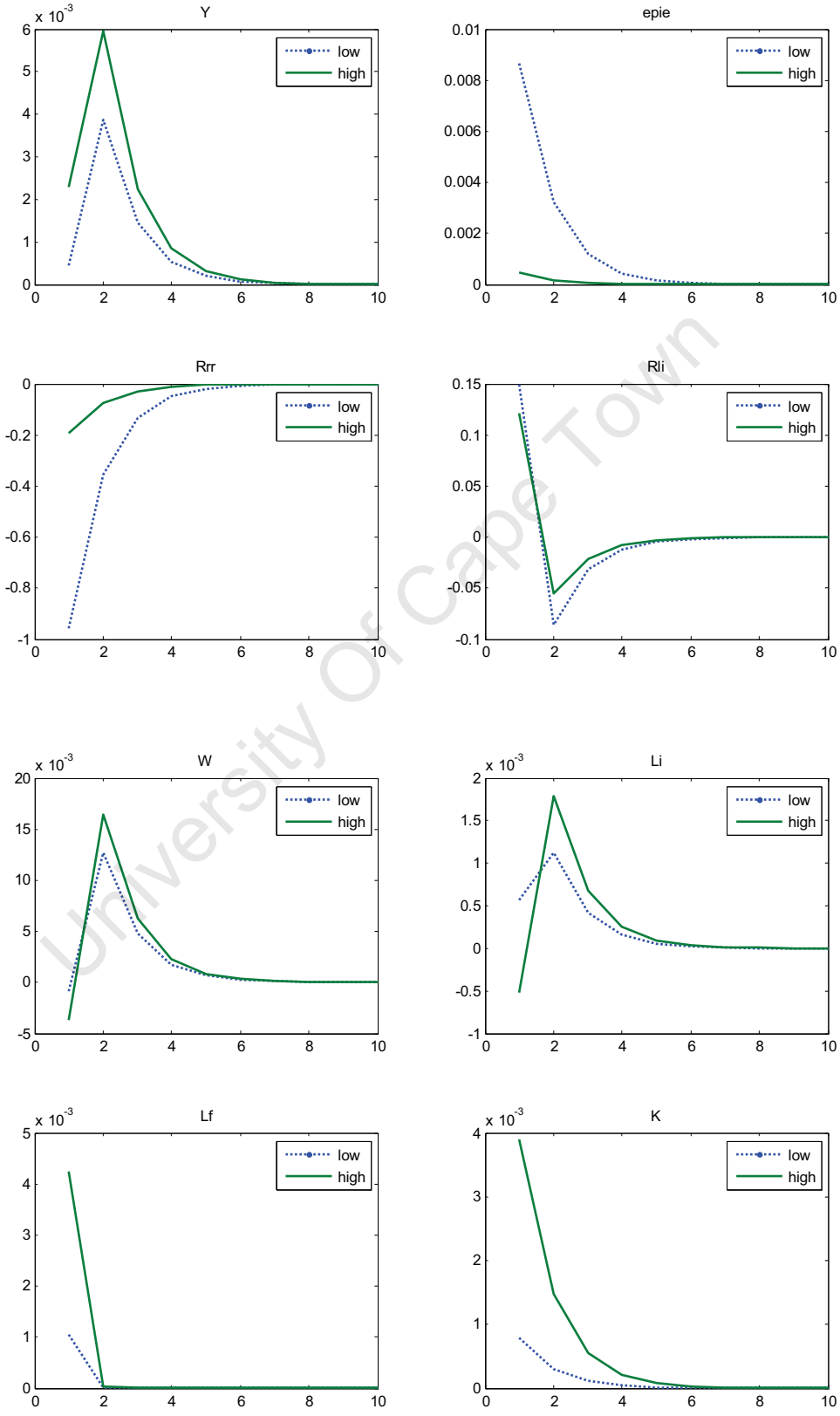
Figure 3-3: Impulse Responses of a Shock on the Probability of Success for High Risk Borrowers with High and Low Probabilities of Success for Low Risk Borrowers



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to a decline in the average risk on loans following the increase in the probability of success for both types of borrowers, everything else remaining equal.

The higher rate of success for low risk borrowers ($\vartheta_{lr} = 0.95$) also leads to a larger reduction in FFS interest rates. This occurs for the same reason as outlined in the foregoing discussion. That is, a higher probability of success for low risk borrowers reduces the average risk on loans, which leads banks to respond by reducing interest rates with a relatively larger margin. The impulse responses of IFS interest rates, however, are observed to be nearly the same whenever the probability of success for low risk borrowers is high ($\vartheta_{lr} = 0.95$) and when it is low ($\vartheta_{lr} = 0.3$). Since we have assumed that there is no information asymmetry in the IFS, the reduction in the rate of success for low risk borrowers following an unexpected increase in the probability of success for high risk borrowers provides little additional information on the risk profile of potential borrowers. Accordingly, there is little justification to adjust IFS interest rates. Again, this finding is consistent with earlier results that changes in FFS interest rates are not necessarily followed by corresponding changes in IFS interest rates.

3.4.4 Inferences

We draw three important inferences from the experiments carried out in the DSGE model. First, the model reveals that although formal and informal financial sector loans may be substitutes in the borrowing firm's utility function, they are in effect complementary in the aggregate. A complementary credit link exists when growth in demand for credit from one sector is accompanied by an increase in demand for credit from the other sector (Chipeta and Mkandawire, 1991). This implies that an increase in capital formation financed by FFS credit creates additional productive capacity that can be utilised only with IFS credit in order to maintain the economy at an equilibrium level (see Aryeetey, 1992; Chipeta and Mkandawire, 1992). Since the IFS provides additional finance to firms in excess of what comes from the FFS, increasing the use of FFS credit increases the demand for credit in the IFS.

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Second, the model shows that interest rates in the IFS are not necessarily driven by FFS interest rates. While interest rates in the two sectors are observed to change together in the same direction following a positive production technology shock, the same is not observed with either a monetary policy shock or a risk factor shock. In the case of a monetary policy shock, the response of IFS interest rates is diametrically opposed to the direction taken by FFS interest rates in response to the shock. The implication of this outcome is that the IFS may frustrate monetary policy. The experiment with a monetary policy shock illustrates this argument. The impact of a monetary policy shock (a sudden increase in the bank rate) is partly offset by a decline in interest rates in the IFS. Following the sudden increase in the bank rate, credit extended by both the formal and informal financial sectors decline. That is, lending in the formal and informal financial sectors remain complementary. The decline in IFS loans, however, is lessened by the drop in IFS interest rates. Clearly, where the size of the IFS is large, its effect in partly offsetting the outcome of monetary policy is likely to be large as well. Thus, countries with a very large IFS may be associated with a relatively lower impact of monetary policy on economic activity.

Third, the model illustrates that the risk factor (probability of success) for both high and low risk borrowers plays an important role in determining the magnitude by which macroeconomic indicators respond to shocks. In the experiments with a positive production technology shock and a monetary policy shock, it is shown that the response of both formal and informal financial sector loans is sensitive to the rate of success for high risk borrowers. The responses of capital stock, output, employment, wage rates and expected prices to each of the two shocks also show sensitivity to the risk factor of high risk borrowers. Similarly, in the experiment with a shock on the risk factor for high risk borrowers, changes in the risk factor of low risk borrowers determine the magnitude by which macroeconomic indicators respond to the shock. Lending in both the formal and informal financial sectors, capital stock, output, wage rates and expected prices respond to the shock on the risk factor for high risk borrowers with different magnitudes depending on whether or not the risk factor for low risk borrowers is low or high.

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3.5 Summary and Conclusions

This chapter set out to investigate the interaction of formal and informal financial sectors and to examine how economic activity is consequently affected. Commencing with the observation that the IFS in low income countries is large and plays a non-trivial role in determining the direction of economic activity, we developed a four-sector macro-monetary DSGE model for analysis. The model demonstrates that while formal and informal sector loans may be substitutes in a borrower's utility function, they are in the aggregate complementary. Thus, increasing the use of FFS credit increases the demand for credit in the IFS. The observed behaviour of formal and informal financial sector interest rates presents another important finding. The model demonstartes that interest rates in the IFS are not necessarily driven by FFS interest rates. When experimenting with a positive production technology shock, interest rates in the two sectors were observed to move together in the same direction while in the experiments involving a monetary policy shock and a risk factor shock, they were not. In the monetary policy shock experiment, the two interest rates were in fact moving in opposite directions. The implication of this finding is that the IFS has the potential to frustrate monetary policy and its impact is likely to be more pronounced in countries where the sector is very large. Finally, the study shows that the risk factor of borrowers is an important determinant of the extent to which macroeconomic indicators respond to various shocks. In all the three experiments demonstrating how selected macroeconomic indicators respond to a positive production technology shock, a monetary policy shock and a shock on the probability of success for high risk borrowers, the model shows that changing the risk factors of either low or high risk borrowers results in most macroeconomic indicators responding with different magnitudes.

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Chapter 4

Banking Instability and Deposit Insurance

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4.1 Introduction

In the previous chapter, it was observed that the IFS in low income countries is not only large, but growing as well and may not be trivial in determining the direction of economic activity. Using a four-sector DSGE model, we demonstrated that formal and informal financial sectors are complements in the aggregate but interest rates in the two sectors do not necessarily change together in the same direction, with the implication that the IFS may, in some instances, frustrate monetary policy. We further found out that indicators of macroeconomic performance are sensitive to the risk factor (probability of success) for both high and low risk borrowers. In this chapter, we change focus and direct attention to the stability of the financial system. In recent years, proliferation of large-scale banking sector problems has raised widespread concern, particularly because banking instability is capable of disrupting the flow of credit to households and enterprises, reducing investment and consumption and possibly forcing viable firms into bankruptcy (Demirgüç-Kunt and Detragiache, 1998). In addition, banking instability has the potential to undermine confidence in domestic financial institutions, which may trigger panic withdrawals of deposits leading to a breakdown of the payments system.

Given the large costs associated with large scale banking instability and the likelihood of banking instability evolving into a systemic banking crisis, many studies have appealed

to the adoption of deposit insurance for stability. In recent years, deposit insurance has become increasingly popular with a large number of countries adopting the scheme in their regulatory framework for banking system stability. The seminal work of Diamond and Dybvig (1983) supported by several subsequent studies (see, for example Hazlett, 1997; Chang and Velasco, 2001; Green and Lin, 2003; Andolfatto, Nosal and Wallace, 2006) rationalises the adoption of deposit insurance as a way of ensuring stability in a fractional reserve banking system. While recent surveys show that high income countries have been more receptive to the implementation of deposit insurance than low income countries (see, for example Demirgüç-Kunt et al., 2005), more cases of banking instability have been recorded in low income countries (see Demirgüç-Kunt and Detragiache, 1998)[1]. Does the absence of deposit insurance explain the high prevalence of banking instability in low income countries relative to their high income counterparts? Or, are low income countries just more prone to banking instability than high income countries? This chapter sets out to answer these and other questions. Using a new empirical framework that distinguishes banking instability triggered by bank runs from banking instability caused by insolvency of banks, we investigate the vulnerability of a country to banking instability given its income level, the role of deposit insurance in achieving banking stability, and the effect of different designs of deposit insurance on banking fragility.

The number of countries with deposit insurance has risen from an estimated nine at the end of the 1960s to about 22 in 1984 and around 88 by 2003 (Demirgüç-Kunt et al., 2005). Some low income countries have also adopted the scheme, including Algeria (1997), Kenya (1988), Nigeria (1988), Republic of Congo (1999), Tanzania (1994), Uganda (1994) and Zimbabwe (2003) in Africa; Bangladesh (1984), India (1961), Indonesia (1998), Philippines (1963), Sri Lanka (1963) and Vietnam (2000) in Asia; and Bahamas (1999), Honduras (1999) and Nicaragua (2001) in the Caribbean and Central America. Underlining its widespread acceptance, deposit insurance became a standard for the single banking market of the European Union in 1994 (Demirgüç-Kunt and Detragiache, 2002) and more recently, the

[1] Refer to footnote 1 for country classification by income group.

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International Monetary Fund (IMF) endorsed a limited form of deposit insurance in its code of best practices while the World Bank has recommended the scheme to several countries (see Demirgüç-Kunt, Kane and Laeven, 2008; Folkerts-Landau and Lindgren, 1998).

A recent survey carried out by Demirgüç-Kunt et al. (2005) shows that a majority of the countries that have adopted deposit insurance are middle to high income. According to the survey, by 2003, 60.71 percent of the upper middle income and 75 percent of the high income countries had adopted deposit insurance compared to only 16.39 percent of the low income countries. The survey further reveals that 74.07 percent of the countries in Europe and Asia had deposit insurance by 2003 while in Sub-Saharan Africa (SSA), the poorest region in the world, only 10.87 percent of the countries had adopted the scheme.

Countries adopting deposit insurance aim at minimising the risk of banking instability arising from self-fulfilling expectations[2]. The seminal paper by Diamond and Dybvig (1983) demonstrates that in a fractional reserve banking system, full deposit insurance is able to rule out bank runs, which are self-fulfilling prophecies of depositors. In the absence of such deposit insurance, rumours that a bank is on the brink of failure lead to fears (expectations) that the bank may not be able to repay all depositors in full and on time because its funds are tied up in loans and other interest earning assets that cannot be easily converted into cash. This prompts the depositors to rush and simultaneously attempt to withdraw all their deposits before the bank runs out of cash, bringing about failure of the bank and hence fulfillment of the prophecy. In the model, it is shown that complete deposit insurance raises public confidence in the banking system and eliminates depositors' concerns about the safety of their funds in the event of bank failure. Thus, deposit insurance is rationalised directly and indirectly. Directly, it protects depositors as users of banking products and services, and

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[2] In the literature, there are two main theoretical views on the causes of banking instability, namely the fundamental banking instability view and the self-fulfilling view. While the fundamental banking instability view perceives banking instability as a consequence of poor economic performance, the self-fulfilling view regards them as a realisation of a bad equilibrium arising from self-fulfilling expectations in a multiple equilibria framework (see Fontenla and Gonzalez, 2007). In this paper, analysis is based on the self-fulfilling view while controlling for elements of the fundamental banking instability approach.

indirectly, it reduces the risk of a systemic crises involving, for example, panic withdrawals of deposits from sound banks and breakdown of the payments system (MacDonald, 1996).

Deposit insurance, however, also creates a moral hazard problem by freeing economic agents from the consequences of their actions (see Calomiris, 1990; Gennote and Pyle, 1991; MacDonald, 1996) on both the liability and asset sides of a bank's balance sheet. On the liability side, depositors no longer feel obliged to assess the credit-risk associated with depositing money in a particular bank and end up choosing a bank based on the attractiveness of interest rates on offer rather than the bank's financial condition; while on the asset side, the knowledge that depositors will not suffer in the event of bank failure persuades banks to pursue high return risky business strategies more than they otherwise would (MacDonald, 1996). Consequently, the discipline of the market is removed. Excess risk taking by existing commercial banks is encouraged and depositors of insured institutions have little incentive to discriminate with respect to where and with whom they place their funds (Calomiris, 1990).

A number of empirical studies, notably the influential work of Demirgüç-Kunt and Detragiache (2002), have supported the view that moral hazard, arising from the adoption of deposit insurance, is dominant in a general equilibrium framework. Demirgüç-Kunt and Detragiache (2002) demonstrate that deposit insurance increases banking fragility and they conclude that transmission occurs through the moral hazard problem. They further find that a more generous deposit insurance scheme creates additional moral hazard problems which in turn increase banking fragility. Related work with similar findings has been carried out by Wheelock and Wilson (1995), Carapella and Di Giorgio (2004) and Cull et al. (2005), among others.

The validity of some of these findings, however, has been challenged by events. Studies indicate that most cases of banking instability have occurred in low income countries, very few of which have adopted deposit insurance. In a sample of 65 countries covering the period 1980-1994, Demirgüç-Kunt and Detragiache (1998) identified 31 episodes of systemic banking instability of which 23 took place in developing countries while only 8 were recorded

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in developed countries. This is contrary to the notion that countries with deposit insurance are more vulnerable to banking instability arising from the moral hazard problem. The United Kingdom (UK) and United States of America (USA), where deposit insurance is compulsory but coverage is only partial, provide further counter-examples. Northern Rock Bank in the UK was hit by a run on September 14, 2007, which subdued in the afternoon of September 17, 2007 when the Chancellor of the Exchequer announced that the Bank of England would provide full coverage to all deposits held in the bank. In the US, deposit insurance payment was raised from US$100,000 to US$250,000 per deposit in the thick of the subprime mortgage crisis in 2008[3]. Both cases suggest that a less generous deposit insurance may trigger or heighten banking instability.

To disentangle the conflicting predictions, we develop a new empirical framework where we distinguish banking instability initiated by a bank run or panic withdrawals of deposits, and banking instability initiated by the insolvency problem of banks. We then estimate a baseline model whose objectives are threefold: to investigate the vulnerability of a country to banking instability given its income level, to establish the vulnerability of African countries to banking instability relative to other countries, and to examine the role of deposit insurance in achieving banking system stability. The study also explores whether the generosity of deposit insurance payouts increases the likelihood of banking instability. This analysis is carried out by testing the proposition that relative to deposit insurance with limited guarantee, full deposit insurance minimises the likelihood of banking instability (due to bank runs and the insolvency problem of banks), which is a re-statement of the Diamond and Dybvig (1983) hypothesis. We further examine the impact of extending coverage of deposit insurance to foreign exchange and interbank deposits on banking instability. In addition, we test the prediction that banking fragility is affected by the legal authority

[3]In response to the subprime mortgage crisis, the Federal Deposit Insurance Corporation (FDIC) in the US increased deposit insurance only temporarily, covering the period October 2008 to December 2009, from US$100,000 to US$250,000. The standard coverage limit would return to US$100,000 per deposit on January 1, 2010. In May 2009, Congress extended the $250,000 level to December 31, 2013 (see Alert, 2010).

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vested in a deposit insurance agency. Specifically, we examine how banking instability is affected by granting the deposit insurance agency the authority to make a decision to intervene in the bank's affairs, take legal action against bank directors or other bank officials and cancel or revoke deposit insurance for any participating bank. Finally, we analyse how banking instability is affected by the manner and style in which a deposit insurance fund is administered. In particular, the chapter examines the effect of the presence or absence of a coinsurance mechanism, whether membership of a deposit insurance scheme is compulsory or voluntary, whether the scheme has a permanent fund or not, whether it is funded by the government, the private sector or jointly by both, whether premiums are adjusted to risk or not, and whether it is administered by the private or public sector or both sectors jointly.

The rest of the chapter is organised as follows. Section 4.2 discusses the interrelationships among deposit insurance, moral hazard and banking instability. An overview of the estimation methodology, data analysis techniques, scope of coverage, data sources and variables is presented in Section 4.3. Estimation results and inferences are outlined in Section 4.4. A summary and conclusion follow in Section 4.5.

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4.2 Deposit Insurance, Moral Hazard and Banking Instability

4.2.1 Deposit Insurance

Deposit insurance can be explicit (formal) or implicit (ad hoc). With explicit deposit insurance, countries formally commit in advance to guaranteeing some or all of the deposits of failed banks, usually through legislation (McCoy, 2007). Banks may also purchase full or partial insurance on behalf of depositors from a government agency or from a private insurer (Demirgüç-Kunt and Detragiache, 2002). An implicit system of deposit protection, on the other hand, is not planned in advance. It is created if monetary authorities are willing to take measures that would protect depositors in the event of one or two isolated bank failures, which gives rise to a presumption that they will take similar action in subsequent

cases (MacDonald, 1996). Accordingly, depositors (correctly) believe that the government will either prevent banks from failing, or that in the case of failure, it would step in and compensate them for their losses (Demirgüç-Kunt and Detragiache, 2002). In this study, we focus on explicit deposit insurance. The term 'deposit insurance,' therefore, is used to imply 'explicit deposit insurance,' unless otherwise required to unambiguously distinguish it from implicit deposit insurance.

In most cases, a deposit insurance scheme is viewed as a supplement to other official measures such as systems of bank licensing and supervision, which are designed to protect bank depositors from the risk of loss or to contain that risk (MacDonald, 1996). Thus, even with deposit insurance in place, the central bank continues to provide bank supervision services and playing the role of lender of last resort. The central bank lending is widely regarded as part of a public safety net that supports the stability of the banking system since the bank can avert liquidity crises by providing large amounts of liquidity at short notice (Marini, 2003)

Consistent with Bagehot's principle, the central bank as a lender of last resort is presumed to lend only to illiquid but solvent banks (see, for example Fischer, 1999; Freixas, Giannini, Hoggarth and Soussa, 2000; Wood, 2003; Rochet and Vives, 2004; Kahn and Santos, 2005). In the wake of a run on a bank, the central bank provides credit to pay off depositors without having to liquidate the bank's assets. Deposit insurance, on the other hand, ensures that all depositors are paid off to the coverage limit even if all the bank's assets have been liquidated. The complementary roles of deposit insurance and the central bank's lender of last resort function, therefore, ensure that depositors do not 'run' on banks, whether they are illiquid or insolvent.

Since the first recorded scheme in history[4], deposit insurance has been rationalised by the desire to instil confidence among depositors in the safety of their funds, and conse-

[4]The first recorded deposit insurance in history is the New York Safety Fund in the US, which was established in 1829, funded by limited annual contributions of members and regulated by the state government (see Calomiris, 1990)

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quently guard against panic withdrawals of deposits and breakdown of the payments system, which may adversely affect the production sector of the economy. A seminal paper by Diamond and Dybvig (1983) demonstrates that full deposit insurance is able to rule out bank runs. The paper argues that while uninsured demand deposit contracts are able to provide liquidity, they leave banks vulnerable to multiple equilibria, one of which is a bank run where all depositors panic and immediately withdraw their funds because of concerns about the possibility of the banks failing. Since deposit insurance provides a safe asset to depositors, they do not rush to withdraw their deposits from insolvent banks, consequently preventing the costly liquidation of the banks' assets that can aggravate the banks' insolvency (Marini, 2003). In a later study, Diamond and Dybvig (1986) re-affirm that deposit insurance is the only known effective measure to prevent bank runs.

4.2.2 Moral Hazard

While deposit insurance may be regarded as a tool for stopping or minimising bank runs, it is also a source of moral hazard for excessive risk taking, which in turn may lead to more bank failures. With deposit insurance, banks are encouraged to finance high-risk, high-return projects as their ability to attract deposits no longer reflects the risk of their asset portfolio (Demirgüç-Kunt and Detragiache, 2002). This crop-up of moral hazard with deposit insurance has been widely supported in the empirical literature. For instance, Demirgüç-Kunt and Detragiache (2002) conclude that moral hazard matters based on the finding that deposit insurance tends to increase the likelihood of banking instability. Laeven (2002) observed that the cost of deposit insurance has some power in predicting bank failures, which he interpreted as evidence of support for the view that deposit insurance creates moral hazard for banks. His results further show a strong positive correlation between credit growth and the cost of deposit insurance, against which he concludes that deposit insurance promotes excessive risk taking behaviour.

In a study of Kansas, Wheelock and Wilson (1995) found that deposit insurance membership increases the probability of bank failure, consistent with the hypothesis that insurance

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encourages banks to hold higher risk portfolios than they otherwise would. Similar findings are reported by Carapella and Di Giorgio (2004), who demonstrate that deposit insurance increases the lending-deposit spread in banking, the main effect of which arises not from the deposit side, but from an increase in the lending rate. They interpret this result as evidence of the presence of moral hazard behaviour emanating from deposit insurance. Cull et al. (2005) use the volatility of credit to the private sector as a proxy for risk in a cross-country analysis and establish that the decision to introduce deposit insurance increases the volatility of credit and hence risky behaviour in the financial sector, particularly in countries with weak institutions.

4.2.3 Banking Instability

Banking instability can be characterised by a bank run or insolvency of banks. In a bank run, depositors rush to withdraw their deposits in full following expectations of looming bank failure, consequently forcing the bank to liquidate its assets at a loss and fail indeed. A number of studies have presented various explanations of the trigger mechanism of bank runs. Among the earliest are Fischer (1911) and Bryant (1980), who hold that a bank run occurs when the value of the bank's total assets falls short of its holdings of deposits, which incites depositors to rush and quickly withdraw their deposits in order to cut their losses. Diamond and Dybvig (1983) have also argued that a bank run is caused by a shift in expectations, which could depend on almost anything (referred to as sunspots run equilibrium) (see Diamond and Dybvig, 1983; Adao and Temzelides, 1998; Carmona, 2004).

In yet another explanation, Chari and Jagannathan (1988) maintain that a bank run can occur even if no one has any adverse information about future returns of a bank. The essence of the model is that if individuals observe long queues of depositors at a bank, regardless of the information content held by the people on queues, they correctly infer that there is a possibility that the bank is about to fail and precipitate a bank run. Unlike the Diamond and Dybvig (1983) model which presents a bank run as a bad equilibrium in a series of possible multiple equilibria, the Chari and Jagannathan (1988) framework models

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a bank run as an equilibrium phenomenon in a formulation where all equilibria have bank runs.

Banking instability can also show up in the form of insolvency of banks characterised by large amounts of unanticipated non-performing loans. A bank is insolvent whenever its assets are less than its liabilities to the extent that it is unable to pay depositors. Kim and Santomero (1988) define bank insolvency as an event where a bank's equity capital is completely eliminated. A bank may still be regarded as insolvent even if its total assets exceed its total liabilities but the assets cannot be readily converted into cash.

4.3 Methodology and Data

4.3.1 Data and Data Sources

The study is carried out using a panel dataset covering 118 countries over the period 1980-2004. The choice of both the number of countries and cut-off dates has been dictated by data availability. We started off with 211 countries defined as such by the World Bank and eliminated all countries where data for selected macroeconomic indicators was not available, losing 93 countries in the process (see Appendix B, Section B.1 for a list of countries in the sample). The World Development Indicators (WDI), a World Bank database of economic and demographic indicators, was used as a primary source for this data. Additional data for the selected macroeconomic indicators was sourced from International Financial Statistics (IFS), an International Monetary Fund (IMF) database. Deposit insurance data was collected from Demirgüç-Kunt et al.'s (2005) comprehensive database of deposit insurance around the world.

In the sample, only 12 countries had deposit insurance at the beginning of the study period in 1980. Among the 12, only two were low income countries and none was African. The total number of countries with deposit insurance rose to 27 by 1990 and 52 by 2003 with low income countries and African countries also increasing to six and two, respectively by 1990 and 14 and six, in that order by 2003 (see Table 4.1).

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Table 4.1: Summary Statistics of Deposit Insurance Around the World

	1980		1980-1985		1986-1990		1991-1995		1996-2000		2001-2004	
	LICs	HIC	LIC	HIC	LIC	HIC	LIC	HIC	LIC	HIC	LIC	HIC
Number of countries with deposit insurance	2	10	3	16	6	21	9	25	12	34	14	38
Proportion of countries with deposit insurance	3.85	18.18	6.12	27.59	12.50	35.59	24.32	35.71	33.33	47.89	40.00	52.78
Number of countries with unlimited guarantee (full) deposit insurance	0	3	0	3	0	4	0	5	1	8	1	5
Number of countries with coinsurance	0	3	0	4	0	6	0	7	0	8	0	8
Number of countries with risk adjusted premiums of deposit insurance	0	1	0	2	0	3	0	6	0	7	0	7
Number of countries with deposit insurance covering foreign exchange deposits	2	8	3	11	3	15	4	21	4	27	5	27
Number of countries with deposit insurance covering interbank deposits	1	1	2	1	3	1	4	1	5	3	5	3
Number of countries with deposit insurance with a permanent fund	2	8	4	11	7	15	7	22	7	30	8	31
Number of countries with a compulsory membership deposit insurance	2	8	4	11	5	18	6	26	6	34	8	34

NOTE: - LIC stand for low income countries and HIC for high income countries

- All figures are for end period

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Table 4.2: Deposit Insurance Features in Low Income Countries (1980-2004)

Country	Year Enacted	Coverage Limit (2003 US$)	Payment per Deposit[1]	Coinsurance	Risk Adjusted Premium
Bahamas	1999	50,000	Yes	No	No
Bangladesh	1984	1,021	Yes	No	No
Congo, Rep.	1994	-	-	-	-
Honduras	1999	14,429	No	No	No
India	1961	2,193	No	No	No
Indonesia	1998	Full	-	-	-
Kenya	1988	1,313	No	No	No
Nicaragua	2001	20,000	No	No	No
Nigeria	1988	366	No	No	No
Philippines	1963	1,800	No	No	No
Sri Lanka	1987	1,034	No	No	No
Tanzania	1994	235	No	No	No
Uganda	1994	1,550	No	No	No
Zimbabwe	2003	3,640	No	No	-

Country	Permanent Fund[2]	Foreign Exchange Covered	Interbank Deposits Covered	Compulsory Membership	Government/ Private/Joint Funding
Bahamas	Yes	No	No	Yes	Private
Bangladesh	Yes	No	No	Yes	Joint
Congo	-	-	-	-	-
Honduras	Yes	Yes	Yes	Yes	Joint
India	Yes	Yes	No	Yes	Joint
Indonesia	-	-	-	-	-
Kenya	Yes	Yes	Yes	Yes	Joint
Nicaragua	Yes	Yes	No	Yes	Private
Nigeria	Yes	No	Yes	Yes	Joint
Philippines	Yes	Yes	Yes	Yes	Joint
Sri Lanka	Yes	No	No	No	Joint
Tanzania	Yes	Yes	Yes	Yes	Joint
Uganda	Yes	No	No	Yes	Joint
Zimbabwe	Yes	No	No	Yes	Joint

Source:Demirgüç-Kunt et al. (2005)

[1]Payment can be per deposit (Yes) or per depositor (No)

[2]The alternative to a permanent fund is a non-funded system

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While low income and African countries appear to have kept pace with high income countries with regard to the speed with which they have adopted deposit insurance, the numbers in the former are small in comparison to the latter (see also Table 4.2). Propor-

tionately, the number of low income and African countries is lagging behind high income countries in the adoption of deposit insurance. Whereas 44 percent of the countries in the sample had deposit insurance by 2003, only 29 percent of the low income and 17 percent of African countries (in the sample) had adopted the scheme.

The data shows that deposit insurance with unlimited coverage (full guarantee) is not popular. It had been adopted only in six of the 52 countries with deposit insurance (in the sample) of which only one, Indonesia, is low income, as at 2003. Coinsurance and risk adjusted deposit insurance schemes are also rare. In our sample, there were only eight countries with coinsurance mechanisms and seven with risk adjusted premiums, none of which was low income or African as at 2003 (see Table 4.2 for deposit insurance features in developing countries).

We further observe that a large number of countries extend coverage of deposit insurance to include foreign exchange deposits (30 of the 52 countries in the sample) while only a few (8 of the 52 countries in the sample) extend coverage to include interbank deposits. Whereas this is a general impression for the whole sample, the picture in low income countries is somewhat different, depicting a fairly even distribution. A total of six low income countries extended coverage to include foreign currency deposits compared to five who did not; and another set of five low income countries included interbank deposits in their deposit insurance coverage, while six did not, as at 2003.

Furthermore, we observe that most deposit insurance schemes have a permanent fund. In our sample, 38 countries out of 52, including all the low income countries with deposit insurance, have a permanent fund in place. On the whole, countries prefer compulsory membership to their deposit insurance systems. Against the 52 countries that adopted deposit insurance in the sample, as at 2003, a total of 40 countries had compulsory membership; and, with the exception of Sri Lanka, all low income countries that had deposit insurance had compulsory membership.

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4.3.2 Measures of Banking Instability

To quantify banking instability, we build on the ideas of Eichengreen, Rose and Wyplosz (1995; 1996a; 1996b) and Von Hagen and Ho (2007). Using monthly time series data, we compute deseasonalised growth rates of demand deposits (DD_t) and time deposits (TD_t) to construct an indicator of bank runs ($brun1_t$); demand deposits, time deposits and foreign liabilities (FL_t) to compute a second indicator of bank runs ($brun2_t$); and credit extended to the private sector (CR_t) to calculate an indicator of insolvency ($insolv_t$). The deseasonalised growth rates of demand deposits (gr_DD_t), for instance, are computed as:

$$gr_DD_t = \left(DD_t - DD_{t-12}\right)/DD_{t-12} \tag{4.1}$$

Deseasonalised growth rates for time deposits (gr_TD_t), foreign liabilities (gr_FL_t) and credit to the private sector (gr_CR_t) are calculated analogously, replacing DD_t with TD_t, FL_t and CR_t, respectively. Next, we compute an index of bank runs (with foreign liabilities excluded in the definition of total deposits) using the formula:

$$run1_t = \left[\left(\frac{gr_DD_t - \overline{gr_DD_t}}{\sigma_{gr_DD_t}}\right) + \left(\frac{gr_TD_t - \overline{gr_TD_t}}{\sigma_{gr_TD_t}}\right)\right]/2 \tag{4.2}$$

where $\overline{gr_DD_t}$ and $\overline{gr_TD_t}$ are mean growth rates and $\sigma_{gr_DD_t}$ and $\sigma_{gr_TD_t}$ are standard deviations of deseasonalised growth rates of demand and time deposits, respectively. An index of bank runs (with foreign liabilities included in the definition of total deposits) is calculated using a similar formula:

$$\begin{aligned} run2_t \;=\; \Bigg[& \left(\frac{gr_DD_t - \overline{gr_DD_t}}{\sigma_{gr_DD_t}}\right) + \left(\frac{gr_TD_t - \overline{gr_TD_t}}{\sigma_{gr_TD_t}}\right) + \\ & \left(\frac{gr_FL_t - \overline{gr_FL_t}}{\sigma_{gr_FL_t}}\right) \Bigg]/3 \end{aligned} \tag{4.3}$$

where $\overline{gr_FL_t}$ and $\sigma_{gr_FL_t}$ are mean growth rate and standard deviation of deseasonalised growth rate of foreign liabilities, respectively; and an index of insolvency ($solv_t$) is calculated using the formula:

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$$solv_t = \left(\frac{gr_CR_t - \overline{gr_CR_t}}{\sigma_{gr_CR_t}} \right) \tag{4.4}$$

where $\overline{gr_CR_t}$ and $\sigma_{gr_CR_t}$ are mean growth rate and standard deviation of deseasonalised growth rate of credit extended to the private sector, respectively. Given that bank runs and insolvency are generally characterised by a sharp decrease in bank deposits and credit extended to the private sector, in that order, we use extreme values of $run1_t$, $run2_t$ and $solv_t$ to calculate measures of bank runs and insolvency denoted as $brun1_t$, $brun2_t$ and $insolv_t$, respectively. We distinguish between narrow and broad definitions of banking instability described by the three measures. We define the narrow measure of banking instability ($nbrun1$, $nbrun2$ and $ninsolv$) as cases where the calculated indices ($run1$, $run2$ and $solv$, respectively) fall within the lowest 5 percent of the data and we let the measure take the value 1 reflecting a period of banking instability. When the calculated indices fall within the highest 95 percent of the data, we classify this as a period of banking stability and the measure takes the value zero. The broad definition is characterised analogously. The indices take the value 1 if they fall within the lowest 10 percent of the data, which we define as a period of banking instability, and zero otherwise.

Converting the data from monthly to annual frequency, we commence with an attempt to construct a trichotomous variable for each classification of banking instability. We describe any year that has no recording of banking instability as a year of banking stability and the variable takes the value zero; a year that has six or less months of recorded banking instability is defined as a year of moderate banking instability and the variable gets the value one; and a year that has more than six months of recorded banking instability is identified as a year of severe banking instability and the variable gets the value two[5]. Table 4.3 reports the proportionate distribution of banking stability, moderate banking instability and severe banking instability for the three classifications of banking stability/instability.

[5]The six-month classification of a severe banking instability is in line with the standard dating of a recession as two consecutive quarters of declining real GDP(see Bloomberg.Com, 2000; BusinessDictionary.com, 2007-2008).

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Table 4.3: Proportionate Distribution of Banking Stability and Instability (1980-2004)

	*brun*1		*brun*2		*insolv*	
	*nbrun*1	*bbrun*1	*nbrun*2	*bbrun*2	*ninsolv*	*binsolv*
Banking Stability	87.14	78.14	95.18	90.42	88.74	83.74
Moderate Banking Instability	10.35	16.46	4.16	7.75	8.96	12.64
Severe Banking Instability	2.51	5.40	0.66	1.83	2.30	3.62

The table shows that observations of severe banking instability are consistently less than five percent of the total observations except in the case of bank runs broadly defined with foreign liabilities excluded in the definition of total deposits. On this basis, we drop the three-layered dummy variable and settle for a simple zero/one dummy variable. Any year that has no recording of banking instability is defined as a year of banking stability and the variable takes the value zero; while a year that has at least a month of recorded banking instability is defined as a year of banking instability and takes the value one.

To ascertain that our indicators of banking instability are measuring what is intended, we compare our data with similar data compiled in other studies. Table (B.28) in Appendix B, Section B.4 present insolvency narrowly and broadly defined (*ninsolv* (shortened to *ni*) and *binsolv* (shortened to *bi*), respectively) alongside major bank insolvencies identified by Caprio and Klingebiel (1997) in selected countries. The table shows that most of Caprio and Klingebiel's (1997) identified insolvencies are captured in our measures of banking instability. The few cases that do not match between the two datasets are a consequence of definitional differences between our measures of insolvency and Caprio and Klingebiel's (1997) measures of insolvency[6].

Figures (B-4) - (B-5) in Appendix B, Section B.4 present all measures of banking instability used in this study (bank runs (with and without foreign liabilities included in the definition of total deposits) and insolvencies, narrowly and broadly defined) alongside

[6] Caprio and Klingebiel (1997) define insolvency as a case where the net worth of the banking system has been almost or is entirely eliminated.

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major historical financial crises in graphic format. The four charts in Figures (B-4) - (B-5) show a high degree of correlation between our six measures of banking instability and the recorded major financial crises, indicating that the six measures are indeed capturing banking fragility as intended.

A zero-order correlation matrix for the constructed indicators of banking instability is presented in Table B.1, Appendix B, Section B.3. The table shows that there is a high degree of cross correlation between the narrow and broad definitions of each of the classifications of banking instability. This is not unexpected since the broad definitions contain all the information in the corresponding narrow definitions of banking instability plus some additional information. The table also shows that the cross correlations between insolvency and bank runs are relatively higher when foreign liabilities are excluded from total deposits than when they are included, suggesting that commercial banks with large foreign liabilities are less likely to suffer from insolvency in the wake of bank runs than banks with low or no foreign liabilities; and that insolvent banks with high levels of foreign liabilities have higher chances of escaping bank runs than similar banks with low or no foreign liabilities.

On the whole, however, the correlations between the four identifiers of banking instability show relatively low cross correlations, indicating that banking instability may occur due to insolvency or bank runs only. That is, the two need not necessarily occur together. This finding demonstrates the importance of distinguishing between the two forms of banking instability, an approach that has been adopted in this study.

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4.3.3 Control Variables

We use six control variables, namely, growth of real gross domestic product (GDP) ($gdpgr$), real interest rates (rir), inflation rates ($inflatn$), ratio of M2 to foreign exchange reserves ($m2fxres$), ratio of private sector credit to real GDP ($crgdp$) and exchange rate depreciation ($xrdepr$) to control for macroeconomic factors that are expected to have a significant impact on banking fragility (the fundamental banking instability view) (see Appendix B, Section

B.2 for brief definitions of variables used in the model and how they have been measured). Following Demirgüç-Kunt and Detragiache (2002), inflation, real GDP growth and real interest rates are used to capture macroeconomic developments that are likely to affect the quality of bank assets. Higher values of real GDP growth reflect a higher ability of borrowers to repay their loans while higher inflation rates entail higher operating costs and a lower ability of borrowers to repay their loans. Real interest rates are expected to have an adverse effect on banks' profitability through their impact on the cost of funds. Besides being associated with high default rates, high real interest rates indicate high cost of funds to banks. Since bank loans and other assets are usually fixed over long periods, rising real interest rates push up the cost of funds, adversely affecting the liability side of the banks' balance sheets and consequently squeezing the banks' profits.

Exchange rate depreciation and the ratio of M2 to foreign exchange reserves are used to capture commercial banks' vulnerability to sudden capital outflows triggered by a run on the currency and the banks' exposure to foreign exchange risk (Demirgüç-Kunt and Detragiache, 2002). Demirgüç-Kunt and Detragiache (2002) argue that since deposit insurance guarantees the domestic value of deposits and not their foreign currency value, the expectation of a devaluation triggers withdrawals of domestic currency deposits to purchase foreign assets even in the presence of deposit insurance. Finally, the ratio of private sector credit to GDP is used to capture the level of the private sector's indebtedness to commercial banks relative to the size of the economy. An increasing ratio of private sector credit to GDP signals increasing private sector indebtedness relative to the size of the economy and very high values of the ratio may depict over-indebtedness, which may result in widespread bankruptcy and consequent banking instability with borrowers unable to repay their loans (see Table B.2 in Appendix B, Section B.3 for a summary of expected signs of variables used in the regressions).

A zero-order correlation matrix of the control variables for the study sample period 1980-2004 is presented in the upper part of Table $B.3$ in Appendix B, Section B.3. The table shows very low correlation coefficients, the highest being 0.21, which is about a quar-

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ter of what is generally regarded as a quick reference point for high multicollinearity[7]. The control variables plus real GDP per capita (*gdppc*), an Africa dummy ($africa$) and deposit insurance (*dinsur*) are used to estimate a baseline model. Real GDP per capita is used to investigate the relationship between a country's level of income and the probability of banking instability. Higher values of real GDP per capita indicate higher levels of development and fairly developed financial structures, which are expected to be associated with low levels of banking instability. The Africa dummy, which takes the value one for African countries and zero otherwise, measures the vulnerability of African countries to banking instability. African countries are expected to have high levels of non-performing loans, poorly regulated financial systems and an ineffectual cushion against shocks as characterised by the absence of complex financial instruments and limited access to international financial markets. It is anticipated, therefore, that African countries should, in general, depict greater vulnerability to banking instability than non-African countries.

Finally, the deposit insurance variable is used to investigate the effect of deposit insurance on banking instability. A simple dummy variable, which takes the value 1 when a country has deposit insurance and zero otherwise, is used. As explained in Sections 4.1 and 4.2, the theory in inconclusive on whether deposit insurance destabilises or stabilises the banking system. Most empirical studies, albeit without distinguishing between banking instability caused by bank runs and and banking instability caused by insolvency of banks, have found that deposit insurance increases the vulnerability of a banking system to instability (see Gonzalez-Hermosillo, Pazarbasioglu and Billings, 1997; Demirgüç-Kunt and Detragiache, 1998; Demirgüç-Kunt and Detragiache, 2002). Since our approach is different, we investigate this relationship again. Prior to estimating the baseline model, we check the degree of correlation between the control variables and the three additional variables (*gdppc*, $africa$ and *dinsur*). A zero order correlation matrix presented in Table $B.3$ in Appendix B, Section B.3 shows that multicollinearity may not be a problem in the baseline model.

[7] Gujarati (2003, pp. 359) states that as a rule of thumb, if the pairwise or zero order correlation coefficient between two regressors is in excess of 0.8, then multicollinearity is a problem.

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4.3.4 Deposit Insurance Variables

To examine the behaviour of banking instability in relation to certain features of deposit insurance, we estimate four sets of equations, each characterising particular features in the design of deposit insurance, namely, generosity of payouts, coverage, legal environment and administration of the deposit insurance. 'Generosity of payouts' is represented by a single variable, *guarantee*, which takes the value one if a country has full deposit insurance (unlimited guarantee) and zero if the deposit insurance scheme provides partial coverage (limited guarantee). In any deposit insurance scheme, the amount of coverage matters since it directly affects market discipline exerted by depositors (Demirgüç-Kunt et al., 2005). From the depositors' point of view, the most attractive scheme is one which provides the most generous payouts for those types of deposit which qualify (MacDonald, 1996). Increasing the generosity of deposit insurance payouts reassures depositors that higher proportions of their deposits are protected in the event of bank failure, and effectively minimises any incentives the depositors may have of running on a bank on rumours that the bank is on the brink of failure. In the extreme case, Diamond and Dybvig (1983) demonstrate that full deposit insurance completely rules out bank runs. The theory, however, also counter argues that the moral hazard problem is at the maximum when the coverage of deposit insurance is unlimited (MacDonald, 1996). Effectively, full deposit insurance takes away any incentives from depositors to monitor the financial soundness of their bankers. The banks, on their part, are incentivised to undertake more risky high return projects on the basis that their customers may suffer reduced losses in the event of failure of the projects. The sign of the marginal effects of *guarantee* on banking instability, therefore, cannot be determined *a priori*. Full deposit insurance is expected to be associated with a marginally low likelihood of banking instability if the Diamond-Dybvig (1983) hypothesis is correct; whereas if the moral hazard problem dominates, partial deposit insurance will be associated with a high probability of banking instability.

'Coverage' is captured in two variables namely, whether or not interbank deposits are covered (*intbank*) and whether or not foreign currency deposits are covered ($fxcoverd$).

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Countries with deposit insurance need to decide on the type of deposits to be covered and the sort of financial institutions to be included or excluded from the coverage. Due to data limitations, our analysis is limited to coverage of deposit types and we focus on the impact of covering interbank and foreign currency deposits on banking fragility. While a more comprehensive coverage provides a better guarantee against depositor runs, the theory suggests that it also creates more incentives for excessive risk taking (Demirgüç-Kunt and Detragiache, 2002). Exclusion of interbank deposits in the coverage of insured deposits, for instance, may increase the probability of banking instability because banks, who are regarded as the most well informed depositors, are now without protection and may lead a run at the slightest suspicion of failure in one of the banks holding their deposits. Also, in the event that one bank fails, other banks that had placed deposits in the failing bank would sustain losses that would weaken their financial position, making them susceptible to failure too (see Talley and Mas, 1990). Inclusion of the interbank deposits in the coverage of insured deposits, on the other hand, may also increase the likelihood of banking instability, since the banks now have no incentive to monitor each other's financial conditions. In the process, market discipline deteriorates leading to excessive risk-taking behaviour by the banks. Interchanging the terms 'exclusion' and 'inclusion' reverses the argument. On the balance, therefore, it is not clear if extending insurance coverage to interbank deposits will increase or decrease the likelihood of banking instability.

In the case of foreign currency deposits, some studies suggest that their inclusion in deposit insurance coverage will make a banking system more vulnerable to instability (Demirgüç-Kunt and Detragiache, 2002). Coverage of foreign currency deposits may also serve to reassure depositors of the safety of their funds. While this reassurance may take away the depositors' incentives to monitor the financial soundness of their bankers, leading to increased risk-taking behaviour by the banks and hence a higher probability of banking instability, it may also prevent bank runs. Even in the wake of news that a bank is likely to fail, the depositors may not run on the bank because they are assured of the safety of their funds. The expected sign of the variable, therefore, is indeterminate *a priori.*

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'Legal environment' answers the following questions:

(i) Does the deposit insurance authority make the decision to intervene in a bank's affairs (*interven*)?

(ii) Does the deposit insurance authority have the legal power to cancel or revoke deposit insurance for any participating bank (*leglcancel*)?

(iii) Can the deposit insurance agency/fund take legal action against bank directors or other bank officials (*leglmgr*)?

An explicit deposit insurance scheme founded on a sound legal system with proper enforcement mechanisms is *a priori* expected to command credibility. Banks are likely to be restrained from indulging in certain activities that interfere with banking stability while depositors are reassured of the safety of their funds even in the event of bank failure. The expected outcome, therefore, is banking stability. This state, however, may also create moral hazard. With a credible deposit insurance scheme, depositors are no longer persuaded to place their deposits in banks chosen on the basis of their financial condition. They will probably choose banks solely in accordance with the interest rates they offer; and banks, on their part, may follow more risky business strategies than they otherwise would, given the knowledge that depositors will not suffer in the event of bank failure (MacDonald, 1996). For these reasons, the expected signs of the legal environment indicators are indeterminate *a priori*.

'Administration' is covered in six variables, namely, whether the deposit insurance is administered by government, by the private sector or jointly by government and the private sector (*admin*); whether there is coinsurance or not (*coinsur*); whether the deposit insurance is funded or not ($funding$); whether deposit insurance premiums are risk adjusted or not ($rskadj$); whether membership to the deposit insurance scheme is compulsory or voluntary (*membship*); and whether the deposit insurance is solely funded by government or by the private sector or jointly by the two ($sourcefnd$). In all cases, the signs of the marginal effects may be positive or negative depending on whether the moral hazard problem is dominant or not.

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With a coinsurance system, depositors are required to bear part of the cost in the event of bank failure (Demirgüç-Kunt et al., 2005). The system, therefore, is used as a technique for quelling moral hazard (McCoy, 2007). It provides a risk-sharing mechanism between depositors and the insurer, thereby instilling a considerable degree of market discipline (Talley and Mas, 1990) that minimises the probability of banking instability. To the extent that some component of deposits is left uninsured, depositors are incentivised to monitor the financial condition of their banks, which leads to market discipline in the banking industry. By exposing some of the deposits to non-protection, however, coinsurance may also increase the probability of bank runs. On rumours that a bank is likely to fail, its depositors may run on it to secure the uninsured component of their deposits. Since coinsurance is expressed as a component of the deposit, depositors will simultaneously attempt to withdraw all their funds to ensure that they minimise their losses. On their part, banks may undertake high-risk high-return projects proportionate to the level of their clients' deposits that are covered by the deposit insurance, which may increase the probability of insolvency.

Cross-correlation matrices presented in Tables B.4-B.7 in Appendix B, Section B.3 show that multicollinearity may not be a problem in any of these sets of equations.

4.3.5 Model and Estimation

We employ the random effects logit model to estimate the probability of banking instability using the maximum likelihood method. The logit is a large-sample technique which has been commonly used in a number of similar studies (see, for example Cole and Gunther, 1995; Gonzalez-Hermosillo et al., 1997; Demirgüç-Kunt and Detragiache, 1998). If fixed (rather than random) effects are included in the model, it may require omitting from the panel all countries that did not experience banking instability during the period under consideration, which would imply throwing away a large amount of information (see Greene, 2003; Demirgüç-Kunt and Detragiache, 1998). In addition, limiting the panel to countries with banking instability would produce a biased sample (Demirgüç-Kunt and Detragiache, Ibid).

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To draw the framework of a logit model, suppose the probability of a banking crisis $\Pr(Y_{i,t})$ is given by:

$$\Pr(Y_{i,t}) = E_{i,t}(Y_{i,t} = 1|X_{i,t}) = \frac{e^{(\alpha+\beta X_{i,t}+\varepsilon_{i,t})}}{1+e^{(\alpha+\beta X_{i,t}+\varepsilon_{i,t})}} \tag{4.5}$$

where $\begin{cases} Y = 1 \text{ if there is a banking crisis in country } i \text{ at time } t. \\ 0 \qquad \text{Otherwise} \end{cases}$

α and β are parameters, $X_{i,t}$ is a vector of variables, including deposit insurance, that explain the probability of a banking crisis and $\varepsilon_{i,t}$ is a disturbance term assumed to be $iidN(0, \sigma^2)$. It can be shown that the logit regression specification is reduces to:

$$\frac{\Pr(Y_{i,t})}{1-\Pr(Y_{i,t})} = e^{\alpha+\beta X_{i,t}+\varepsilon_{i,t}}$$

$$L_{i,t} = \ln \frac{\Pr(Y_{i,t})}{1-\Pr(Y_{i,t})} = \alpha + \beta X_{i,t} + \varepsilon_{i,t} \tag{4.6}$$

4.4 Results and Inferences

4.4.1 Baseline Model

Estimation Results

Estimation results of the baseline model showing marginal effects of selected variables on the probability of banking instability are presented in Table 4.4[8]. Contrary to popular findings (see, for example Demirgüç-Kunt and Detragiache, 2002; Gonzalez-Hermosillo et al., 1997), the results show that deposit insurance *per se* is statistically insignificant in explaining banking fragility whether characterised by bank runs or by insolvency of banks. In the earlier literature, Demirgüç-Kunt and Detragiache (2002) find out that when the simple

[8] All regression results in this chapter report marginal effects of selected variables on the probability of banking instability.

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explicit/implicit deposit insurance dummy variable is entered directly into a banking instability regression, it has a positive coefficient, which is significant only at 10 percent. They conclude that deposit insurance increases banking fragility. Similar results from an analogous approach are reported in Demirgüç-Kunt and Detragiache (1998) and Wheelock and Wilson (1995). Demirgüç-Kunt and Detragiache (1998) observed that deposit insurance increases banking fragility, using a panel dataset of 61 countries over the period 1980-1997; and Wheelock and Wilson (1995) showed that deposit insurance membership increased the probability of failure among banks during the period 1910-1928 in a study of state-chartered banks in Kansas, United States of America (USA). Common to these studies is that they use a composite indicator of banking instability, which does not distinguish between bank runs and insolvency of banks.

Demirgüç-Kunt and Detragiache (1998, 2002), for instance, define a banking crisis as a situation in which significant segments of the banking sector become insolvent or illiquid, and cannot continue without special assistance from the monetary or supervisory authority. They argue that an episode of distress in the banking industry is identified as a banking crisis if at least one of four conditions exists. These conditions are: the ratio of nonperforming assets to total assets in the banking system exceeding 10 percent; the cost of a rescue operation being at least 2 percent of GDP; banking sector problems resulting in a large scale nationalization of banks; extensive bank runs taking place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees being enacted by government in response to a crisis[9].

While either bank runs or insolvency of banks may characterise banking instability, Demirgüç-Kunt and Detragiache (1998, 2002) introduce several other indicators into the definition of banking instability. Thus, banking instability is defined as not simply either bank runs or insolvency of banks, but includes several other indicators of distress in the banking industry. The problem with this approach is that the behaviour of any of the distress indicators, which may include bank runs and insolvency, cannot be isolated. In

[9] (see page 91 of Demirgüç-Kunt and Detragiache, 1998)

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Table 4.4: Deposit Insurance and Banking Instability: Baseline Model

Variables	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0643***	-0.0586***	-0.0643***	-0.0942***	-0.0523***	-0.0555***
	(0.0145)	(0.0123)	(0.0224)	(0.0178)	(0.0164)	(0.0141)
rir	-0.00410	-0.00651*	-0.00942	-0.0179	-0.0227***	-0.00406
	(0.00378)	(0.00391)	(0.0168)	(0.0138)	(0.00693)	(0.00413)
inflatn	-0.000109	-0.000205	-0.0140	-0.0149*	-0.000338	-1.05e-05
	(0.000171)	(0.000180)	(0.0107)	(0.00875)	(0.000258)	(0.000154)
m2fxres	-2.67e-05	5.34e-05	0.00185	0.00391*	0.00147	-0.000845
	(5.51e-05)	(0.000116)	(0.00358)	(0.00221)	(0.00166)	(0.000782)
crgdp	0.00256	0.00361*	0.0113***	0.0116***	0.00732***	0.00567*
	(0.00245)	(0.00219)	(0.00388)	(0.00371)	(0.00280)	(0.00342)
xrdepr	-0.0126***	-0.0139***	-0.00987	-0.00653	-0.0117**	-0.0249***
	(0.00380)	(0.00364)	(0.00949)	(0.00716)	(0.00529)	(0.00466)
gdppc	-3.78e-07	-1.49e-05	-9.79e-06	-6.17e-06	-3.82e-05**	-8.75e-06
	(1.32e-05)	(1.18e-05)	(2.27e-05)	(2.25e-05)	(1.61e-05)	(2.05e-05)
africa	0.188	0.442***	0.0980	0.172	0.0262	0.271
	(0.165)	(0.143)	(0.350)	(0.344)	(0.199)	(0.263)
dinsur	-0.0763	-0.0803	0.361	0.254	0.124	0.158
	(0.182)	(0.153)	(0.302)	(0.258)	(0.191)	(0.215)
countries	94	96	109	109	89	105
obs.	1944	1980	2326	2349	1821	2135

Standard errors are in parenthesis

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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this case, the results can only be generalised. Thus, while our results do not necessarily refute the findings in this earlier literature because of differences in the measurement of the banking instability variable, we lay claim to having presented more expressive findings following our distinction of bank runs and insolvency of banks as identifiers of banking instability.

Table 4.4 further provides very weak evidence that low income countries are susceptible to banking instability more than high income countries. The table shows that low income countries are vulnerable only to insolvency (narrowly defined) more than high income countries. The marginal effect of the income indicator, real GDP per capita, on the probability of insolvency is, however, negligible (very small). On the whole, therefore, we fail to substantiate the view that the probability of banking instability in low income countries is greater than in high income countries.

African countries, however, are observed to be at greater risk of encountering bank runs (broadly defined, with foreign liabilities excluded in the definition of total deposits) than other countries. Table 4.4 shows that the probability of bank runs (broadly defined with foreign liabilities excluded in the definition of total deposits) is 44.2 percent higher for African countries than the rest of the countries. There is no evidence, though, that African countries are more vulnerable to insolvency than other countries.

On this basis, we deduce that there is some evidence, although not conclusive, that the banking system in African countries possibly has underlying characteristics that make it susceptible to bank runs more than banking systems in other countries. A likely explanation for this finding is low trust in banks in African countries arising from large public sector debts, most of which are obtained from local banks. Economic agents in most African countries have the option of investing their financial resources in either the formal or informal financial sector. A lack of trust in the formal banking system, therefore, may result in an outflow of funds from the FFS to the IFS, exposing the banking sector to instability characterised by bank runs. In addition, financial markets in most African countries are inefficient and poorly regulated relative to other countries, which adds to the lack of trust

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in the local banking system.

Within the group of control variables, the coefficient of GDP growth is negative and significant in all the six equations for all definitions of banking instability, which is consistent with economic theory. The rate of inflation has insignificant marginal effects (except in the case of broadly defined bank runs, with foreign liabilities included in the definition of total deposits). We conclude, therefore, that macroeconomic developments generally matter in explaining banking instability. A rise in GDP growth reflects a general improvement in borrowers' ability to repay their loans, which amounts to enhanced quality of the banks' assets. Effectively, higher GDP growth is associated with a lower occurrence of banking instability. The ratio of the coefficient of M2 to foreign exchange reserves is positive and significant only in the case of broadly defined bank runs (with foreign liabilities included in the definition of total deposits), indicating that a high level of commercial banks' exposure to foreign exchange risk is associated with banking instability characterised by broadly defined bank runs (with foreign liabilities included in the definition of total deposits).

Exchange rate depreciation has significant coefficients (except in the case of bank runs with foreign liabilities included in the definition of deposits), albeit with unexpected signs. Conventional wisdom argues that by allowing depreciations to take place, the monetary authorities achieve a more competitive real exchange rate, which is good for output in the tradeable sector and for the sustainability of external accounts, unless it is anticipated (Hausman, Gavin, Pages-Serra and Stein, 1999). This effect has a positive effect on borrowers' ability to repay their loans. Accordingly, an exchange rate depreciation, in this instance, would be associated with a lower probability of banking instability as suggested by the findings in Table 4.4. This finding indicates that the balance sheet effect is not dominant. In the balance sheet effect, a depreciation of the (real) exchange rate increases the output value of debt repayments, because of dollarization of liabilities, and reduces net worth (Céspedes, Chang and Velasco, 2003), which may triger banking instability.

Finally, the ratio of private sector credit to real GDP is significant and positively related to banking instability in all cases (except in narrowly defined bank runs that exclude foreign

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liabilities in the definition of deposits), which is consistent with economic theory. This result indicates that the private sector's indebtedness to commercial banks relative to the size of the economy is of consequence in determining banking stability, whether characterised by bank runs or insolvency of banks. A rise in the ratio of private sector credit to GDP indicates an increase in the private sector's indebtedness relative to the size of the economy, which in turn, reflects a decline in the sector's ability to repay its loans. Ultimately, the quality of the banks' assets deteriorates, which may trigger banking instability.

Predicting Banking Instability

To establish the predictive power of the baseline model, we calculate the probability of banking instability for each country in a sub-sample of 30 countries. We use these probabilities to estimate the expected number of banking instabilities over the study period (1980-2004), which are plotted against the actual number of banking instabilities (identified from the data using our measures of banking instability) over the same period. Figures (B-1)-(B-3) in Appendix B, Section B.4 show that on the whole, the baseline model provides a good prediction of actual cases of banking instability in the 30 countries.

As illustrated in Table 4.5, the average number of banking instabilities per country in the study period (for the 30 countries in the sub-sample) is exactly predicted for $nbrun1$, $bbrun1$, $nbrun2$ and $binsolv$. For $bbrun2$ and $ninsolv$, 3 and 2 banking instabilities are predicted over the study period per country while the actual instabilities are 2 and 3, respectively. Thus, the baseline model is generally robust and on the whole predicts banking instabilities with near certainty.

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Table 4.5: Average Number of Predicted and Actual Banking Instabilities per Country (1980-2004)

Classification of Banking Instability	Predicted Number of Banking Instabilities	Actual Number of Average Banking Instabilities
*nbrun*1	3	3
*bbrun*1	6	6
*nbrun*2	1	1
*bbrun*2	2	3
ninsolv	3	2
binsolv	4	4

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4.4.2 Design Features of Deposit Insurance

Generosity of Payouts

Estimation results presented in Table 4.6 show that *guarantee* has significant marginal effects and is positively correlated with banking instability characterised by broadly defined bank runs (with and without foreign liabilities included in the definition of total deposits), suggesting that full deposit insurance is associated with greater susceptibility to banking instability. Thus, in an economy with a more generous deposit insurance scheme, the moral hazard problem dominates, making it more vulnerable to banking fragility triggered by bank runs.

Coverage

Table 4.7 presents estimation results illustrating the impact of extending deposit insurance coverage to foreign currency and interbank deposits on banking instability. The table shows that marginal effects of both variables are insignificant in all six equations, illustrating that whether foreign currency or interbank deposits are covered by a deposit insurance scheme or not does not significantly affect banking fragility.

Table 4.6: Banking Instability and the Generosity of Deposit Insurance Payouts

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0691*	-0.0763**	-0.116*	-0.139***	-0.0222	-0.0778*
	(0.0409)	(0.0366)	(0.0592)	(0.0516)	(0.0449)	(0.0418)
rir	0.00144	0.00122	-0.0302	-0.00321	-0.0657***	-0.0490**
	(0.00645)	(0.00637)	(0.0320)	(0.0256)	(0.0228)	(0.0208)
inflatn	0.000385	-0.000208	-0.0118	-0.00400	-0.0116	-0.0130
	(0.000904)	(0.000887)	(0.0110)	(0.00712)	(0.00930)	(0.00844)
m2fxres	-7.34e-06	0.000296*	-0.00132	0.0271	0.000660	-0.00226
	(4.62e-05)	(0.000172)	(0.0218)	(0.0188)	(0.0150)	(0.00545)
crgdp	0.00516*	0.00678**	0.0105**	0.0111***	0.00569	0.00701**
	(0.00303)	(0.00310)	(0.00435)	(0.00414)	(0.00360)	(0.00332)
xrdepr	-0.00972	-0.0238***	-0.0147	-0.00721	-0.0272**	-0.0315**
	(0.00980)	(0.00913)	(0.0160)	(0.0131)	(0.0138)	(0.0126)
guarantee	0.415	0.673*	0.645	1.734***	0.314	0.392
	(0.365)	(0.366)	(0.546)	(0.481)	(0.442)	(0.429)
countries	45	47	48	49	46	48
obs.	545	581	592	606	550	595

Standard errors are given in parenthesis

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table 4.7: Banking Instability and Deposit Insurance Coverage

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.115**	-0.111***	-0.100	-0.102*	-0.0680	-0.123**
	(0.0511)	(0.0427)	(0.0629)	(0.0551)	(0.0530)	(0.0477)
rir	-0.00133	0.000637	-0.0298	-0.0117	-0.0697***	-0.0467**
	(0.00667)	(0.00644)	(0.0301)	(0.0266)	(0.0244)	(0.0214)
inflatn	0.000790	-0.000135	-0.00699	-0.00296	-0.00890	-0.0103
	(0.000932)	(0.000897)	(0.00970)	(0.00598)	(0.00883)	(0.00776)
m2fxres	0.0157	0.0193	-0.00965	0.0394*	-0.00546	-0.00238
	(0.0215)	(0.0171)	(0.0231)	(0.0214)	(0.0174)	(0.0150)
crgdp	0.00578	0.00432	0.0137***	0.0125**	0.00678	0.00861**
	(0.00457)	(0.00396)	(0.00466)	(0.00520)	(0.00428)	(0.00409)
xrdepr	-0.0112	-0.0244**	-0.0179	-0.0190	-0.0204	-0.0272**
	(0.0112)	(0.00977)	(0.0160)	(0.0138)	(0.0144)	(0.0128)
fxcoverd	-0.152	-0.523	0.124	0.636	-0.301	0.260
	(0.484)	(0.437)	(0.537)	(0.677)	(0.472)	(0.479)
intbank	0.601	0.450	-0.334	-0.511	0.552	0.774
	(0.532)	(0.486)	(0.679)	(0.793)	(0.482)	(0.504)
countries	39	41	42	43	41	44
obs.	497	541	567	581	527	563

Standard errors given in parentheses

***, ** and * denote statistical significance at 1,5 and 10 percent, respectively

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Thus, in the case of interbank deposits, neither the moral hazard effect of insuring these deposits nor the eagerness of banks to run on a fellow bank at the slightest indication of failure of the bank that is holding their deposits has a dominant impact on banking instability. With foreign currency deposits, their coverage in a deposit insurance scheme does not necessarily reassure depositors of the safety of their funds in the event of bank failure. One reason, particularly applicable to developing countries, is that the deposit insurance agency might not be able to acquire needed foreign exchange in order to pay off holders of the foreign currency deposits, which may compel the depositors to force the agency into bankruptcy for failing to honour its obligations (see Talley and Mas, 1990).

If the agency has the option of paying off the foreign currency deposits in local currency at the prevailing exchange rate, the depositors may end up in a worse off position as the exchange rate may not be realistic enough to compensate them for their foreign currency deposits lost in the failed bank (Ibid, 1990). Thus, at the time of placing their foreign currency deposits in the banks of their choice, economic agents will have already taken into consideration all risks involved, which are not expected to change with insurance of the foreign currency deposits.

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Legal Environment

Estimation results illustrating the importance of the legal environment in explaining banking instability are presented in Table 4.8. Two of the legal environment indicators, *interven* and *leglmgr* have insignificant marginal effects, suggesting that whether or not a deposit insurance agency has the legal mandate to intervene in the affairs of a bank or to take legal action against bank directors or other bank officials has no bearing on a country's banking stability. The third indicator, *leglcancel* is positively related to banking instability and is statistically significant at 10 percent, albeit only for the bank runs equation (broadly defined with foreign liabilities excluded in the definition of deposits).

This outcome demonstrates that instituting a deposit insurance agency with legal powers to cancel or revoke deposit insurance for any participating bank increases the likelihood of

Table 4.8: Banking Instability and the Deposit Insurance Legal Environment

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0778	-0.0732	-0.110	-0.0950	-0.0731	-0.0894*
	(0.0530)	(0.0452)	(0.0706)	(0.0636)	(0.0596)	(0.0540)
rir	0.00130	0.00576	-0.0523	-0.0120	-0.0509	-0.0442
	(0.00708)	(0.00772)	(0.0361)	(0.0343)	(0.0319)	(0.0284)
inflatn	0.000582	-0.000669	-0.00684	-0.00324	-0.00896	-0.0148
	(0.000960)	(0.00109)	(0.00866)	(0.00628)	(0.00998)	(0.00997)
m2fxres	0.0122	0.0244	-0.0173	0.0412*	-0.00797	-0.0110
	(0.0211)	(0.0173)	(0.0241)	(0.0234)	(0.0198)	(0.0167)
crgdp	0.00496	0.00521	0.0102**	0.00941*	0.0102**	0.0102**
	(0.00477)	(0.00435)	(0.00491)	(0.00568)	(0.00478)	(0.00469)
xrdepr	-0.0123	-0.0287***	-0.0225	-0.0305*	-0.0317*	-0.0524***
	(0.0120)	(0.0108)	(0.0175)	(0.0159)	(0.0165)	(0.0159)
interven	-0.0711	-0.680	0.743	0.335	-0.321	0.685
	(0.870)	(0.756)	(0.740)	(1.073)	(0.974)	(0.802)
leglcancel	0.567	0.901*	0.391	0.771	0.366	0.267
	(0.508)	(0.480)	(0.531)	(0.752)	(0.528)	(0.547)
leglmgr	0.0463	0.374	-0.793	-0.289	0.372	-0.432
	(0.499)	(0.489)	(0.558)	(0.755)	(0.565)	(0.540)
countries	33	35	35	36	35	37
obs.	411	455	460	474	441	465

Standard errors given in parentheses

***, ** and * denote statistical significance at 1,5 and 10 percent, respectively

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bank runs (broadly defined with foreign liabilities excluded in the definition of deposits). While deposit insurance assures economic agents of the safety of their insured deposits, the speed with which they can get their money in the event of bank failure remains of concern. A deposit insurance agency that has the legal authority to close a bank, therefore, may indeed fuel a bank run on rumours that the bank is on the brink of failure[10]. In this state, economic agents will simultaneously queue to withdraw their funds, not because they doubt the safety of their funds, but because they want to have access to their money when they need it.

Administration

Table 4.9 presents estimation results of the deposit insurance administration indicators. Among the six indicators, banking fragility does not respond to three, namely, whether the deposit insurance scheme is administered by the government, by the private sector or jointly by the two, whether premiums are adjusted according to varying risk or not, and whether membership to a scheme is compulsory or voluntary. The remaining three indicators display significant marginal effects on some of the measures of banking fragility. The results show that the impact of coinsurance on the probability of bank runs is insignificant. In the narrowly defined insolvency equation, however, coinsurance shows up with a positive sign and a significant marginal effect, indicating that moral hazard on the part of the banks dominates the market discipline effect created by the coinsurance mechanism. A practical example is the case of Chile which has a coinsurance scheme and experienced widespread insolvencies in the early 1980s, forcing the government to intervene and liquidate eight insolvent institutions in 1981, place a further eight institutions under the management of the central bank between 1982 and 1983, and extend financial support to all but one of the

[10] In countries where deposit insurance membership is compulsory, cancellation of a participating bank's deposit insurance membership implies cancellation of the bank's banking licence. Since deposit insurance membership is compulsory in most countries, we generalise that if a deposit insurance agency has the mandate to cancel or revoke membership for any participating bank, it effectively holds the authority to close the bank.

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Table 4.9: Banking Instability and the Administration of Deposit Insurance

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.100*	-0.1000**	-0.0684	-0.0895	-0.0431	-0.115**
	(0.0557)	(0.0443)	(0.0706)	(0.0577)	(0.0538)	(0.0486)
rir	-0.000499	0.000621	-0.0286	-0.0115	-0.0808***	-0.0594***
	(0.00673)	(0.00643)	(0.0336)	(0.0275)	(0.0233)	(0.0221)
inflatn	0.000698	-6.99e-05	-0.00581	-0.00216	-0.0119	-0.0117
	(0.000948)	(0.000906)	(0.0105)	(0.00591)	(0.00938)	(0.00787)
m2fxres	0.0310	0.0200	-0.00878	0.0371*	0.0107	-0.000492
	(0.0230)	(0.0181)	(0.0240)	(0.0220)	(0.0169)	(0.0150)
crgdp	0.000980	0.00435	0.0124**	0.0106*	0.00138	0.00649
	(0.00547)	(0.00421)	(0.00519)	(0.00545)	(0.00485)	(0.00429)
xrdepr	-0.0132	-0.0249**	-0.0102	-0.0160	-0.0209	-0.0292**
	(0.0118)	(0.0100)	(0.0171)	(0.0140)	(0.0148)	(0.0131)
admin	0.258	0.193	0.130	0.410	-0.253	0.124
	(0.297)	(0.244)	(0.354)	(0.413)	(0.284)	(0.280)
coinsur	1.316	0.728	-0.303	-0.248	1.574**	-0.327
	(0.873)	(0.689)	(0.721)	(0.938)	(0.643)	(0.594)
funding	0.742	1.301**	-0.835	-0.683	1.453**	-0.722
	(0.802)	(0.648)	(0.639)	(0.904)	(0.694)	(0.557)
rskadj	-0.175	0.0590	0.166	0.602	-0.307	0.0327
	(0.643)	(0.514)	(0.737)	(0.836)	(0.643)	(0.590)
membship	-0.00705	0.187	-0.0588	-0.0409	0.0167	0.262
	(0.666)	(0.555)	(0.761)	(0.956)	(0.546)	(0.620)
sourcefnd	0.370	0.698	0.155	0.373	0.00656	0.766*
	(0.553)	(0.431)	(0.516)	(0.666)	(0.445)	(0.446)
countries	36	38	39	40	38	41
obs.	485	529	555	569	515	551

Standard errors given in parentheses

***, ** and * denote statistical significance at 1,5 and 10 percent, respectively

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remaining financial institutions (see Talley and Mas, 1990)

The estimation results in Table 4.9 also show that countries with a permanent fund of the deposit insurance scheme are more prone to banking instability than countries with a non-funded system of deposit insurance. In a funded deposit insurance (permanent fund) system, members or the government make periodic contributions to the fund, which are then used as a primary resource base for paying out depositors in the event of bank failure; and in a non-

funded system, members pay their contributions to the fund after bank failure has already occurred (Demirgüç-Kunt et al., 2005)[11]. Consistent with the theoretical literature and the findings of Demirgüç-Kunt and Detragiache (2002), the marginal effects of funding type are positive and significant (for broadly defined bank runs with foreign liabilities excluded in the definition of total deposits and narrowly defined insolvency), indicating that deposit insurance schemes with a permanent fund give rise to moral hazard, which in turn leads to banking instability.

It is further shown in Table 4.9 that the source of funding for a deposit insurance scheme does not affect the probability of bank runs. Government funded deposit insurance schemes, however, increase the probability of insolvency of banks (broadly defined). The table reveals that the probability of insolvency of banks is lowest when a deposit insurance scheme is wholly funded by the private sector, increases in cases of joint funding by the government and the private sector, and it is highest when the government is the sole financier.

4.4.3 Sensitivity Analysis

To ensure that our estimation results are robust, we break the sample period into four overlapping periods namely, 1981-1999, 1988-1996, 1988-2001 and 1989-2004, and attempt to replicate the results from each sub-sample period. We re-estimate two groups of models. In the first group (see Tables B.8 - B.11 in Appendix B, Section B.3), we re-estimate the baseline model for each of the four sub-sample periods. Each equation in the model is re-estimated on data for all countries in the sample where data is available for a specific indicator of banking instability, whether the countries have deposit insurance or not. In the second group (see Tables B.12 - B.27 in Appendix B, Section B.3), we re-estimate the four sets of equations characterising design features of deposit insurance. In this group, estimations are carried out on data for only countries with deposit insurance, which considerably

[11] As at 2003, only 14 countries out of 88 had unfunded deposit insurance, 11 of which were European and Chile was the only country with the government as a sole contributor to the fund (Demirgüç-Kunt et al., 2005).

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reduces the sample size.

The four sub-sample periods are drawn to take into account major global financial events. Each sub-sample period takes in or is just outside one or several major financial events. The idea is to ensure that the estimation results presented in the foregoing sections are invariant to sample period. The first sub-sample period starts in 1981, a year before the onset of the Latin American Debt Crisis sparked by Mexico's default on international debt; and ends in 1999 when implementation of the European Monetary Union (EMU) entered the last (third) stage, and a year after the (official) end of the East Asian financial crisis[12]. The second sub-sample period, 1988-1996, starts during the period when the former Union of Soviet Socialist Republics (USSR) was disintegrating, allowing us to account for financial stability/instability in countries that were formerly member states of the Union. This period ends in 1996, a year before the East Asian financial crisis (officially) started. The third sub-sample extends the second and ends in 2001. Besides what is covered in the second sub-sample, the 1988-2001 sub-sample takes in the East Asian Financial Crisis (1997-1998) and the third phase of the EMU of the European Union, which started in January 1999 and is on-going. The final sub-sample, 1989-2004 starts a year before the collapse of the Japanese Asset Price Bubble and extends to the end of the period under study.

Estimation results for the first group of equations (the baseline model) are presented in Tables B.8-B.11 in Appendix B, Section B.3. The tables show that the results for all four sub-sample periods are generally similar to the estimation results of the baseline model presented in Table 4.4, which demonstrates that estimation results of our baseline model are not sample period dependent. This is a manifestation that our results are reasonably

[12]The European Central Bank (ECB) was established on 1st June 1998 with 11 initial participating countries and on 1st January 1999, a single monetary policy for the Euro Zone was introduced under the authority of the ECB. The ECB effectively took over responsibility for monetary policy from national central banks of the 11 member states(see European Central Bank, n.d.).

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robust. In all cases, deposit insurance has insignificant marginal effects; the Africa dummy is positive and significant only for broadly defined bank runs (excluding foreign liabilities in the definition of total deposits); and GDP per capita has negative and insignificant marginal effects, except in the case of bank runs broadly defined (with foreign liabilities included in the definition of total deposits). Consistent with the previous results, marginal effects in the latter are considerably small to explain any country differences in vulnerability to banking instability based on income level.

Tables B.12 - B.27 in Appendix B, Section B.3 show estimation results for the second group of equations characterising design features of deposit insurance. The tables reveal that the findings do not change much and on the whole, our results outlining how design features of deposit insurance affect banking fragility are robust. The tables show that vulnerability to banking instability increases with the increasing generosity of deposit insurance payments; and that extending coverage to include foreign currency and interbank deposits has no effect on a country's exposure to banking instability.

An exception is prersented in Tables B.16-B.17 in Appendix B, Section B.3, where it is shown that extending coverage to include foreign currency deposits has a significant impact on a country's susceptibility to banking instability characterised by both bank runs and insolvency in the sample period 1981-1999 and only insolvency in the sample period 1988-1996. In the sample period 1981-1999, it is also shown that extending coverage to include interbank deposits has a significant marginal effect which is positively correlated with banking instability characterised by bank runs. These results need to be treated as an exception because the sample period has a high concentration of years when some of the world's major financial crises occurred (including the Mexican Peso and East Asian financial crises). In addition, most countries were migrating from fixed to floating exchange rate systems in the late 1980s and early 1990s, which increased their exposure to banking instability. Furthermore, this was the period when the transition economies of Eastern Europe were moving away from command economies to become market economies, in the process exposing themselves to currency crises and banking instability. When the sample

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period is changed to cover more recent years of moderation (1988-2001 and 1989-2004), our original results are validated.

Variables characterising the legal environment are on the whole unchanged except the variable capturing whether the deposit insurance agency has the authority to take legal action against bank officials, which consistently comes out (except in the 1989-2004 sample period) with negative and significant marginal effects for narrowly defined bank runs (with foreign liabilities included in the definition of total deposits). Tables B.24-B.27 in Appendix B, Section B.3 further show that marginal effects of the variables characterising the administration of deposit insurance also support the major findings of the study. It is shown in the tables that whether premiums are risk-adjusted or not and whether membership to a deposit insurance scheme is compulsory or voluntary has no bearing on banking fragility. The variable capturing whether a deposit insurance scheme has a permanent fund or non-funded system, however, emerges with a negative relationship, contrary to what was observed in our results.

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4.5 Summary and Conclusions

This chapter set out to investigate the vulnerability of a country to banking instability given its income level, the role of deposit insurance in achieving banking stability, and the effect of different designs of deposit insurance on banking fragility. Using a new empirical framework that distinguishes banking instability triggered by bank runs from banking instability caused by insolvency of banks, the study finds very weak evidence that low income countries are more vulnerable to banking instability than high income countries. Although not conclusive, the results demonstrate some evidence that African countries may be at greater risk of encountering bank runs than other countries. We argue, therefore, that there is a possibility the banking system in African countries may have underlying aspects that make it susceptible to bank runs more than is the case with banking systems in other countries. There is no evidence, though, that African countries are more vulnerable to insolvency than other countries. We argue, therefore, that the banking system in African countries has

some underlying aspects that make it more susceptible to bank runs than is the case with banking systems in other countries.

Contrary to popular findings, the study finds out that deposit insurance *per se* has no bearing on banking fragility, whether characterised by bank runs or by insolvency of banks. While our results do not necessarily refute the findings in the earlier literature because of differences in measurement of the banking instability variable, we lay claim to having presented more expressive findings following our distinction of bank runs and insolvency of banks as identifiers of banking instability. Certain features in the design of deposit insurance are, nonetheless, observed to have a statistically significant effect on banking fragility. We establish that a country is more vulnerable to banking instability when it has a more generous deposit insurance scheme, when the deposit insurance agency has a legal mandate to cancel or revoke deposit insurance for any participating bank, when the deposit insurance has a permanent fund, and when the scheme is funded jointly by the government and the private sector or solely by the government. We argue, therefore, that it is not whether or not a country has deposit insurance that matters; rather, it is the design of the insurance scheme that makes a difference.

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Chapter 5

Summary and Conclusions

This study investigates three separate but related topics in the macro-monetary economics of low income countries. In the first part of the study (Chapter 2), we employ innovation accounting in a structural vector autoregressive model with short run restrictions to investigate the process through which monetary policy affects consumer prices and output in a typical low income country, Malawi. Using monthly time series data covering the period 1988:1-2005:12, the study isolates monetary policy autonomous disturbances from other shocks, quantifies their dynamic behaviour and measures the consequent macroeconomic implications to establish the country's monetary policy transmission process. Within the same framework, the study also assesses how the monetary transmission mechanism was altered following the country's migration from direct to indirect tools of monetary control in the late 1980s and the 1990s.

Contrary to the official position that monetary policy in Malawi targets reserve money only, the study finds that monetary authorities in the country also target short term interest rates (specifically the bank rate), suggesting that the country employs hybrid operating procedures. The study further demonstrates that the bank rate is a more effective measure of monetary policy than reserve money. In addition, it is established that monetary authorities in the country pursue both price stability and high growth and employment objectives, in line with the country's central bank act (Part III, Section 4(d) of the RBM Act of 1989).

The study also finds that price stability is the principal objective of monetary policy in the country. With the exception of exchange rate shocks, however, consumer prices respond weakly to monetary impulses suggesting that inflation in Malawi may not be predominated

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by monetary factors. Given that food costs have a preponderant weight (58.1 percent) in the all items national composite consumer price index, it is possible that structural rigidities in food production may be more important determinants of inflation than monetary considerations in Malawi. The consumer prices may also be responding weakly to monetary policy shocks as a direct consequence of the IFS's offsetting effect of monetary policy.

In addition, the study illustrates that bank lending, exchange rates and aggregate money supply contain important additional information on the transmission process of monetary policy shocks in Malawi. Besides own shocks, output fluctuations are largely attributed to M2 up to about a year, exchange rates at about 2 years and bank lending from about 3 years and beyond. Excluding own shocks, variations in consumer prices are mostly accounted for by exchange rates up to about 3 years and bank lending thereafter. The study further finds that following the country's migration from a fixed to a floating exchange rate regime in February 1994, the role of the exchange rate has become more conspicuous although its impact on economic activity has been weakened. In addition, the importance of aggregate money supply and bank lending in transmitting monetary policy impulses has been enhanced.

In the second part of the study (Chapter 3), we develop a four sector dynamic stochastic general equilibrium model calibrated using Malawian data to investigate the interaction of formal and informal financial markets and their impact on economic activity in low income countries. The model incorporates asymmetric information in the FFS and it is drawn against the observation that the IFS in low income countries is large and plays a non-trivial role in determining the direction of economic activity. Focusing on three experiments identified by a positive production technology shock, a monetary policy shock and a shock on the risk factor of high risk borrowers, we demonstrate that while formal and informal financial sector loans are substitutes in a borrowing firm's utility function, they are in effect complementary in the aggregate, suggesting that an increase in capital formation financed by FFS credit creates additional productive capacity that can be utilised only with IFS credit in order to maintain the economy at an equilibrium level. Effectively, increasing the

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use of FFS credit increases demand for credit in the IFS.

Another important finding derives from the behaviour of interest rates in the formal and informal financial sectors. The model shows that interest rates in the IFS are not necessarily driven by FFS interest rates. While interest rates in the two sectors are observed to change together in the same direction following a positive production technology shock, a similar co-movement of the interest rates is not observed with a monetary policy shock. In the case of a monetary policy shock, the response of IFS interest rates is diametrically opposed to the direction taken by FFS interest rates. The implication of this finding is that the IFS may frustrate monetary policy, and the extent to which this may occur is dependent on the size of the IFS in a country. The larger the size of the IFS, the lower the likely impact of monetary policy on economic activity.

The model also demonstrates that the risk factor (probability of success) for both high and low risk borrowers plays an important role in determining the magnitude by which macroeconomic indicators respond to shocks. The responses of both formal and informal financial sector loans, capital stock, output, wage rates and expected prices to either a positive production technology shock or a monetary policy shock are seen to vary depending on the size of the risk factor for high risk borrowers. Similarly, in the experiment with a shock on the risk factor for high risk borrowers, changes in the risk factor of low risk borrowers determine the magnitude by which the selected macroeconomic indicators respond to the shock. Lending in both the formal and informal financial sectors, capital stock, output, wage rates and expected prices respond to the shock on the risk factor for high risk borrowers with different magnitudes depending on whether or not the risk factor for low risk borrowers is low or high.

The third part of the study (Chapter 4), investigates the vulnerability of a country to banking instability given its income level, the role of deposit insurance in achieving banking stability, and the effect of different designs of deposit insurance on banking fragility. Using a new empirical framework that distinguishes banking instability triggered by bank runs from that triggered by insolvency of banks, we estimate logit models in samples of countries

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ranging from 33 to 109 in a pool of 118 countries, varying according to the availability of data for each of the dependent variables.

The study finds very weak evidence that low income countries are more vulnerable to banking instability than high income countries. While the results indicate that there is no significant relationship between a country's income level and bank runs, it is observed that low income countries are vulnerable to insolvency (narrowly defined) more than high income countries. The marginal effects of the income indicator (real GDP per capita) on the probability of insolvency, nonetheless, are considerably small to have any meaningful economic impact. There is, however, some evidence, although not conclusive, that African countries may be at greater risk of encountering bank runs more than other countries. There is no evidence, though, that the African countries are vulnerable to insolvency more than other countries. We conclude, therefore, that the banking system in African countries may have underlying characteristics that make it susceptible to bank runs more than banking systems in other countries. The co-existence of the FFS with a large IFS and lack of trust in the FFS emanating from large public sector debts and a weak system of prudential supervision of financial institutions are likely to force economic agents in Africa to move their funds from the FFS to the IFS, thereby exposing commercial banks to bank runs.

Contrary to popular findings, the study shows that deposit insurance *per se* has no bearing on banking fragility, whether characterised by bank runs or by insolvency of banks. While our results do not necessarily refute the findings in the earlier literature because of differences in measurement of the banking instability variable, we lay claim to having presented more expressive findings following our distinction of bank runs and insolvency of banks as separate identifiers of banking instability.

Certain features in the design of deposit insurance, however, have statistically significant effects on banking fragility. We establish that a country is more vulnerable to banking instability when it has a more generous deposit insurance scheme, when the deposit insurance agency has a legal mandate to cancel or revoke deposit insurance for any participating bank, when the deposit insurance has a permanent fund, and when the scheme is funded jointly

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by government and the private sector or solely by the government. We argue, therefore, that it is not whether or not a country has deposit insurance that matters; rather, it is the design of the insurance scheme that makes a difference.

In summary, we conclude that IFS transactions play an important role in influencing economic activity in low income countries. Monetary authorities in low income countries, therefore, should strive to compile and update data on IFS activities, which should be used in policy formulation and implementation. Following the finding that the IFS does not only serve clients that self-selectively seek loans only in the informal financial market but also the excess demand for loans that spills over from the FFS, it is essential to enhance the role of lenders in the IFS through measures that would make more funds available to them.

On deposit insurance, we maintain that adoption of the scheme may either increase the vulnerability of a country to banking fragility or propel the economy towards banking system stability depending on design features of the scheme. Countries, therefore, should be careful whenever they are adopting deposit insurance to avoid design features of a deposit insurance that may have a negative impact on banking stability. In particular, a deposit insurance scheme should have no mandate to cancel or revoke deposit insurance membership for any participating bank, it must be funded solely by the private sector and its coverage must be partial. Where possible, countries should consider moving away from a deposit insurance scheme that has a permanent fund (funded system) towards a non-funded system.

Finally, we make two policy recommendations for Malawi. First, monetary authorities in the country should consider moving away from using hybrid operating procedures to a scalar indicator of policy. In this case, there is need to abandon the use of reserve money as a measure of monetary policy in favour of the more effective bank rate. Second, we propose that the RBM should narrow down its focus to concentrate on price stability and this should be reflected in the RBM Act which governs its operations. The evidence that RBM targets economic growth and employment objectives besides price stability suggests that the bank may be overloaded and hence unable to achieve its targeted objectives due to inefficiencies arising from the multiple objectives. In the literature, there is near consensus that to

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achieve the maximum attainable level of sustainable economic growth, the main objective of monetary policy should be price stability. Accordingly, we do not expect the Malawi Government objective of promoting economic growth and employment to be compromised by the central bank's focus on a single objective, namely price stability. In addition, if RBM takes heed of the recommendation to take into account the IFS in its policy formulation and implementation, the weak link between monetary policy and economic activity observed in Chapter 2 is likely to be improved upon, indicating that monetary authorities may have greater influence over economic activity through policy.

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Appendix A

Appendix to Chapter 2

A.1 Interpolation of GDP Using Related Time Series

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While this study sets out to use monthly GDP time series, among other variables, the series is not available in monthly frequency. For this reason, we employ the Friedman method of interpolating time series by related series to obtain the required monthly GDP series from annual data[1]. The method employs log-linear interpolations of a vector of variables X_t, which are available in both annual and monthly frequency, that explain the variable of interest Y_t, to compute actual errors in the trend interpolation for the elements of X_t. These errors are then used to adjust the linear trend interpolation for Y_t by the weighted individual error in trend interpolation for each regressor, where the weights are given by the respective coefficients on the X_{jt} variable in the annual regression of X_t on Y_t.

To illustrate the mechanics of the approach, suppose variable Y_t is available at annual but not monthly frequency and a vector of related variables X_t is available at both annual and monthly frequency. The criteria for the selection of variables X_t is that the intra-yearly movements of X_t are highly correlated with the intra-yearly movements of Y_t. This may be based on non-quantitative considerations; on observed high correlation but for a different time period other than that earmarked for the interpolation; on co-movements between Y_t and X_t for different time units for the same period; or on co-movements between series other than Y_t and X_t but analogous to them for the same time units and for the same period.

[1]This methodology is adopted from Friedman (1962). "The Interpolation of Time Series by Related Series," Journal of American Statistical Association, Vol. 57, No. 300 (Dec. 1962), pp. 729-757.

In addition, the vector X_t should not contain any variables that will be included in the analysis of the study. The interpolation process is carried out in the following four steps:

(1) Using annual observations only, compute the mean monthly growth for Y_t and X_t. Use this to derive log-linear interpolations for both Y_t and X_t. The linear interpolations are given by:

$$y^*_{t:i} = y_t + iT_y \tag{A.1}$$

where $i = 1, 2, ..., 12$ and $T_y = i\left(y_{t:12} - y_{t-1:12}\right)/12$.

$$x^*_{jt:i} = x_{jt} + iT_{jx} \tag{A.2}$$

where $i = 1, 2, ..., 12$, $j = 1, 2, ..., k$ and $T_{jx} = \left(x_{jt:12} - x_{jt-1:12}\right)/12$.

(2) Using the annual observations only, run the regression:

$$Y_t = \beta_0 + \Sigma^k_{j=1}\beta_j X_{jt} + \varepsilon_{jt} \tag{A.3}$$

(3) From the actual monthly values of the x_{jt} variables and their interpolated values $\left(x^*_{jt:i}\right)$, compute the actual error in the trend interpolation for the elements of x_{jt}, expressed as:

$$\delta_{jt:i} = \left(x_{jt:i} - x^*_{jt:i}\right) \tag{A.4}$$

(4) This error term is then used to adjust the simple linear trend interpolation for Y_t by the weighted individual error in trend interpolation for each regressor where the weights are given by the β_j coefficient on the X_j variable in the annual regression estimated in equation (A.3). The final interpolation of Y_t is:

$$\widehat{y}_{t:i} = y^*_{t:i} + \Sigma^k_{j=1}\beta_j\delta_{jt:1} \tag{A.5}$$

Clearly, this method results in every twelfth observation being exactly correct (since the error in the interpolation of the X_t variables is identically equal to zero for each variable), so that the interpolated series always returns to the known annual observations for the series. In addition, it provides a robust and transparent way of weighting the error term.

In the interpolation of GDP for Malawi, we use actual errors in the trend interpolation of tobacco exports to adjust the linear trend interpolation for GDP. The choice of tobacco

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exports is based on the fact that agriculture is the mainstay of the Malawi economy, accounting for about 36 percent (2007 estimate) of the country's GDP and nearly 80 percent (2006 estimate) of the country's exports; employing an estimated 84.5 percent of the labour force; and responsible for about 82.5 percent of foreign exchange earnings (Malawi Government, 2004). In addition, the economy is monoculture, with tobacco accounting for 60 percent of total export earnings followed by tea and sugar, contributing about 10 percent each. It is, therefore, expected that tobacco exports and GDP will be highly correlated as shown in Figure A-1.

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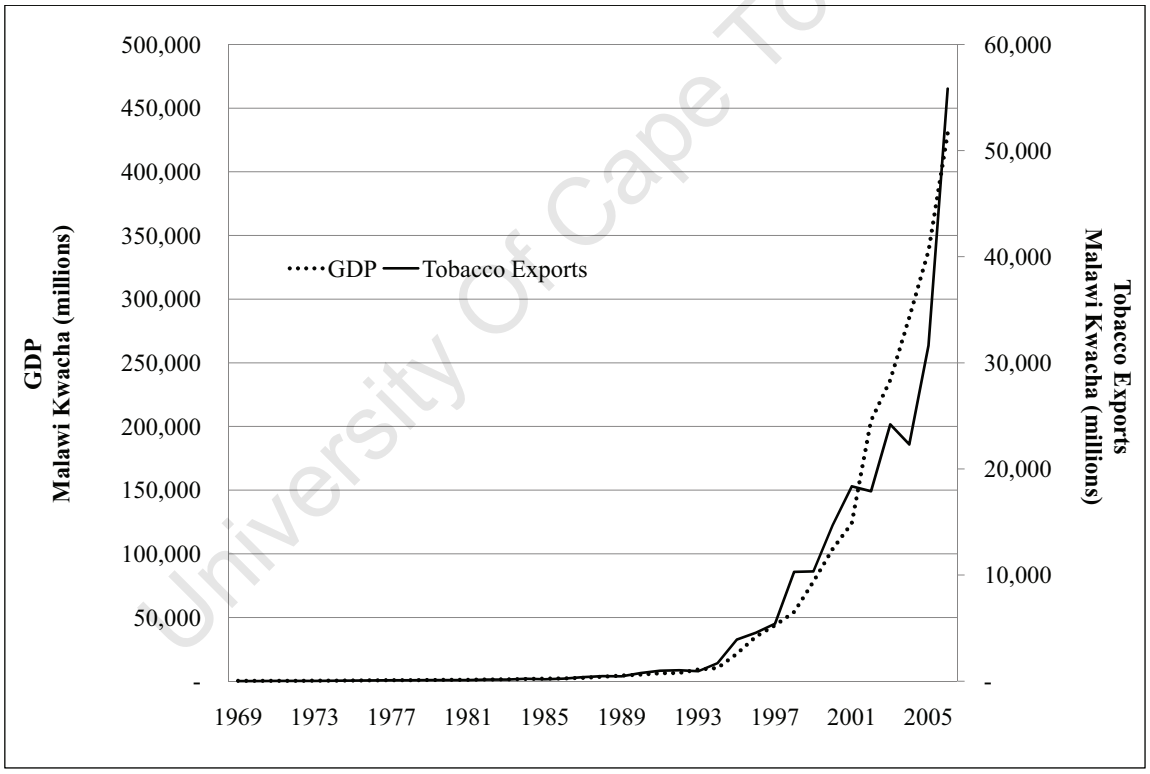
Figure A-1: GDP and Tobacco Exports for Malawi (1968-2006)



Source: NSO (Malawi)

Our annual time series for the regression of tobacco exports on GDP cover the period 1968-2006 and the regression results are presented in Table A.1. Both variables are I(1) and, accordingly, an error correction model is estimated. ERROR is the error correction

Table A.1: Regression Results of GDP on Tobacco Exports

Dependent Variable: GDP				
	Coefficient	Std. Error	t-Statistic	Prob.
TOBACCO(-6)	20.8318	1.6494	12.8617	0.0000
ERROR(-4)	-0.8202	0.2832	2.8962	0.0077
R-squared	0.6749			
Adjusted R-squared	0.6359			
S.E. of Regression	14849.58			
Durbin-Watson stat	1.4135			

term. The coefficient of tobacco exports, 20.83184, is used as a weight to compute weighted individual errors in the trend interpolation of tobacco exports, which in turn are used for adjusting the linear trend interpolation of GDP.

Figure A-2 shows actual and interpolated tobacco exports, the difference of which is weighted against the calculated coefficient of tobacco exports (20.83184) to adjust the linear trend interpolation of GDP. The interpolated monthly GDP series is expected to be highly correlated with the actual monthly tobacco exports series as shown in Figure A-3.

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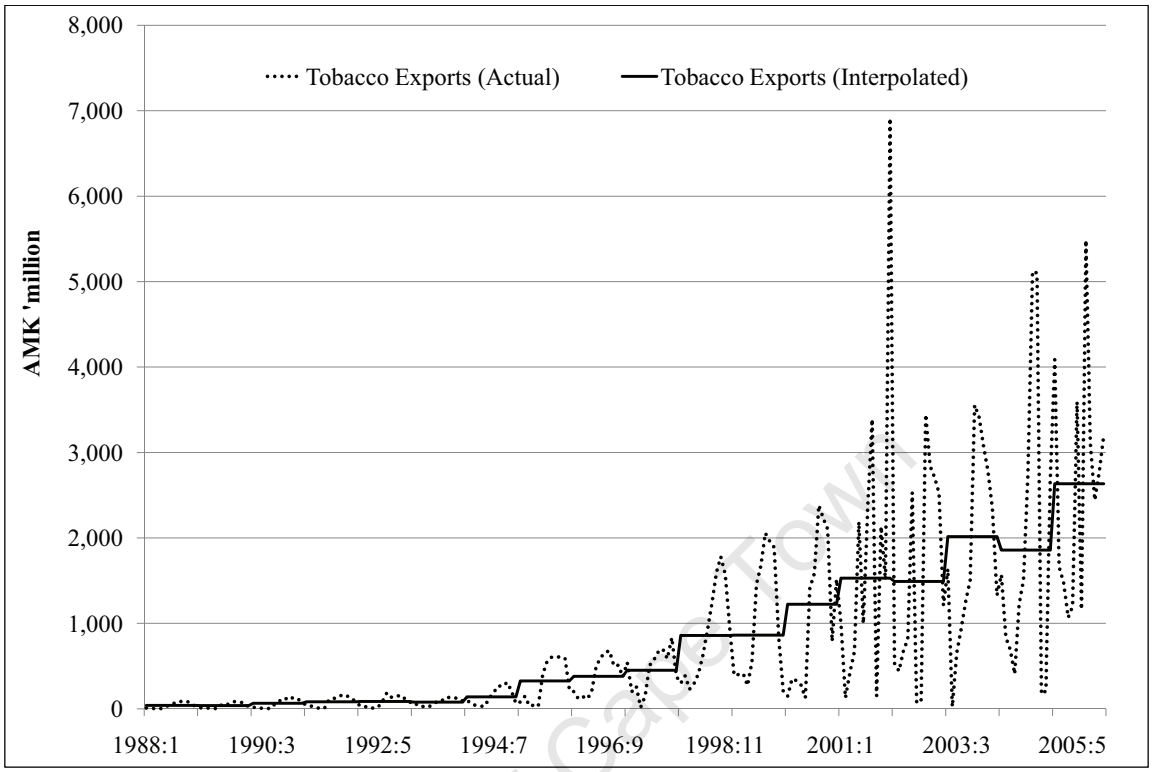
Figure A-2: Tobacco Exports (Actual and Interpolated) for Malawi (1988:1-2005:12)



Source (Tobacco Exports): NSO (Malawi)

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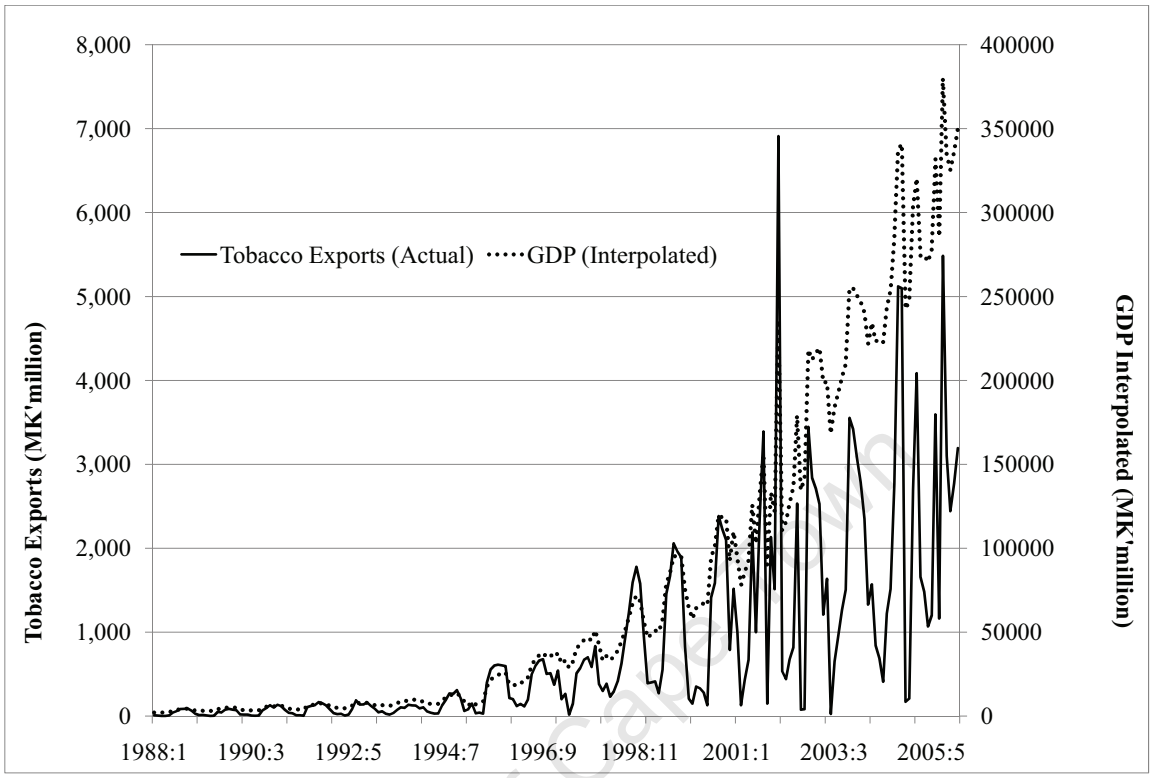
Figure A-3: Tobacco Exports (Actual) and GDP (Interpolated) for Malawi (1988:1-2005:12)



Source (Tobacco Exports): NSO (Malawi)

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A.2 Cointegrated Structural VAR Approach

A.2.1 Cointegrated Structural VAR Framework

To draw a cointegrated structural vector autoregression (SVAR) model, we commence by defining a primitive system of equations as given by:

$$Ay_t = \Omega_{it} + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + ... + \Phi_p y_{t-p} + B\mu_t \tag{A.6}$$

where A is an invertible $(n \times n)$ matrix of contemporaneous parameters; y_t is an $(n \times 1)$ vector of endogenous variables such that $y_t = (y_{1t}, y_{2t}, ..., y_{nt})$; Ω_{it} is a vector of deterministic variables; Φ_i is an $(n \times n)$ matrix of coefficients of lagged endogenous variables $(\forall i = 1, 2, 3, \ldots, p)$; B is an $(n \times n)$ matrix whose non-zero off–diagonal elements allow for direct effects of some shocks on more than one endogenous variable in the system; and μ_t are uncorrelated or orthogonal white-noise structural disturbances. Structural equation (A.6) can be reformulated into a vector error correction model (VECM) given by:

$$A\Delta y_t = \Omega_{it} + \Pi y_{t-1} + \Gamma \Delta y_{t-i} + B\mu_t \tag{A.7}$$

where $\Pi = -\left(I - \Sigma_{i=1}^{p} \Phi_i\right)$; $\Gamma = \Sigma_{i=1}^{p-1} \Psi_i$; and $\Psi_i = -\left(\Sigma_{j=i+1}^{p} \Phi_j\right)$. The Π matrix of parameters contains both short run (adjustment) and long run (levels) components. It is defined as $\alpha\beta^{'}$, where the α_{ij} coefficients show the speed of adjustment to equilibrium and the β_{ij} coefficients show the long run relationship between levels of variables. The Γ_{ij} coefficients show short run changes that occur as a result of previous changes in the variables. Pre-multiplying the equation (A.7) by inverted matrix A^{-1} yields a reduced form VECM of order p in the spirit of Engle and Granger (1987) and Watson (1994), which in standard matrix form is written as:

$$\Delta y_t = \Lambda + \Theta y_{t-1} + \Xi \Delta y_{t-i} + \varepsilon_t \tag{A.8}$$

where $\Lambda = A^{-1}\Omega_{it}$; $\Theta = A^{-1}\Pi$; $\Xi = A^{-1}\Gamma$; and $\varepsilon_t = A^{-1}B\mu_t$. Applying the Johansen approach to cointegration of multivariate systems, three possible cases are expected in the relationship between the rank of matrix Π and its characteristic roots. First is a case

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of full rank i.e. rank $(\Pi) = n$ (number of variables). All rows (columns) are linearly independent (i.e. all variables are I(0)) and all characteristic roots are inside the unit circle with modulus less than 1. The system is effectively stationary and the levels of the variables have stationary means. The appropriate modelling strategy, therefore, is to estimate the standard VAR in levels. Second is a case of zero rank i.e. rank $(\Pi) = 0$. In this event, $\Sigma_{i=1}^{p}\Omega_i = I$, all rows are linearly dependent, there are no cointegrating variables and the system is non-stationary. In this case, Π is an $(n \times n)$ matrix of zeros and the appropriate model is a VAR in first differences involving no long run elements as given by:

$$\Delta y_t = \Lambda + \Xi \Delta y_{t-i} + \varepsilon_t \tag{A.9}$$

The third case is one of reduced rank i.e. rank $(\Pi) = r < n$. The system is nonstationary but there are r cointegrating relations among the variables. The cointegrating relation is determined by $\Pi = \alpha\beta^{'}$ and $\beta^{'} y_{t-1} \neq 0$.

A.2.2 Data Properties

Analysis of the cointegrated SVAR is carried out on the truncated sample only (1994:03-2005:12) covering the period when Malawi adopted indirect tools of monetary control. Using the Augmented Dickey-Fuller Test, it is established that all variables are integrated of order 1 at one percent except for reserve money, which is integrated of order 1 at five percent (see Table A.2). This provides a basis to test for cointegrating relations, defined as deviations from steady state relations. In line with the exploratory data analysis carried out in Chapter 2, Section 2.3.3, we allow for each endogenous variable a linear deterministic trend with intercept and trend in the cointegrating equation and no trend in the VAR. A lag length of 3 is chosen in conformity with the standard information criteria (AIC, SIC and HIC) while ensuring stability of the system. At this lag length, the system is stationary or stable with all 21 inverse roots of the characteristic autoregressive polynomial showing modulus less than one and lying inside the unit circle (see Table A.3). Results of the Johansen Cointegration Test reveal that the system has a reduced rank. While a trace test suggests that there are three cointegrating relations, a maximum eigenvalue test indicates that there

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is only one cointegrating relation (see Table A.4). The study adopts results of the trace test since it is known that the test is more robust to both skewness and excess kurtosis in the residuals than the maximal eigenvalue test (see Harris and Sollis, 2003; Cheung and Lai, 1993).

A.2.3 Structural Analysis

System of equations (A.6) is identified using structural factorisation as presented in system of equations (2.5), which is reproduced in (A.10):

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} \\ a_{41} & a_{42} & 0 & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & 0 & 0 & 1 & a_{56} & 0 \\ 0 & 0 & 0 & a_{64} & 0 & 1 & 0 \\ 0 & 0 & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{pmatrix} \qquad \varepsilon_t = \begin{pmatrix} \varepsilon_t^{GY} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{BL} \\ \varepsilon_t^{XR} \\ \varepsilon_t^{M2} \\ \varepsilon_t^{BR} \\ \varepsilon_t^{RM} \end{pmatrix}$$

$$B = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{pmatrix} \qquad \mu_t = \begin{pmatrix} \mu_t^{GY} \\ \mu_t^{CP} \\ \mu_t^{BL} \\ \mu_t^{XR} \\ \mu_t^{M2} \\ \mu_t^{BR} \\ \mu_t^{RM} \end{pmatrix} \tag{A.10}$$

Estimation results from the cointegrated structural VAR are generally similar to those from the levels estimation carried in line with Sims et al. (1990). Understandably, a number of differences also show up. Among the differences, impulse responses from the cointegrated SVAR die off very quickly compared to those from the estimation in levels. In order to

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retain clear visual images, the forecast horizon is reduced from 60 months in the levels estimation to 12-month in the cointegrated SVAR.

The cointegrated SVAR confirms the finding in the levels estimation that monetary policy in Malawi employs hybrid operating procedures, with the bank rate and reserve money as operating tools. Both the bank rate and reserve money respond significantly to shocks in the three intermediate targets of monetary policy namely exchange rates, aggregate money supply and bank lending (see Figure A-4), revealing that the central bank is concerned with movements in the three targets and to achieve desired levels in these targets, the two policy tools are used. Consistent with the levels estimation, the cointegrated SVAR also shows that the exchange rate and money effect are important channels of monetary transmission in the country, though the impact is not as pronounced as in the levels estimation. The effect of bank lending in the monetary transmission process, however, is insignificant in the cointegrated SVAR, which contradicts the finding in the levels estimation.

The observed differences from the two estimation approaches are not unexpected. An important source of these differences is the imposition of what may be possibly incorrect cointegrating restrictions in the process of estimating the cointegrated VAR. Kim and Roubini (2000) and Becklemans (2005) argue that this is usually the case in cointegrated VARs with the implication that the resulting inferences are often incorrect as well. In an attempt to circumvent the problem, some studies opt for a simple differences specification (see, for example Weitong, 2007; Boivin and Giannoni, 2002; Kasa and Popper, 1997; Kugler et al., 2004; Karame and Olmedo, 2002; Mihira and Sugihara, 2000). The approach, however, is not persuasive as it yields inconsistent estimates if some variables are cointegrated (Bernanke and Mihov, 1997).

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Table A.2: Stationarity Results

Variable	ADF p-value (t-statistic)	Test Critical Values	Order of Integration	Level of Significance
BR	0.0000 (-14.6572)	1% level:-3.4609 5% level:-2.8749 10% level:-2.5740	I(1)	1%
XR	0.0000 (-8.4607)	1% level:-4.0015 5% level:-3.4310 10% level:-3.1391	I(1)	1%
CP	0.0000 (-10.4826)	1% level:-4.0032 5% level:-3.4318 10% level:-3.1396	I(1)	1%
GY	0.0000 (-11.3189)	1% level:-4.0037 5% level:-3.4320 10% level:-3.1397	I(1)	1%
$M2$	0.0000 (-5.5909)	1% level:-4.0037 5% level:-3.4320 10% level:-3.1397	I(1)	1%
RM	0.0000 (-4.0233)	1% level:-4.0041 5% level:-3.4322 10% level:-3.1399	I(1)	5%
BL	0.0000 (-18.1133)	1% level:-4.0015 5% level:-3.4310 10% level:-3.1391	I(1)	1%

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Table A.3: Roots of Characteristic Polynomial

Endogenous variables: GY, CP, BL, XR, M2, BR, RM

Exogenous variables: C

Lag specification: 1 3

Root	Modulus
0.9980	0.9980
0.9199-0.0592i	0.9218
0.9199+0.0592i	0.9218
0.7918-0.4408i	0.9062
0.7918+0.4408i	0.9062
0.8792-0.0381i	0.8800
0.8792+0.0381i	0.8800
0.6642-0.1637i	0.6840
0.6642+0.1637i	0.6840
-0.3299+0.5194i	0.6153
-0.3299-0.5194i	0.6153
0.1145+0.5323i	0.5445
0.1145-0.5323i	0.5445
-0.4846	0.4846
-0.1569-0.4183i	0.4467
-0.1569+0.4183i	0.4467
-0.4355	0.4355
0.0352-0.3677i	0.3694
0.0352+0.3677i	0.3694
0.0288-0.1213i	0.1246
0.0288+0.1213i	0.1246

No root lies outside the unit circle

VAR satisfies the stability condition

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Table A.4: Johansen Cointegration Test Results

Series: GY, CP, BL, XR, M2, BR, RM

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None*	0.4273	203.5590	150.5585	0.0000
At most 1*	0.2217	126.0823	117.7082	0.0132
At Most 2*	0.1898	91.2453	88.8038	0.0329
At most 3	0.1657	61.9936	63.8761	0.0713
At most 4	0.1301	36.8046	42.9153	0.1784
At most 5	0.0935	17.4240	25.8721	0.3839
At most 6	0.0268	3.7759	12.5180	0.7743

* denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eignevalue)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Values	Prob.**
None*	0.4273	77.4768	50.5999	0.0000
At most 1	0.2217	34.8370	44.4972	0.3745
At most 2	0.1898	29.2517	38.3310	0.3723
At most 3	0.1657	25.1890	32.1183	0.2755
At most 4	0.1301	19.3806	25.8232	0.2804
At most 5	0.0935	13.6481	19.3870	0.2786
At most 6	0.0268	3.7759	12.5180	0.7743

* denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

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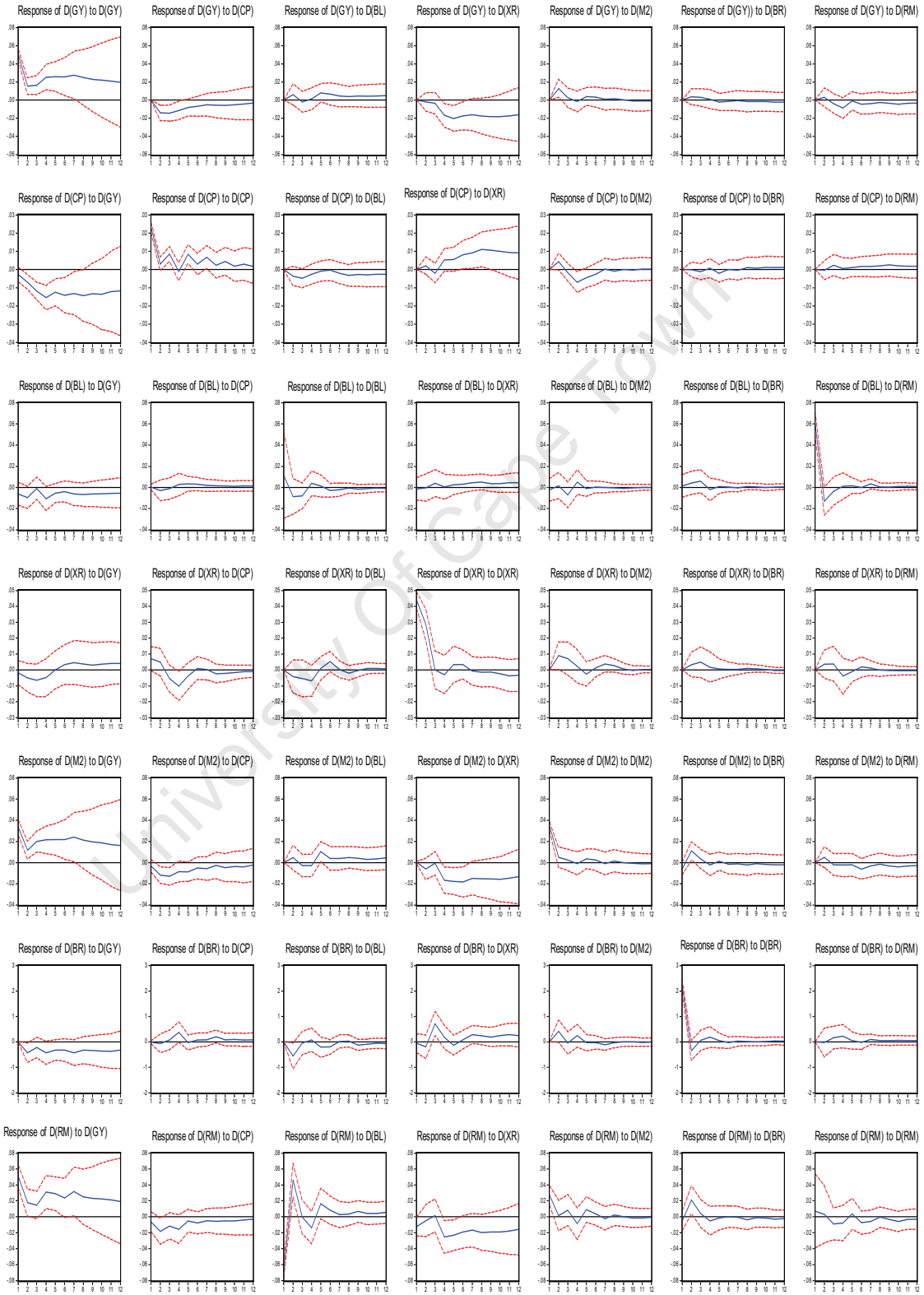
Figure A-4: Impulse Responses of the Composite Model (Cointegrated SVAR) (1994:03-2005:12)



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A.3 Other Tables and Figures

Table A.5: Roots of Characteristic Polynomial for the Generic Model

Endogenous variables: LOG(GY), LOG(CP), BR, LOG(RM)	
Exogenous variables: C	
Lag specification: 1 2	
Root	Modulus
0.9959	0.9959
0.9780	0.9780
0.8801	0.8801
0.7340	0.7340
-0.2486	0.2486
-0.2107-0.0524i	0.2171
-0.2107+0.0524	0.2171
0.0995	0.0995
No root lies outside the unit circle	
VAR satisfies the stability condition	

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Table A.6: VAR Lag Exclusion Wald Test Results for the Generic Model

Sample: 1988M01-2005M12

Included observations:214

Chi-squared test statistics for lag exclusion:

Numbers in [ ] are p-values

	LOG(GY)	LOG(CP)	BR	LOG(RM)	Joint
Lag 1	42.1441	224.7095	205.1882	127.8966	566.2024
	[1.56e-08]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Lag 2	18.1053	5.5830	12.1492	8.6872	42.4266
	[0.0012]	[0.2325]	[0.0163]	[0.0694]	[0.0003]
df	4	4	4	4	16

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Table A.7: Structural VAR Estimates for the Generic VAR Model

Sample (adjusted): 1988M03 2005M12

Included observations: 214 after adjustments

	Coefficient	Std. Error	z-Statistic	Prob.
a_{21}	0.0013	0.0139	0.0958	0.9237
a_{43}	0.0028	0.0024	1.1565	0.2475
b_{11}	0.1081	0.0052	20.6882	0.0000
b_{22}	0.0219	0.0011	20.6882	0.0000
b_{33}	2.1635	0.1046	20.6882	0.0000
b_{44}	0.0753	0.0036	20.6882	0.0000

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Table A.8: Structural VAR Estimates for the Composite Model with a Truncated Sample

Estimated A Matrix						
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
-0.0076	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0879	-0.2082	1.0000	-0.1116	0.1113	-0.0012	-0.2662
-0.0134	-1.1879	0.0000	1.0000	0.0000	0.0000	0.0000
-0.0619	0.2216	0.0000	0.0000	1.0000	0.0037	0.0000
0.0000	0.0000	0.0000	2.1780	0.0000	1.0000	0.0000
0.0000	0.0000	0.6140	0.3339	-0.5049	0.0008	1.0000
Estimated B Matrix						
0.1266	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0139	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0676	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0408	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0538	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	2.3084	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0713

	Coefficient	Std. Error	z-Statistic	Prob.	Expected Sign	Right Sign?
a_{21}	-0.0076	0.0092	-0.8269	0.4083	$-$	$\surd$
a_{31}	0.0879	0.0525	1.6745	0.0940	$+$	$\surd$
a_{32}	-0.0134	0.0271	-0.4928	0.6221	$+$	$\times$
a_{34}	-0.0619	0.0357	-1.7315	0.0834	$+$	$\times$
a_{35}	-0.2082	0.4445	-0.4684	0.6395	$-$	$\surd$
a_{36}	-1.1879	0.2457	-4.8339	0.0000	$-$	$\surd$
a_{37}	0.2216	0.3242	0.6834	0.4944	$-$	$\times$
a_{41}	0.6140	0.6239	0.9842	0.3250	$-$	$\times$
a_{42}	-0.1116	0.2405	-0.4639	0.6427	$-$	$\surd$
a_{51}	2.1780	4.3937	0.4957	0.6201	$+$	$\surd$
a_{52}	0.3339	0.1369	2.4384	0.0148	$+$	$\surd$
a_{56}	0.1113	0.2986	0.3726	0.7095	$-$	$\times$
a_{64}	-0.5049	0.1101	-4.5849	0.0000	$\pm$	$\surd$
a_{73}	-0.0012	0.0026	-0.4727	0.6364	$-$	$\surd$
a_{74}	0.0037	0.0020	1.8835	0.0596	$+$	$\surd$
a_{75}	0.0008	0.0027	0.2830	0.7772	$+$	$\surd$
a_{76}	-0.2662	0.5670	-0.4695	0.6387	$-$	$\surd$
b_{11}	-0.1266	0.0075	-16.8523	0.0000		
b_{22}	0.0139	0.0008	16.8523	0.0000		
b_{33}	-0.0676	0.0206	-3.2778	0.0010		
b_{44}	0.0408	0.0024	16.8523	0.0000		
b_{55}	-0.0538	0.0032	-16.8523	0.0000		
b_{66}	-2.3084	0.1370	-16.8523	0.0000		
b_{77}	0.0713	0.0110	6.4689	0.0000		

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Table A.9: Roots of Characteristic Polynomial for the Composite Model with a Truncated Sample

Endogenous variables: LOG(GY) LOG(CP) LOG(BL) LOG(XR) LOG(M2) BR LOG(RM)

Exogenous variables: C

Lag specification: 1 3

Root	Modulus
0.9996	0.9996
0.9629	0.9629
0.9259	0.9259
0.8761-0.1197i	0.8842
0.8761+0.1197i	0.8842
0.7086-0.4128i	0.8201
0.7086+0.4128i	0.8201
0.6319	0.6319
0.1299+0.5279i	0.5436
0.1299-0.5279i	0.5436
-0.2013-0.4450i	0.4884
-0.2013+0.4450i	0.4884
-0.4506-0.0921i	0.4599
-0.4506+0.0921i	0.4599
0.1431-0.3537i	0.3815
0.1431+0.3537i	0.3815
0.2458+0.1638i	0.2954
0.2458-0.1638i	0.2954
-0.2834	0.2834
-0.1603-0.1899i	0.2485
-0.1603+0.1899i	0.2485

No root lies outside the unit circle

VAR satisfies the stability condition

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Table A.10: VAR Residuals Cross Correlations Ordered by Lags for the Composite Model with a Truncated Sample

	LOG(GY)	LOG(CP)	LOG(BL)	LOG(XR)	LOG(M2)	BR	LOG(RM)
LOG(GY)	1.0000	0.0692	-0.1447	0.0644	0.1345	0.0244	0.1215
LOG(CP)	0.0692	1.0000	0.0567	0.3787	-0.0667	0.1325	-0.0636
LOG(BL)	-0.1447	0.0567	1.0000	0.0197	-0.0098	0.0315	-0.2455
LOG(XR)	0.0644	0.3787	0.0197	1.0000	0.0914	-0.0416	-0.1652
LOG(M2)	0.1345	-0.0667	-0.0098	0.0914	1.0000	-0.1583	0.3488
BR	0.0244	0.1325	0.0315	-0.0416	-0.1583	1.0000	-0.0864
LOG(RM)	0.1215	-0.0636	-0.2455	-0.1652	0.3488	-0.0864	1.0000
LOG(GY(-1))	0.0087	0.0030	-0.0019	-2.50E-05	-0.0048	0.0169	-0.0099
LOG(CP(-1))	-0.0237	-0.0178	-0.0084	0.0534	-0.0338	-0.0655	-0.0113
LOG(BL(-1))	0.0059	0.0003	-0.0160	0.0101	0.0109	0.0049	-0.0319
LOG(XR(-1))	-0.0452	0.0198	-0.0655	0.0925	-0.0569	-0.0603	-0.0599
LOG(M2(-1))	0.0528	0.0346	0.0076	-0.0338	0.0183	0.0400	0.0202
BR(-1)	0.0294	0.0075	0.0138	-0.0101	0.0504	-0.0127	0.0369
LOG(RM(-1))	0.0499	-0.0257	0.0071	0.0024	0.0277	-0.0192	-0.0028
LOG(GY(-2))	-0.0079	0.0194	0.0008	-0.0341	0.0396	0.0290	0.0125
LOG(CP(-2))	0.0334	-0.0073	-0.0174	0.0028	0.0135	-0.0463	0.0381
LOG(BL(-2))	0.0086	0.0069	-0.0053	0.0361	0.0253	0.0161	-0.0246
LOG(XR(-2))	0.0191	-0.0048	0.0125	-0.0561	-9.18E-07	0.0309	0.0792
LOG(M2(-2))	0.0268	0.0400	0.0498	-0.0457	-0.0433	0.0337	0.0268
BR(-2)	0.0248	0.0098	0.0160	0.0617	0.0484	-0.0200	0.0047
LOG(RM(-2))	6.47E-05	-0.0106	0.0287	-0.0278	0.0390	0.0386	-0.0003
LOG(GY(-3))	-0.0912	0.0845	-0.0232	0.0311	0.0495	0.1043	-0.0036
LOG(CP(-3))	-0.1066	-0.0050	-0.0231	-0.0372	-0.0826	0.1682	-0.1254
LOG(BL(-3))	0.1923	-0.0301	0.0094	-0.0197	-0.1163	0.1132	-0.1298
LOG(XR(-3))	-0.1484	0.0196	-0.0331	0.0793	-0.2134	-0.0200	-0.1094
LOG(M2(-3))	-0.0221	-0.1987	0.0108	-0.1352	-0.0472	-0.0239	-0.0751
BR(-3)	0.0018	0.0012	-0.0700	0.0691	-0.0069	0.0149	-0.0039
LOG(RM(-3))	0.0149	-0.0733	0.0525	-0.0350	0.0632	0.0045	-0.0186
LOG(GY(-4))	0.1141	0.0490	0.0519	0.0458	0.0446	0.0617	0.0791
LOG(CP(-4))	-0.1645	-0.0156	0.0891	-0.1368	-0.1793	0.0728	-0.0486
LOG(BL(-4))	-0.0314	0.0131	0.0414	0.1706	-0.0556	0.0389	-0.0104
LOG(XR(-4))	0.0419	0.0223	-0.1196	-0.0401	-0.0890	-0.0484	0.0583
LOG(M2(-4))	-0.0190	0.0323	-0.0566	-0.0351	0.0881	0.0928	-0.0080
BR(-4)	0.1321	0.0289	-0.0647	0.0659	-0.0275	-0.0285	-0.0448
LOG(RM(-4))	-0.0625	-0.0753	0.0263	-0.1436	-0.1127	0.0749	-0.1382
LOG(GY(-5))	0.0924	-0.1258	0.1100	-0.1131	0.0577	-0.1214	-0.0333
LOG(CP(-5))	-0.0649	-0.0886	-0.0294	0.0607	-0.1482	-0.0742	0.0065
LOG(BL(-5))	-0.0033	0.1729	-0.0735	0.0843	0.0059	0.1760	0.0331
LOG(XR(-5))	-0.0194	-0.1425	-0.0424	0.0637	-0.1261	-0.1276	0.0176
LOG(M2(-5))	-0.0059	0.0622	0.1403	0.0699	-0.0537	0.0603	-0.0303
BR(-5)	-0.1000	-0.0239	0.1133	-0.0871	-0.0448	-0.1116	0.0377
LOG(RM(-5))	0.0112	-0.0662	-0.0092	-0.0306	0.1475	-0.0423	-0.0407

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Figure A-5: Impulse Responses of the Composite Model (Full Sample) with Endogenous Exchange Rates

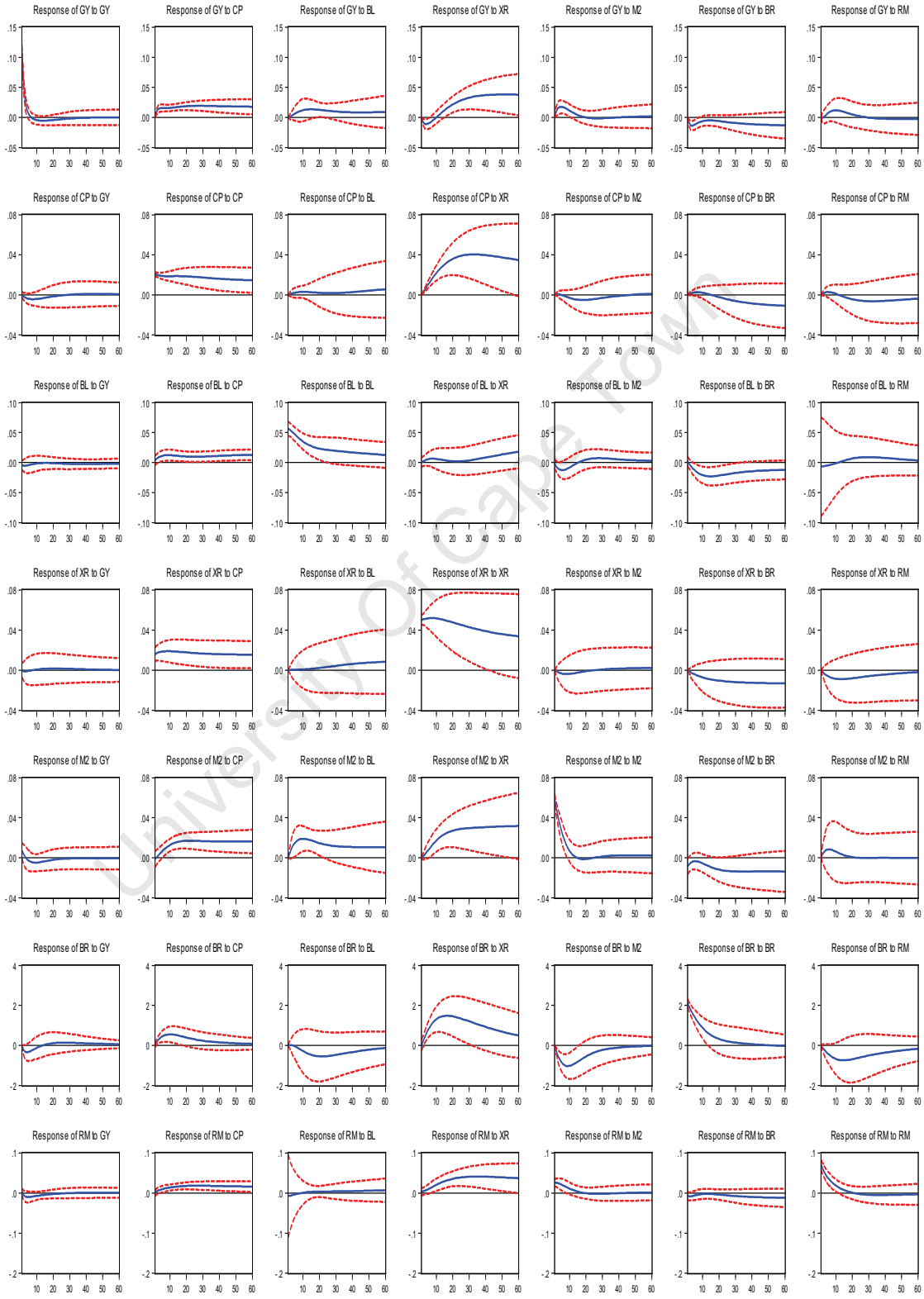

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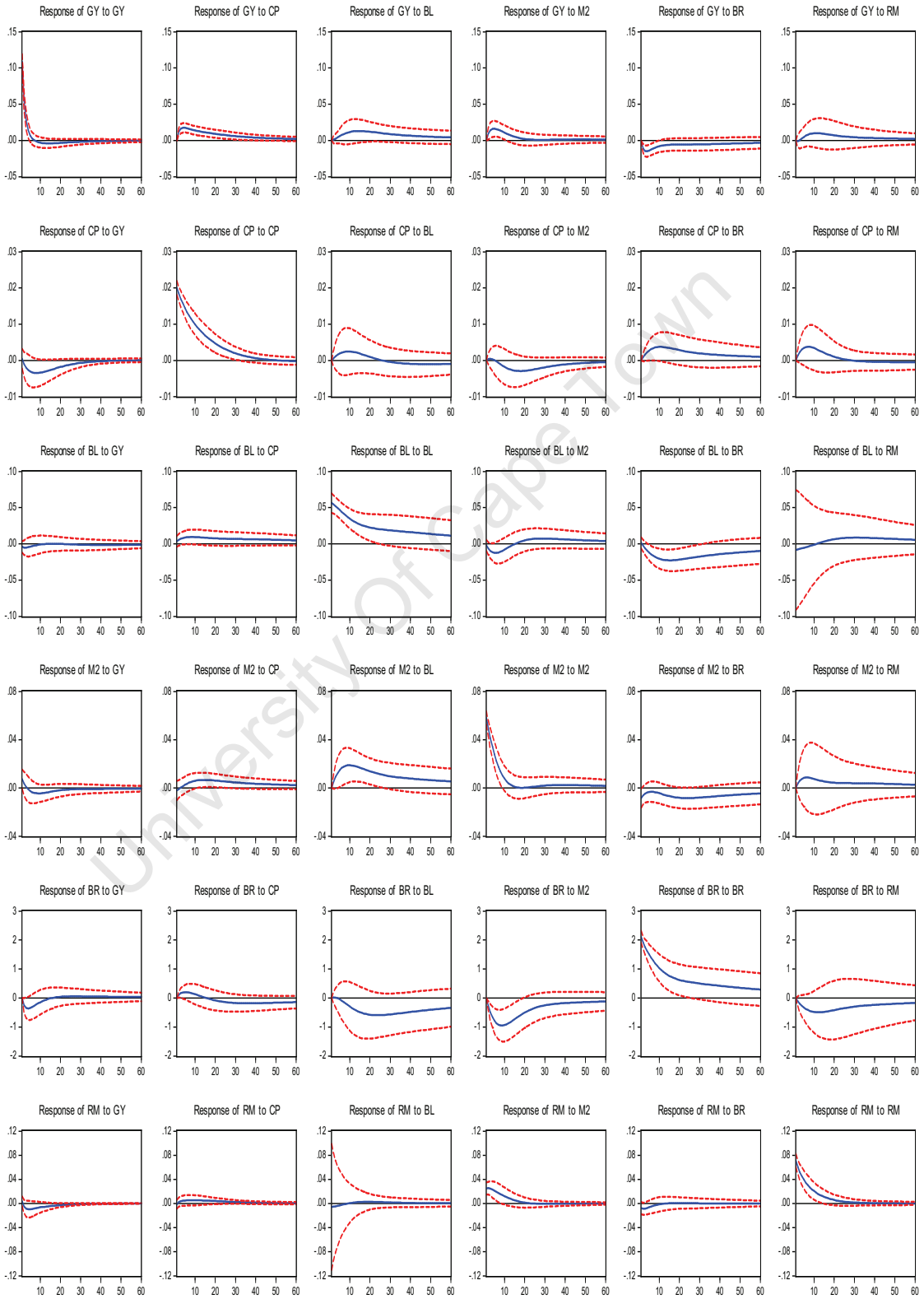
Figure A-6: Impulse Responses of the Composite Model (Full Sample) with Exogenous Exchange Rates



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Appendix B

Appendix to Chapter 4

B.1 Country Sample

B.1.1 Countries with Explicit Deposit Insurance

Argentina, Austria, Bahamas, Bahrain, Bangladesh, Brazil, Canada, Chile, Congo, Cyprus, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, Germany, Greece, Guatemala, Honduras, Iceland, India, Indonesia, Ireland, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Malaysia, Malta, Mexico, Netherlands, Nicaragua, Nigeria, Norway, Oman, Paraguay, Peru, Philippines, Portugal, Spain, Sri Lanka, Switzerland, Tanzania, Thailand, Trinidad and Tobago, Turkey, Uganda, United Kingdom, and Zimbabwe.

B.1.2 Low Income Countries with Explicit Deposit Insurance

Bahamas, Bangladesh, Congo, Honduras, India, Indonesia, Kenya, Nicaragua, Nigeria, Philippines, Sri Lanka, Tanzania, Uganda, and Zimbabwe.

B.1.3 Countries with Implicit Deposit Insurance

Antigua and Barbuda, Australia, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, China, Costa Rica, Cote d'Ivoire, Dominica, Egypt (Arab Republic), Equatorial Guinea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Grenada, Guyana, Iran (Islamic Republic), Israel, Lesotho, Libya, Madagascar, Malawi, Macao China, Maldives, Mali, Mauritius, Morocco, Nepal, New Zealand, Niger, Pakistan, Papua New Guinea, Samoa, Saudi Arabia, Senegal, Seychelles,

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Sierra Leone, Singapore, Solomon Islands, South Africa, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Sweden, Togo, Tonga, Tunisia, Uruguay, Vanuatu, Venezuela (Bolivarian Republic of), Yemen (Republic), and Zambia.

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B.2 Definitions and Measurement of Deposit Insurance Variables

- *admin*: Administration of deposit insurance. It takes the value 3 if administration is private, 1 if it is official and 2 if it is joint.
- *coinsur*: Coinsurance. It takes the value 1 if there is coinsurance of the deposit insurance scheme and zero otherwise.
- *crgdp*: Ratio of domestic private sector credit to GDP.
- *dinsur*: Deposit insurance. It takes the value 1 when a country has explicit deposit insurance and zero otherwise.
- *funding*: Permanent fund. It takes the value 1 if the deposit insurance is funded and zero otherwise. In a funded deposit insurance system, members or government make periodic contributions to the fund, which is then used as the main source for paying out depositors in the event of bank failure (Demirgüç-Kunt et al., 2005). In a non-funded system, on the other hand, members pay their contributions to the fund after a bank failure has already occurred. As at 2003, only 14 countries out of 88 had unfunded deposit insurance, 11 of which were European and Chile was the only country with the government as a sole contributor to the fund (Demirgüç-Kunt et al., 2005).
- *fxcoverd*: Foreign currency deposits covered. The variable takes the value 1 if foreign currency deposits are covered by the deposit insurance and zero otherwise.
- *gdpgr*: GDP growth.
- *gdppc*: Gross domestic product (GDP) per capita measured in constant 2000 US Dollars.
- *guarantee*: Deposits guaranteed coverage. The variable takes the value 2 in the case of unlimited guarantee (full coverage), 1 in the case of limited guarantee (partial

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coverage) and zero otherwise.

- $inflatn$: Inflation measured by year on year percentage changes in the all items national composite consumer price index.
- $intbank$: Interbank deposits covered. The variable takes the value 1 if interbank deposits are covered by the deposit insurance and zero otherwise.
- $interven$: Does the deposit insurance authority make the decision to intervene a bank? The variable takes the the value 1 if yes and zero otherwise.
- $legalcancel$: Does the deposit insurance authority have the legal power to cancel or revoke deposit insurance for any participating bank? The variable takes the value 1 if yes and zero otherwise.
- $legalmgr$: Can the deposit insurance agency/fund take legal action against bank directors or other bank officials? The variable takes the value 1 if yes and zero otherwise.
- $m2fxres$: Ratio of M2 to foreign exchange reserves.
- $membship$: Membership takes the value 1 if affiliating to a deposit insurance scheme is compulsory and zero if it is voluntary. In most countries (almost 90 percent as of 2003), membership to a deposit insurance is compulsory.
- rir: Real interest rates.
- $rskadj$: Risk adjusted premiums. It takes the value 1 in cases where premiums vary according to riskiness of the assessment base and zero otherwise. The number of countries with risk adjusted premiums has risen from only the United States in 1995 to 20 as at 2003 (Demirgüç-Kunt et al., 2005).
- $sourcefnd$: Source of funding. It takes the value 2 if the deposit insurance is solely funded by the government, zero if it is privately funded and 1 if funded jointly by the government and the private sector.
- $xrdepr$: Exchange rate depreciation.

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B.3 Tables and Figures

Table B.1: Zero Order Correlation Matrix of Banking Instability Indicators

	$nbrun1$	$bbrun1$	$nbrun2$	$bbrun2$	$ninsolv$	$binsolv$
$nbrun1$	1.0000					
$bbrun1$	0.7588	1.0000				
$nbrun2$	0.4319	0.3920	1.0000			
$bbrun2$	0.4572	0.4740	0.7253	1.0000		
$ninsolv$	0.3708	0.3541	0.1596	0.2052	1.0000	
$binsolv$	0.3854	0.3568	0.1545	0.2287	0.7082	1.0000

Table B.2: Expected Signs of Variables

Variable	Expected Sign	Variable	Expected Sign
$admin$	$+/-$	$intbank$	$+/-$
$africa$	$+$	$interven$	$+/-$
$coinsur$	$+/-$	$leglcancel$	$+/-$
$crgdp$	$+$	$leglmgr$	$+/-$
$dinsur$	$+/-$	$m2fxres$	$+$
$funding$	$+/-$	$membeship$	$+/-$
$fxcoverd$	$+/-$	rir	$+$
$gdpgr$	$-$	$rskadj$	$+/-$
$gdppc$	$-$	$sourcefnd$	$+/-$
$guarantee$	$+/-$	$xrdepr$	$+$
$inflatn$	$+$		

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Table B.3: Zero Order Correlation Matrix of Control Variables

	$gdpgr$	rir	$inflatn$	$m2fxres$	$crgdp$	$xrdepr$	$dinsur$	$africa$	$gdppc$
$gdpgr$	1.0000								
rir	-0.0330	1.0000							
$inflatn$	-0.0894	0.1581	1.0000						
$m2fxres$	-0.0372	-0.0276	0.0043	1.0000					
$crgdp$	-0.0123	0.0471	-0.0316	-0.0226	1.0000				
$xrdepr$	0.1640	-0.0304	-0.3009	-0.0087	0.2076	1.0000			
$dinsur$	-0.0039	0.0164	-0.0284	-0.0310	0.3535	0.0711	1.0000		
$africa$	-0.0095	-0.0469	-0.0421	0.0716	-0.4446	-0.0306	-0.3107	1.0000	
$gdppc$	-0.0287	0.0241	-0.0383	-0.0313	0.7085	0.1865	0.4567	-0.4170	1.0000

Table B.4: Zero Order Correlation Matrix of Control Variables and Deposit Insurance Guarantee

	$gdpgr$	rir	$inflatn$	$m2fxres$	$crgdp$	$xrdepr$	$guarantee$
$gdpgr$	1.0000						
rir	-0.0199	1.0000					
$inflatn$	-0.1452	0.5699	1.0000				
$m2fxres$	-0.0726	-0.1268	0.0304	1.0000			
$crgdp$	-0.1226	0.0328	-0.0952	-0.0665	1.0000		
$xrdepr$	0.2179	-0.0104	-0.4636	-0.0245	0.3160	1.0000	
$guarantee$	-0.0336	-0.0418	-0.0060	-0.0354	-0.0291	-0.1170	1.0000

Table B.5: Zero Order Correlation Matrix of Control Variables and Deposit Insurance Coverage

	$gdpgr$	rir	$inflatn$	$m2fxres$	$crgdp$	$xrdepr$	$fxcoverd$	$intbank$
$gdpgr$	1.0000							
rir	-0.1151	1.0000						
$inflatn$	-0.1762	0.6187	1.0000					
$m2fxres$	-0.0632	-0.0204	-0.0167	1.0000				
$crgdp$	-0.1732	0.0208	-0.0955	0.3905	1.0000			
$xrdepr$	0.2341	-0.0759	-0.4650	0.0633	0.3399	1.0000		
$fxcoverd$	-0.0219	-0.0110	0.0628	-0.4094	-0.2318	-0.1199	1.0000	
$intbank$	0.0070	-0.0475	-0.0304	0.1049	-0.1396	-0.0245	-0.0599	1.0000

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Table B.6: Zero Order Correlation Matrix of Control Variables and Deposit Insurance Legal Environment

	gdpgr	*rir*	*inflatn*	*m2fxres*	*crgdp*	*xrdepr*	*interven*	*legalcancel*	*legalmgr*
gdpgr	1.0000								
rir	-0.1494	1.0000							
inflatn	-0.1846	0.6340	1.0000						
m2fxres	-0.0593	-0.0156	-0.0198	1.0000					
crgdp	-0.1446	0.0194	-0.1067	0.4316	1.0000				
xrdepr	0.2419	-0.1096	-0.4810	0.0807	0.3639	1.0000			
interven	-0.0597	0.0169	-0.0447	0.1051	-0.0170	0.0837	1.0000		
legalcancel	0.0936	-0.0715	-0.0895	-0.0279	-0.0199	0.1803	0.2093	1.0000	
legalmgr	-0.0685	0.0151	0.0976	-0.1651	-0.2760	-0.2076	0.1613	-0.1957	1.0000

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Table B.7: Zero Order Correlation Matrix of Control Variables and Deposit Insurance Administration

	gdpgr	*rir*	*inflatn*	*m2fxres*	*crgdp*	*xrdepr*	*admin*	*coinsur*	*funding*	*rskadj*	*membship*	*sourcefnd*
gdpgr	1.0000											
rir	-0.1243	1.0000										
inflatn	-0.1807	0.6204	1.0000									
m2fxres	-0.0696	-0.0216	-0.0169	1.0000								
crgdp	-0.1669	0.0185	-0.0944	0.3980	1.0000							
xrdepr	0.2202	-0.0835	-0.4693	0.0624	0.3438	1.0000						
admin	-0.1668	0.0427	0.0349	-0.0120	0.2093	0.0538	1.0000					
coinsur	0.0618	0.0242	-0.0526	-0.2372	0.2591	0.1395	-0.0661	1.0000				
funding	-0.0087	-0.0225	0.0457	0.1981	-0.1767	-0.1204	0.0274	-0.2691	1.0000			
rskadj	-0.0704	-0.0105	-0.0046	-0.1853	-0.1291	-0.0932	0.3375	-0.2064	-0.0303	1.0000		
membship	0.0356	-0.0413	-0.2133	-0.0023	-0.0231	0.2097	-0.2449	0.1722	-0.1485	0.1592	1.0000	
sourcefnd	0.1237	-0.0854	-0.0960	0.1302	-0.2082	-0.0195	-0.2242	-0.1440	-0.0727	0.1431	0.1472	1.0000

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Table B.8: Deposit Insurance and Banking Crises: Baseline Model (1981-1999)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0714***	-0.0613***	-0.0568**	-0.0845***	-0.0474**	-0.0525***
	(0.0161)	(0.0136)	(0.0248)	(0.0196)	(0.0186)	(0.0158)
rir	-0.00258	-0.00418	-0.0131	-0.0262	-0.0227***	-0.00381
	(0.00350)	(0.00357)	(0.0202)	(0.0181)	(0.00767)	(0.00425)
inflatn	-0.000125	-0.000183	-0.0171	-0.0202*	-0.000311	1.21e-05
	(0.000178)	(0.000180)	(0.0135)	(0.0122)	(0.000246)	(0.000155)
m2fxres	7.52e-05	3.45e-05	-0.000517	0.00431	0.00161	-0.000744
	(0.000116)	(0.000110)	(0.00555)	(0.00288)	(0.00169)	(0.000711)
crgdp	-0.000697	-0.000104	0.0110**	0.0107**	0.00541	0.00793**
	(0.00311)	(0.00261)	(0.00452)	(0.00465)	(0.00350)	(0.00401)
xrdepr	-0.0138***	-0.0117***	-0.00393	0.000135	-0.0108*	-0.0221***
	(0.00409)	(0.00363)	(0.0109)	(0.00834)	(0.00588)	(0.00497)
gdppc	1.01e-05	-5.21e-06	-2.36e-05	-2.03e-06	-4.01e-05**	-2.26e-05
	(1.60e-05)	(1.36e-05)	(2.47e-05)	(2.48e-05)	(1.90e-05)	(2.32e-05)
africa	0.307	0.569***	0.210	0.369	0.0394	0.347
	(0.189)	(0.153)	(0.364)	(0.362)	(0.227)	(0.286)
dinsur	-0.0370	-0.0385	0.554	0.366	0.350	0.398
	(0.218)	(0.176)	(0.351)	(0.325)	(0.219)	(0.253)
countries	94	96	108	108	89	105
obs.	1480	1512	1756	1773	1391	1694

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively

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Table B.9: Deposit Insurance and Banking Crises: Baseline Model (1988-1996)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.103***	-0.112***	-0.0444	-0.101***	-0.0993***	-0.0925***
	(0.0254)	(0.0233)	(0.0391)	(0.0320)	(0.0293)	(0.0261)
rir	0.000397	-0.000940	-0.0105	-0.0336	-0.0262**	-0.00404
	(0.00363)	(0.00370)	(0.0327)	(0.0313)	(0.0116)	(0.00476)
inflatn	-0.000112	-0.000265	-0.0191	-0.0441*	-0.000553	0.000333
	(0.000273)	(0.000293)	(0.0229)	(0.0243)	(0.000415)	(0.000443)
m2fxres	0.000253	0.000109	0.000886	0.00556*	0.00143	-0.000863
	(0.000174)	(0.000203)	(0.00456)	(0.00313)	(0.00194)	(0.000945)
crgdp	-0.00974*	-0.00369	-0.00769	-0.00794	0.000793	0.00347
	(0.00513)	(0.00451)	(0.00729)	(0.00712)	(0.00645)	(0.00672)
xrdepr	-0.0105*	-0.0147**	0.00911	-0.00179	-0.0205**	-0.0250***
	(0.00634)	(0.00590)	(0.0187)	(0.0145)	(0.00864)	(0.00735)
gdppc	3.17e-05	1.88e-05	5.24e-05	9.02e-05**	-2.01e-05	2.81e-06
	(2.45e-05)	(2.38e-05)	(3.35e-05)	(3.62e-05)	(3.32e-05)	(3.63e-05)
africa	-0.0149	0.514*	0.259	0.418	0.397	0.697
	(0.288)	(0.277)	(0.487)	(0.483)	(0.363)	(0.429)
dinsur	-0.0679	-0.257	0.258	-0.525	-0.0116	0.0148
	(0.320)	(0.311)	(0.506)	(0.556)	(0.367)	(0.432)
countries	94	96	108	108	89	105
obs.	735	753	860	867	696	860

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively

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Table B.10: Deposit Insurance and Banking Crises: Baseline Model (1988-2001)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0956***	-0.103***	-0.0604**	-0.111***	-0.108***	-0.113***
	(0.0205)	(0.0185)	(0.0294)	(0.0243)	(0.0238)	(0.0215)
rir	-0.00106	-0.00212	-0.00687	-0.0171	-0.0297***	-0.00579
	(0.00344)	(0.00355)	(0.0213)	(0.0213)	(0.0103)	(0.00454)
inflatn	-0.000225	-0.000313	-0.0102	-0.0239*	-0.000568	0.000306
	(0.000275)	(0.000286)	(0.0121)	(0.0145)	(0.000415)	(0.000414)
m2fxres	-2.55e-05	9.72e-05	-0.000443	0.00555*	0.00129	-0.000830
	(9.26e-05)	(0.000185)	(0.00590)	(0.00304)	(0.00184)	(0.000862)
crgdp	-0.00131	0.00147	0.00933**	0.00778*	0.00817**	0.00738*
	(0.00308)	(0.00284)	(0.00385)	(0.00435)	(0.00376)	(0.00424)
xrdepr	-0.0182***	-0.0188***	-0.0156	-0.0167	-0.0179**	-0.0233***
	(0.00551)	(0.00527)	(0.0131)	(0.0110)	(0.00789)	(0.00646)
gdppc	2.29e-05	5.36e-06	4.75e-06	1.28e-05	-4.16e-05*	-9.86e-06
	(1.64e-05)	(1.56e-05)	(2.20e-05)	(2.49e-05)	(2.24e-05)	(2.48e-05)
africa	0.0972	0.407*	0.114	0.000743	0.141	0.420
	(0.221)	(0.211)	(0.364)	(0.391)	(0.283)	(0.327)
dinsur	-0.179	-0.251	0.133	-0.0819	0.0215	0.0684
	(0.241)	(0.220)	(0.343)	(0.347)	(0.268)	(0.287)
countries	94	96	108	108	89	105
obs.	1133	1156	1348	1360	1064	1217

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively

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Table B.11: Deposit Insurance and Banking Crises: Baseline Model (1989-2004)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0879***	-0.0947***	-0.0675**	-0.111***	-0.107***	-0.115***
	(0.0195)	(0.0174)	(0.0285)	(0.0235)	(0.0215)	(0.0200)
rir	-0.000273	-0.00176	0.00217	-0.0137	-0.0262***	-0.00582
	(0.00340)	(0.00357)	(0.0216)	(0.0195)	(0.00916)	(0.00419)
inflatn	-0.000167	-0.000284	-0.0175	-0.0300**	-0.000631	0.000158
	(0.000277)	(0.000287)	(0.0146)	(0.0140)	(0.000431)	(0.000345)
m2fxres	-2.78e-05	0.000150	0.00242	0.00772**	0.00117	-0.000834
	(6.37e-05)	(0.000192)	(0.00495)	(0.00311)	(0.00176)	(0.000821)
crgdp	0.00305	0.00328	0.00972**	0.00862**	0.00947***	0.00874**
	(0.00266)	(0.00264)	(0.00391)	(0.00416)	(0.00311)	(0.00375)
xrdepr	-0.0143***	-0.0174***	-0.0246**	-0.0260***	-0.0201***	-0.0256***
	(0.00532)	(0.00501)	(0.0119)	(0.00956)	(0.00686)	(0.00609)
gdppc	6.27e-06	-2.95e-06	1.44e-05	9.43e-06	-4.52e-05**	-1.15e-05
	(1.47e-05)	(1.46e-05)	(2.26e-05)	(2.49e-05)	(1.86e-05)	(2.18e-05)
africa	0.0504	0.352*	0.0923	-0.0864	0.110	0.356
	(0.210)	(0.204)	(0.383)	(0.404)	(0.239)	(0.291)
dinsur	-0.141	-0.209	0.0484	-0.0603	0.0198	-0.0930
	(0.219)	(0.200)	(0.337)	(0.312)	(0.225)	(0.253)
countries	94	96	109	109	89	105
obs.	1298	1322	1554	1568	1215	1341

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively

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Table B.12: Banking Instability and the Generosity of Deposit Insurance Payouts (1981-1999)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0904**	-0.0705*	-0.106	-0.141**	0.0473	-0.0327
	(0.0461)	(0.0425)	(0.0792)	(0.0694)	(0.0488)	(0.0455)
rir	-0.00111	-0.000732	-0.0351	-0.0125	-0.0856***	-0.0562**
	(0.00639)	(0.00640)	(0.0405)	(0.0322)	(0.0272)	(0.0239)
inflatn	0.000695	0.000223	-0.0118	-0.00319	-0.0149	-0.0144
	(0.000881)	(0.000913)	(0.0187)	(0.00926)	(0.0116)	(0.0101)
m2fxres	0.000163	0.000301	0.00779	0.0389	0.00493	-0.00193
	(0.000122)	(0.000188)	(0.0281)	(0.0247)	(0.0186)	(0.00418)
crgdp	-0.000567	0.00490	0.00752	0.00942	0.00751	0.0115**
	(0.00386)	(0.00462)	(0.00837)	(0.00778)	(0.00564)	(0.00535)
xrdepr	-0.000697	-0.0212*	-0.00996	-0.00198	-0.0256	-0.0314**
	(0.0102)	(0.0109)	(0.0203)	(0.0166)	(0.0160)	(0.0144)
guarantee	0.529	0.330	1.355	2.543***	0.948*	0.955*
	(0.379)	(0.462)	(0.864)	(0.849)	(0.561)	(0.548)
Countries	40	42	42	43	41	44
Obs.	370	395	400	404	368	423

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.13: Banking Instability and the Generosity of Deposit Insurance Payouts (1988-1996)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0982	-0.0727	-0.0886	-0.133	0.0667	-0.00881
	(0.0616)	(0.0563)	(0.101)	(0.103)	(0.0538)	(0.0588)
rir	0.000964	0.00134	0.00149	0.0173	-0.113***	-0.0982**
	(0.00697)	(0.00701)	(0.0502)	(0.0591)	(0.0353)	(0.0413)
inflatn	0.000440	-0.000301	-0.00672	-0.0132	-0.0519**	-0.0498**
	(0.00101)	(0.00105)	(0.0205)	(0.0295)	(0.0229)	(0.0224)
m2fxres	0.000234	0.000237	0.0189	0.0642	0.0338	-0.00176
	(0.000168)	(0.000228)	(0.0300)	(0.0399)	(0.0230)	(0.00274)
crgdp	-0.00487	0.00310	-0.00287	-0.00306	-0.0142	0.00170
	(0.00597)	(0.00552)	(0.0114)	(0.0140)	(0.00899)	(0.00854)
xrdepr	-0.00171	-0.0268*	-0.00365	-0.0182	-0.0298	-0.0787***
	(0.0155)	(0.0150)	(0.0318)	(0.0311)	(0.0247)	(0.0247)
guarantee	0.313	0.451	0.616	2.182*	1.148*	1.168
	(0.527)	(0.608)	(1.003)	(1.221)	(0.629)	(0.952)
Countries	30	32	33	33	31	35
Obs.	209	222	228	228	205	246

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.14: Banking Instability and the Generosity of Deposit Insurance Payouts (1988-2001)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0675	-0.0563	-0.0722	-0.105	0.0136	-0.0381
	(0.0458)	(0.0430)	(0.0701)	(0.0660)	(0.0526)	(0.0485)
rir	0.000803	0.00118	-0.0353	0.00269	-0.114***	-0.0850***
	(0.00663)	(0.00675)	(0.0376)	(0.0423)	(0.0337)	(0.0319)
inflatn	9.10e-06	-0.000603	-0.00666	-0.00981	-0.0394*	-0.0299*
	(0.000924)	(0.000990)	(0.0135)	(0.0187)	(0.0220)	(0.0171)
m2fxres	-6.96e-06	0.000264	0.00670	0.0540**	0.00854	-0.00184
	(9.18e-05)	(0.000228)	(0.0266)	(0.0265)	(0.0210)	(0.00320)
crgdp	0.00219	0.00616	0.00850	0.0104	0.00220	0.00586
	(0.00335)	(0.00381)	(0.00578)	(0.00635)	(0.00506)	(0.00507)
xrdepr	-0.0207*	-0.0379***	-0.0190	-0.0291	-0.0333*	-0.0535***
	(0.0122)	(0.0130)	(0.0222)	(0.0208)	(0.0198)	(0.0185)
guarantee	0.296	0.605	1.097	2.474***	1.043*	0.585
	(0.397)	(0.449)	(0.727)	(0.755)	(0.575)	(0.630)
Countries	43	45	45	46	44	47
Obs.	352	375	388	396	353	385

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.15: Banking Instability and the Generosity of Deposit Insurance Payouts (1989-2004)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0838*	-0.0720*	-0.101	-0.128**	-0.0304	-0.0839*
	(0.0473)	(0.0417)	(0.0665)	(0.0605)	(0.0511)	(0.0507)
rir	0.00302	0.00160	-0.0344	-0.00550	-0.0970***	-0.0680**
	(0.00726)	(0.00679)	(0.0431)	(0.0412)	(0.0292)	(0.0301)
inflatn	0.000322	-0.000475	-0.0236	-0.0255	-0.0230	-0.0195
	(0.00104)	(0.000956)	(0.0245)	(0.0253)	(0.0184)	(0.0150)
m2fxres	-1.27e-05	0.000336	0.00752	0.0499**	-0.00221	-0.00245
	(5.61e-05)	(0.000234)	(0.0251)	(0.0237)	(0.0173)	(0.00592)
crgdp	0.00670**	0.00807**	0.0104**	0.00950*	0.00569	0.00841*
	(0.00339)	(0.00345)	(0.00512)	(0.00541)	(0.00395)	(0.00432)
xrdepr	-0.00867	-0.0310**	-0.0260	-0.0230	-0.0341**	-0.0494***
	(0.0127)	(0.0121)	(0.0203)	(0.0179)	(0.0168)	(0.0168)
guarantee	0.419	0.745*	0.669	1.818***	0.399	0.334
	(0.433)	(0.427)	(0.654)	(0.644)	(0.521)	(0.571)
Countries	45	47	48	49	46	48
Observations	435	463	481	495	441	461

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.16: Banking Instability and Deposit Insurance Coverage (1981-1999)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.118**	-0.103**	-0.102	-0.113	-0.00468	-0.0972*
	(0.0566)	(0.0484)	(0.0884)	(0.0707)	(0.0624)	(0.0537)
rir	0.000105	-0.000199	-0.0278	-0.0176	-0.0849***	-0.0500**
	(0.00669)	(0.00644)	(0.0380)	(0.0317)	(0.0285)	(0.0243)
inflatn	0.000547	0.000178	-0.00731	-0.00446	-0.00994	-0.0105
	(0.000948)	(0.000921)	(0.0126)	(0.00822)	(0.00979)	(0.00863)
m2fxres	0.0338	0.0279	0.00988	0.0447*	0.00476	0.0134
	(0.0217)	(0.0179)	(0.0294)	(0.0255)	(0.0216)	(0.0196)
crgdp	-0.00352	-0.00176	0.0148	0.0138	0.00745	0.0126*
	(0.00592)	(0.00533)	(0.00935)	(0.00865)	(0.00664)	(0.00665)
xrdepr	-0.00371	-0.0175	-0.0133	-0.0123	-0.0137	-0.0263*
	(0.0120)	(0.0110)	(0.0209)	(0.0168)	(0.0166)	(0.0148)
fxcoverd	0.725	-0.130	1.513	1.637*	0.277	1.181*
	(0.567)	(0.470)	(0.954)	(0.889)	(0.628)	(0.666)
intbank	0.924*	0.531	0.448	0.269	0.842	1.069
	(0.517)	(0.504)	(0.924)	(0.919)	(0.622)	(0.683)
Countries	35	37	38	39	37	40
Obs.	350	378	399	403	367	407

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.17: Banking Instability and Deposit Insurance Coverage (1988-1996)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.129*	-0.131**	-0.0855	-0.0908	-0.0870	-0.136
	(0.0713)	(0.0611)	(0.102)	(0.0975)	(0.0942)	(0.0856)
rir	0.00329	0.00259	-0.0293	-0.0135	-0.127***	-0.0900*
	(0.00753)	(0.00716)	(0.0569)	(0.0675)	(0.0434)	(0.0462)
inflatn	0.000348	-0.000492	-0.0110	-0.0150	-0.0421*	-0.0409*
	(0.00105)	(0.00104)	(0.0227)	(0.0252)	(0.0234)	(0.0233)
m2fxres	0.0661***	0.0398**	0.0337	0.0875*	0.0357	0.0517*
	(0.0225)	(0.0195)	(0.0318)	(0.0473)	(0.0262)	(0.0312)
crgdp	-0.0211**	-0.00923	-0.00460	-0.00694	-0.0179*	-0.00302
	(0.00935)	(0.00671)	(0.0120)	(0.0155)	(0.0106)	(0.0121)
xrdepr	0.00531	-0.0213	-0.00598	-0.0305	-0.0197	-0.0720***
	(0.0164)	(0.0149)	(0.0341)	(0.0322)	(0.0249)	(0.0260)
fxcoverd	0.523	-0.578	0.997	0.695	0.123	2.277**
	(0.559)	(0.514)	(1.006)	(1.272)	(0.709)	(1.119)
intbank	0.291	-0.208	-22.58	-26.61	-1.030	0.190
	(0.587)	(0.628)	(38448)	(94112)	(0.882)	(1.222)
Countries	29	31	33	33	31	34
Obs.	203	216	231	231	208	240

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.18: Banking Instability and Deposit Insurance Coverage (1988-2001)

Variables	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.117**	-0.109**	-0.0638	-0.0796	-0.0696	-0.117*
	(0.0596)	(0.0516)	(0.0780)	(0.0710)	(0.0719)	(0.0620)
rir	0.00113	0.00132	-0.0299	-0.00271	-0.111***	-0.0780**
	(0.00715)	(0.00694)	(0.0362)	(0.0397)	(0.0387)	(0.0329)
inflatn	-9.29e-05	-0.000719	-0.00531	-0.0102	-0.0270	-0.0228
	(0.00103)	(0.00103)	(0.0105)	(0.0134)	(0.0237)	(0.0165)
m2fxres	0.0364	0.0440**	0.00378	0.0638**	0.0138	0.0171
	(0.0232)	(0.0210)	(0.0271)	(0.0285)	(0.0242)	(0.0201)
crgdp	0.00141	0.000773	0.0137**	0.0115	0.00267	0.00730
	(0.00539)	(0.00507)	(0.00623)	(0.00717)	(0.00670)	(0.00646)
xrdepr	-0.0244	-0.0377***	-0.0246	-0.0465**	-0.0116	-0.0458**
	(0.0151)	(0.0142)	(0.0232)	(0.0229)	(0.0214)	(0.0194)
fxcoverd	0.644	0.134	1.016	1.239	0.527	1.136
	(0.565)	(0.556)	(0.768)	(0.916)	(0.693)	(0.736)
intbank	0.353	0.245	-0.231	-0.827	0.812	0.865
	(0.574)	(0.594)	(0.825)	(1.053)	(0.691)	(0.760)
Countries	38	40	41	42	40	43
Obs.	328	356	378	386	343	369

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.19: Banking Instability and Deposit Insurance Coverage (1989-2004)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.148**	-0.113**	-0.0729	-0.0644	-0.105*	-0.162***
	(0.0630)	(0.0510)	(0.0711)	(0.0657)	(0.0634)	(0.0619)
rir	0.000986	0.00153	-0.0222	-0.0142	-0.103***	-0.0678**
	(0.00778)	(0.00702)	(0.0436)	(0.0462)	(0.0312)	(0.0310)
inflatn	0.000939	-0.000550	-0.0135	-0.0310	-0.0171	-0.0155
	(0.00113)	(0.00100)	(0.0233)	(0.0305)	(0.0151)	(0.0132)
m2fxres	0.0441	0.0403*	0.00156	0.0698**	-0.00394	-0.000882
	(0.0285)	(0.0213)	(0.0274)	(0.0283)	(0.0199)	(0.0170)
crgdp	0.00463	0.00421	0.0146***	0.00962	0.00691	0.00919*
	(0.00628)	(0.00512)	(0.00560)	(0.00708)	(0.00490)	(0.00532)
xrdepr	-0.00465	-0.0323**	-0.0292	-0.0436**	-0.0229	-0.0421**
	(0.0162)	(0.0136)	(0.0211)	(0.0210)	(0.0175)	(0.0170)
fxcoverd	0.0580	-0.310	0.336	0.785	-0.206	0.257
	(0.698)	(0.603)	(0.656)	(1.016)	(0.551)	(0.638)
intbank	0.117	0.0122	-0.647	-1.224	0.234	0.395
	(0.798)	(0.683)	(0.843)	(1.227)	(0.589)	(0.680)
Countries	39	41	42	43	41	44
Observations	395	431	455	469	417	437

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.20: Banking Instability and the Legal Environment of Deposit Insurance (1981-1999)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0997*	-0.0752	-0.160	-0.115	-0.0320	-0.0624
	(0.0580)	(0.0531)	(0.0998)	(0.0884)	(0.0681)	(0.0613)
rir	0.00181	0.00383	-0.0666	-0.0380	-0.0583	-0.0437
	(0.00678)	(0.00718)	(0.0480)	(0.0432)	(0.0356)	(0.0322)
inflatn	0.000216	-0.000311	-0.0100	-0.00550	-0.0111	-0.0190
	(0.000932)	(0.00103)	(0.0133)	(0.00851)	(0.0113)	(0.0125)
m2fxres	0.0240*	0.0319*	0.00154	0.0500*	-0.000611	0.00276
	(0.0144)	(0.0168)	(0.0285)	(0.0296)	(0.0227)	(0.0215)
crgdp	-0.00709	-0.00201	0.00339	0.00944	0.0112	0.0145*
	(0.00551)	(0.00595)	(0.00955)	(0.0111)	(0.00743)	(0.00784)
xrdepr	-0.00851	-0.0258**	-0.0192	-0.0332	-0.0350*	-0.0648***
	(0.0125)	(0.0128)	(0.0232)	(0.0206)	(0.0199)	(0.0196)
interven	0.191	-0.556	1.344	1.370	-0.00432	0.893
	(0.592)	(0.712)	(1.045)	(1.417)	(1.063)	(0.943)
leglcancel	0.484	0.971**	-0.122	0.269	0.502	0.426
	(0.432)	(0.477)	(0.835)	(1.057)	(0.653)	(0.721)
leglmgr	-0.499	-0.110	-1.448*	-0.800	0.473	-0.182
	(0.418)	(0.478)	(0.820)	(1.064)	(0.702)	(0.699)
Countries	29	31	31	32	31	33
Obs.	291	319	324	328	308	336

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.21: Banking Instability and the Legal Environment of Deposit Insurance (1988-1996)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.114	-0.0709	-0.145	-0.153	-0.120	-0.139
	(0.0816)	(0.0682)	(0.122)	(0.127)	(0.101)	(0.0950)
rir	0.00448	0.00655	-0.0114	-0.0248	-0.0846*	-0.0692
	(0.00808)	(0.00830)	(0.0536)	(0.0781)	(0.0500)	(0.0565)
inflatn	0.000277	-0.000786	-0.00241	-0.00708	-0.0421*	-0.0420
	(0.00109)	(0.00115)	(0.0126)	(0.0166)	(0.0252)	(0.0268)
m2fxres	0.0616***	0.0513***	0.0409	0.112*	0.0279	0.0339
	(0.0208)	(0.0192)	(0.0270)	(0.0603)	(0.0251)	(0.0313)
crgdp	-0.0213**	-0.00806	-0.0159	-0.0229	-0.00896	-0.00504
	(0.00909)	(0.00695)	(0.0114)	(0.0238)	(0.00957)	(0.0125)
xrdepr	-0.00336	-0.0320*	-0.00571	-0.0346	-0.0495*	-0.0929***
	(0.0186)	(0.0167)	(0.0321)	(0.0347)	(0.0276)	(0.0297)
interven	-0.479	-1.505	0.778	0.218	-20.20	-0.550
	(0.860)	(0.927)	(0.849)	(2.282)	(17115)	(1.472)
leglcancel	0.747	1.328**	0.713	1.261	0.418	0.520
	(0.570)	(0.555)	(0.827)	(1.653)	(0.787)	(1.050)
leglmgr	-0.694	-0.315	-1.922**	-2.386	-0.00103	-0.847
	(0.552)	(0.567)	(0.836)	(1.877)	(0.776)	(0.979)
Countries	24	26	27	27	26	28
Obs.	172	185	191	191	177	200

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.22: Banking Instability and the Legal Environment of Deposit Insurance (1988-2001)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.112*	-0.0639	-0.103	-0.0900	-0.0780	-0.0990
	(0.0611)	(0.0542)	(0.0842)	(0.0811)	(0.0778)	(0.0681)
rir	0.00241	0.00610	-0.0471	-0.0133	-0.0845*	-0.0688*
	(0.00719)	(0.00790)	(0.0385)	(0.0453)	(0.0470)	(0.0416)
inflatn	-0.000210	-0.00120	-0.00548	-0.00690	-0.0280	-0.0254
	(0.000971)	(0.00111)	(0.00936)	(0.0112)	(0.0256)	(0.0193)
m2fxres	0.0265*	0.0451**	0.000917	0.0676**	0.0155	0.0122
	(0.0147)	(0.0204)	(0.0233)	(0.0303)	(0.0256)	(0.0214)
crgdp	-0.00327	-0.00184	0.00417	0.00469	0.00311	0.00369
	(0.00452)	(0.00527)	(0.00585)	(0.00782)	(0.00711)	(0.00719)
xrdepr	-0.0273*	-0.0463***	-0.0294	-0.0503**	-0.0321	-0.0624***
	(0.0148)	(0.0150)	(0.0215)	(0.0235)	(0.0235)	(0.0220)
interven	-0.798	-0.873	0.862	0.895	-1.246	-0.116
	(0.811)	(0.839)	(0.811)	(1.383)	(1.620)	(1.241)
leglcancel	0.872**	1.165**	0.372	0.787	0.103	0.287
	(0.424)	(0.531)	(0.606)	(0.987)	(0.749)	(0.807)
leglmgr	-0.757*	-0.324	-1.381**	-0.854	-0.0500	-1.003
	(0.458)	(0.546)	(0.667)	(1.024)	(0.775)	(0.799)
Countries	32	34	34	35	34	36
Obs.	273	301	309	317	288	306

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.23: Banking Instability and the Legal Environment of Deposit Insurance (1989-2004)

Variables	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.119*	-0.0525	-0.0631	-0.0609	-0.0973	-0.143**
	(0.0663)	(0.0530)	(0.0793)	(0.0771)	(0.0692)	(0.0698)
rir	0.00431	0.00765	-0.0143	0.0221	-0.0712*	-0.0383
	(0.00907)	(0.00878)	(0.0508)	(0.0632)	(0.0374)	(0.0383)
inflatn	0.000965	-0.00104	-0.00417	-0.0363	-0.0144	-0.0113
	(0.00125)	(0.00118)	(0.0162)	(0.0362)	(0.0156)	(0.0132)
m2fxres	0.0417	0.0443**	0.00244	0.0823**	-0.000499	-0.00554
	(0.0285)	(0.0223)	(0.0311)	(0.0326)	(0.0209)	(0.0181)
crgdp	0.00183	0.00422	0.00972	0.00441	0.00996*	0.00929
	(0.00667)	(0.00558)	(0.00631)	(0.00782)	(0.00544)	(0.00596)
xrdepr	0.00173	-0.0360**	-0.0236	-0.0396*	-0.0296	-0.0501***
	(0.0172)	(0.0144)	(0.0213)	(0.0225)	(0.0187)	(0.0191)
interven	-1.403	-1.285	0.438	0.437	-1.747	-0.289
	(1.483)	(1.087)	(1.033)	(1.816)	(1.489)	(1.169)
leglcancel	0.864	1.087	0.525	0.854	0.306	0.621
	(0.770)	(0.671)	(0.733)	(1.266)	(0.613)	(0.734)
leglmgr	-0.127	0.234	-0.686	-0.103	0.382	-0.644
	(0.733)	(0.669)	(0.737)	(1.252)	(0.644)	(0.710)
Countries	33	35	35	36	35	37
Obs.	327	363	371	385	349	362

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.24: Banking Instability and the Administration of Deposit Insurance (1981-1999)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.0945	-0.0941**	-0.147	-0.145**	0.000468	-0.110**
	(0.0607)	(0.0480)	(0.0914)	(0.0719)	(0.0634)	(0.0534)
rir	0.000646	-0.000411	0.00304	-0.00915	-0.0964***	-0.0678***
	(0.00666)	(0.00623)	(0.0378)	(0.0294)	(0.0277)	(0.0253)
inflatn	0.000702	0.000223	-0.00283	-0.00386	-0.0142	-0.0144
	(0.000946)	(0.000891)	(0.0139)	(0.00966)	(0.0117)	(0.00951)
m2fxres	0.0324*	0.0109	-0.000647	0.0106	0.0192	0.0143
	(0.0184)	(0.0178)	(0.0243)	(0.0283)	(0.0238)	(0.0199)
crgdp	-0.0120*	-0.00220	-0.000142	0.00219	-0.00218	0.00407
	(0.00696)	(0.00515)	(0.00841)	(0.00634)	(0.00864)	(0.00692)
xrdepr	-0.00460	-0.0121	0.00256	0.000225	-0.0119	-0.0292*
	(0.0123)	(0.0107)	(0.0206)	(0.0171)	(0.0170)	(0.0150)
admin	0.749***	0.380*	0.769**	0.743**	-0.434	-0.0426
	(0.270)	(0.226)	(0.380)	(0.305)	(0.376)	(0.351)
coinsur	-0.784	-0.738	-2.879*	-2.350**	1.830**	-0.279
	(0.861)	(0.647)	(1.581)	(1.196)	(0.882)	(0.739)
funding	0.253	0.810	-1.380*	-0.804	1.151	-1.403**
	(0.719)	(0.564)	(0.706)	(0.651)	(0.855)	(0.669)
rskadj	-0.755	-0.399	-1.182	-0.460	-0.0902	0.471
	(0.568)	(0.454)	(0.854)	(0.636)	(0.817)	(0.703)
membship	0.267	0.0935	0.162	0.852	0.0728	0.140
	(0.556)	(0.453)	(0.861)	(0.776)	(0.704)	(0.761)
sourcefnd	1.182*	1.119**	2.393**	1.314*	0.202	0.917
	(0.624)	(0.474)	(1.149)	(0.700)	(0.628)	(0.575)
Countries	33	35	36	37	35	38
Obs.	345	373	394	398	362	402

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.25: Banking Instability and the Administration of Deposit Insurance (1988-1996)

Variables	Estimated Equation			
	nbrun1	bbrun1	bbrun2	binsolv
gdpgr	-0.132*	-0.129**	-0.129	-0.148*
	(0.0793)	(0.0637)	(0.0991)	(0.0856)
rir	0.00486	0.00301	0.0348	-0.0985**
	(0.00797)	(0.00720)	(0.0556)	(0.0438)
inflatn	0.000155	-0.000534	-0.0106	-0.0460**
	(0.00116)	(0.00108)	(0.0268)	(0.0233)
m2fxres	0.0785***	0.0325	0.0467	0.0603*
	(0.0278)	(0.0214)	(0.0412)	(0.0334)
crgdp	-0.0309***	-0.00675	-0.00477	-0.0165
	(0.0114)	(0.00740)	(0.0125)	(0.0130)
xrdepr	-0.00406	-0.0197	-0.0191	-0.0748***
	(0.0176)	(0.0150)	(0.0307)	(0.0259)
admin	1.037***	0.498	1.082**	0.630
	(0.375)	(0.322)	(0.531)	(0.581)
coinsur	-0.974	-1.970	-23.09	0.454
	(1.367)	(1.250)	(41904)	(1.233)
funding	-0.427	0.172	-1.183	-2.621**
	(0.903)	(0.770)	(1.329)	(1.152)
rskadj	-0.689	-0.295	-0.236	0.686
	(0.742)	(0.641)	(1.072)	(1.148)
membship	0.202	-0.313	1.250	-0.136
	(0.717)	(0.627)	(1.377)	(1.255)
sourcefnd	1.041	0.853	0.998	1.026
	(0.786)	(0.639)	(0.992)	(0.856)
Countries	29	31	33	34
Obs.	203	216	231	240

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively

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Table B.26: Banking Instability and the Administration of Deposit Insurance (1988-2001)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.105	-0.0995*	-0.0170	-0.0550	-0.0540	-0.134**
	(0.0655)	(0.0541)	(0.0917)	(0.0746)	(0.0796)	(0.0632)
rir	0.00193	0.00153	-0.0153	-0.00297	-0.128***	-0.0963***
	(0.00705)	(0.00689)	(0.0395)	(0.0447)	(0.0355)	(0.0329)
inflatn	-0.000206	-0.000687	-0.00214	-0.0106	-0.0423*	-0.0299*
	(0.00105)	(0.00105)	(0.00973)	(0.0178)	(0.0237)	(0.0174)
m2fxres	0.0386	0.0406*	-0.00526	0.0548*	0.0212	0.0193
	(0.0278)	(0.0222)	(0.0277)	(0.0295)	(0.0249)	(0.0205)
crgdp	-0.00632	-0.00114	0.00814	0.00672	-0.00735	-0.000175
	(0.00658)	(0.00561)	(0.00681)	(0.00735)	(0.00770)	(0.00658)
xrdepr	-0.0247	-0.0351**	-0.0122	-0.0405*	-0.0179	-0.0531***
	(0.0158)	(0.0146)	(0.0241)	(0.0233)	(0.0222)	(0.0198)
admin	0.791***	0.502*	0.514	0.745	-0.253	0.332
	(0.298)	(0.304)	(0.370)	(0.482)	(0.358)	(0.398)
coinsur	0.00133	-0.310	-1.695	-1.150	2.018**	-0.333
	(1.122)	(1.015)	(1.460)	(1.443)	(0.945)	(0.940)
funding	-0.0506	0.388	-1.197*	-1.102	1.285	-1.591*
	(0.823)	(0.836)	(0.685)	(1.098)	(0.934)	(0.833)
rskadj	-0.484	0.00396	-0.0177	0.873	-0.146	0.277
	(0.624)	(0.637)	(0.769)	(0.987)	(0.881)	(0.840)
membship	-0.383	-0.484	0.279	0.644	-0.0488	-0.0224
	(0.658)	(0.682)	(0.909)	(1.295)	(0.713)	(0.910)
sourcefnd	0.750	0.596	0.911	0.385	0.232	0.844
	(0.634)	(0.568)	(0.760)	(0.824)	(0.593)	(0.629)
Countries	36	38	39	40	38	41
Obs.	321	349	371	379	336	362

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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Table B.27: Banking Instability and the Administration of Deposit Insurance (1989-2004)

Variable	Estimated Equation					
	nbrun1	bbrun1	nbrun2	bbrun2	ninsolv	binsolv
gdpgr	-0.131*	-0.101*	-0.0173	-0.0416	-0.0904	-0.161**
	(0.0685)	(0.0534)	(0.0827)	(0.0698)	(0.0693)	(0.0649)
rir	0.00168	0.00197	-0.0250	-0.0305	-0.118***	-0.0884***
	(0.00768)	(0.00703)	(0.0548)	(0.0501)	(0.0324)	(0.0321)
inflatn	0.000659	-0.000569	-0.0220	-0.0438	-0.0272	-0.0199
	(0.00115)	(0.00105)	(0.0319)	(0.0331)	(0.0207)	(0.0137)
m2fxres	0.0505*	0.0413*	0.00667	0.0726**	0.00783	0.00186
	(0.0278)	(0.0216)	(0.0283)	(0.0288)	(0.0205)	(0.0176)
crgdp	-0.000623	0.00356	0.0121*	0.00636	0.000374	0.00572
	(0.00658)	(0.00528)	(0.00633)	(0.00730)	(0.00537)	(0.00556)
xrdepr	-0.00960	-0.0346**	-0.0199	-0.0428**	-0.0313	-0.0473***
	(0.0168)	(0.0139)	(0.0235)	(0.0216)	(0.0194)	(0.0176)
admin	0.525	0.412	0.294	0.748	-0.152	0.447
	(0.370)	(0.327)	(0.425)	(0.622)	(0.322)	(0.389)
coinsur	1.817*	0.833	-0.336	0.0194	2.133**	-0.134
	(1.102)	(0.952)	(0.947)	(1.457)	(0.831)	(0.855)
funding	0.405	0.880	-1.101	-1.016	1.953**	-0.948
	(1.021)	(0.886)	(0.821)	(1.391)	(0.901)	(0.799)
rskadj	0.0324	0.267	0.572	1.631	-0.363	-0.0255
	(0.816)	(0.702)	(0.903)	(1.281)	(0.773)	(0.840)
membship	-0.245	-0.258	0.168	-0.187	0.0170	0.189
	(0.911)	(0.789)	(1.052)	(1.603)	(0.672)	(0.898)
sourcefnd	0.262	0.496	-0.0868	0.139	0.122	0.718
	(0.675)	(0.564)	(0.615)	(0.978)	(0.488)	(0.589)
Countries	36	38	39	40	38	41
Obs.	383	419	443	457	405	425

Standard errors are given in parentheses

***, ** and * denote statistical significance at 1, 5 and 10 percent respectively

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B.4 Predicted Versus Actual Cases of Banking Instabilities; and Measured Indicators Versus Actual Cases of Banking Instability in Selected Countries

Notes for Figures (B-1) - (B-5)

- DKD: Demirgüç-Kunt and Detragiache (1998). It makes reference to banking crises identified by Demirgüç-Kunt and Detragiache (1998).
- ck: Caprio and Klingebiel (1997). It refers to major bank insolvencies identified by Caprio and Klingebiel (1997)
- ni: *ninsolv*. It is our measure of insolvency narrowly defined (see Chapter 4 Section 4.3.2).
- bi: *binsolv*. It is our measure of insolvency broadly defined (see Chapter 4 Section 4.3.2).
- The Mexican Peso Crisis affected, among others, Malaysia, primariry through the forced floatation of the Thai Baht, which prompted devaluations in Malaysia (Ganapolsky and Schmukler, 2001).
- The dot-com bubble was a speculative bubble in the internet sector that peaked in 2000 and collapsed in 2001.

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Figure B-1: Predicted Versus Actual Cases of Banking Instabilities (nbrun1 and bbrun1) in Selected Countries (1980-2004)

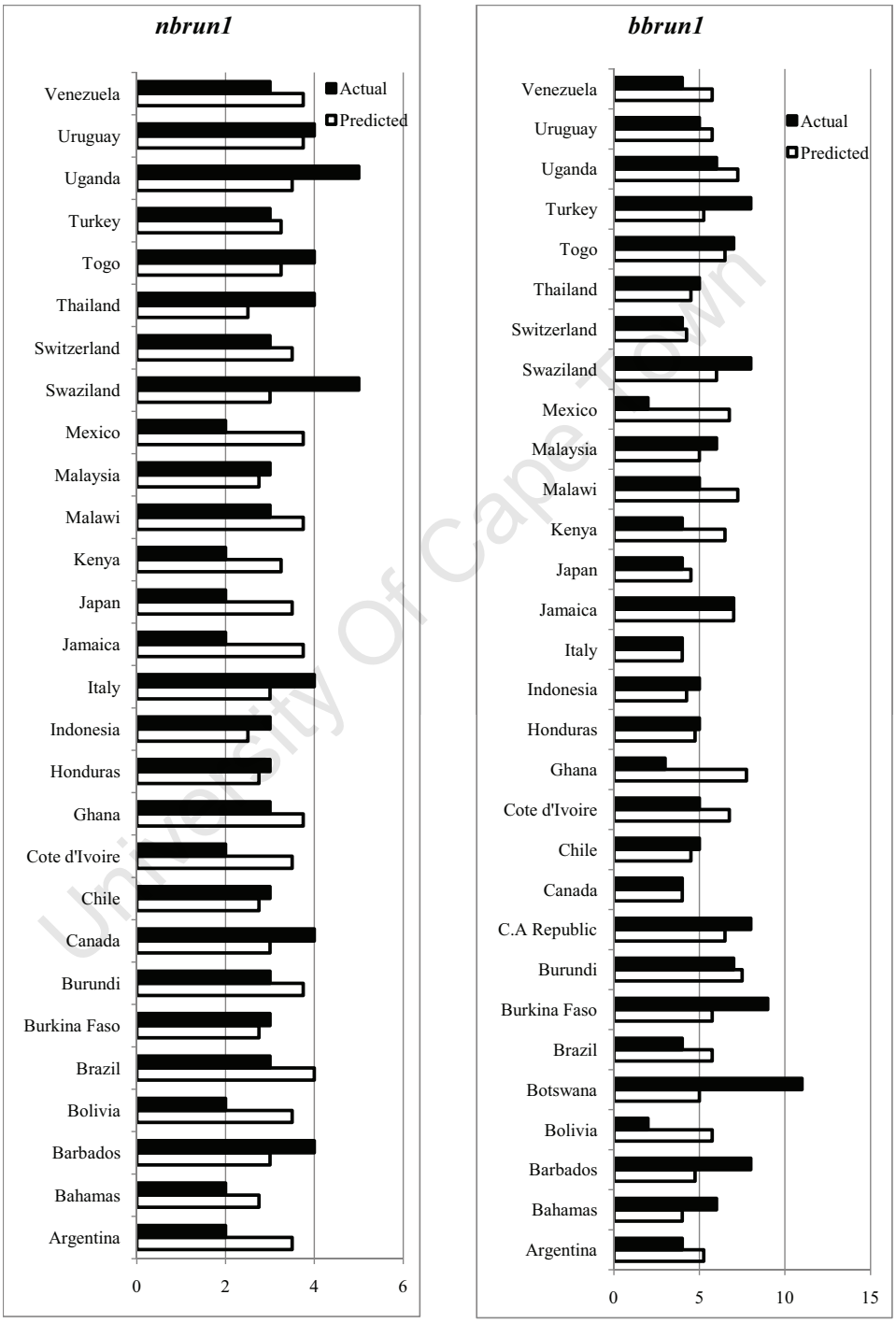

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Figure B-2: Predicted Versus Actual Cases of Banking Instabilities (nbrun2 and bbrun2) in Selected Countries (1980-2004)

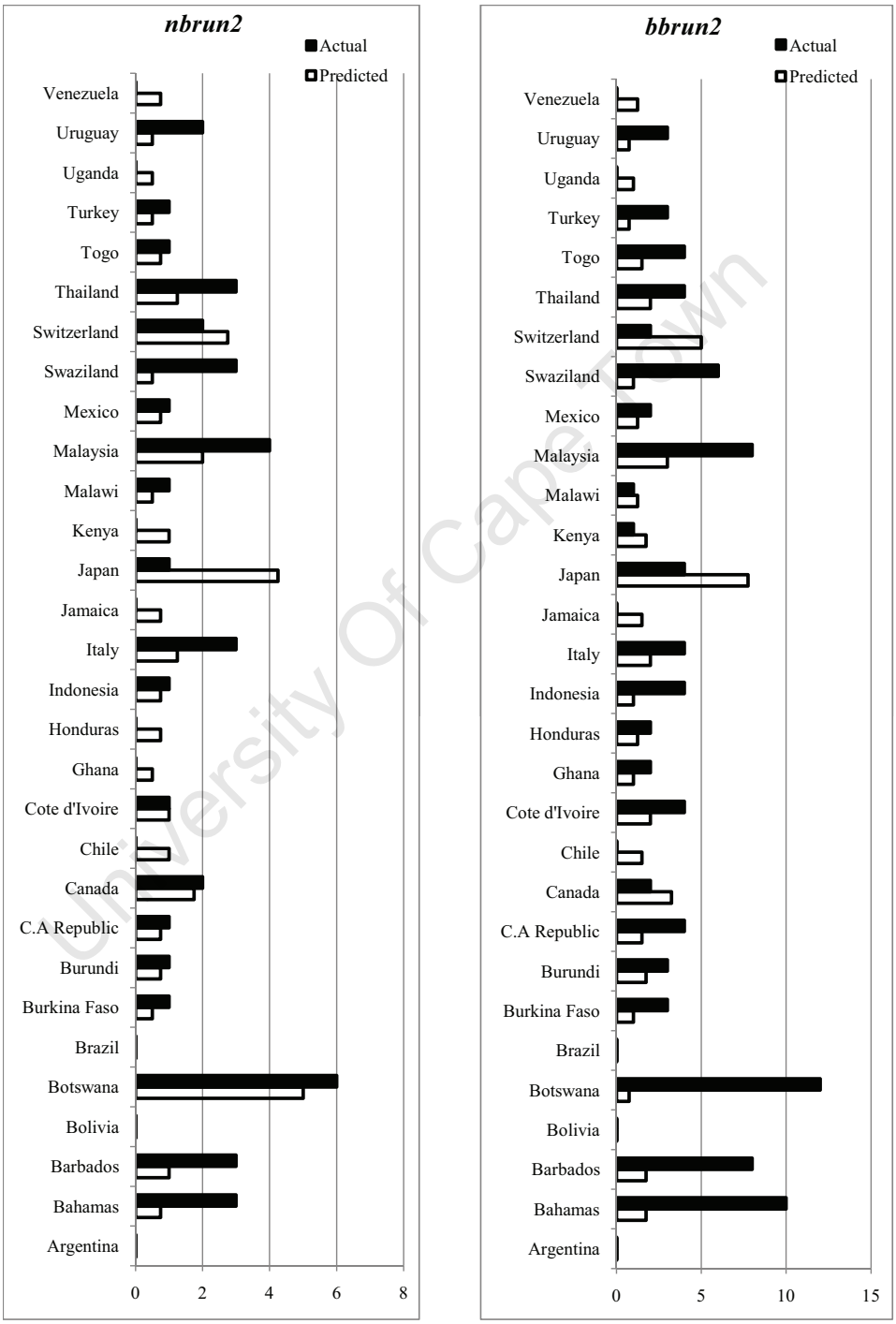

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Figure B-3: Predicted Versus Actual Cases of Banking Instabilities (ninsolv and binsolv) in Selected Countries (1980-2004)

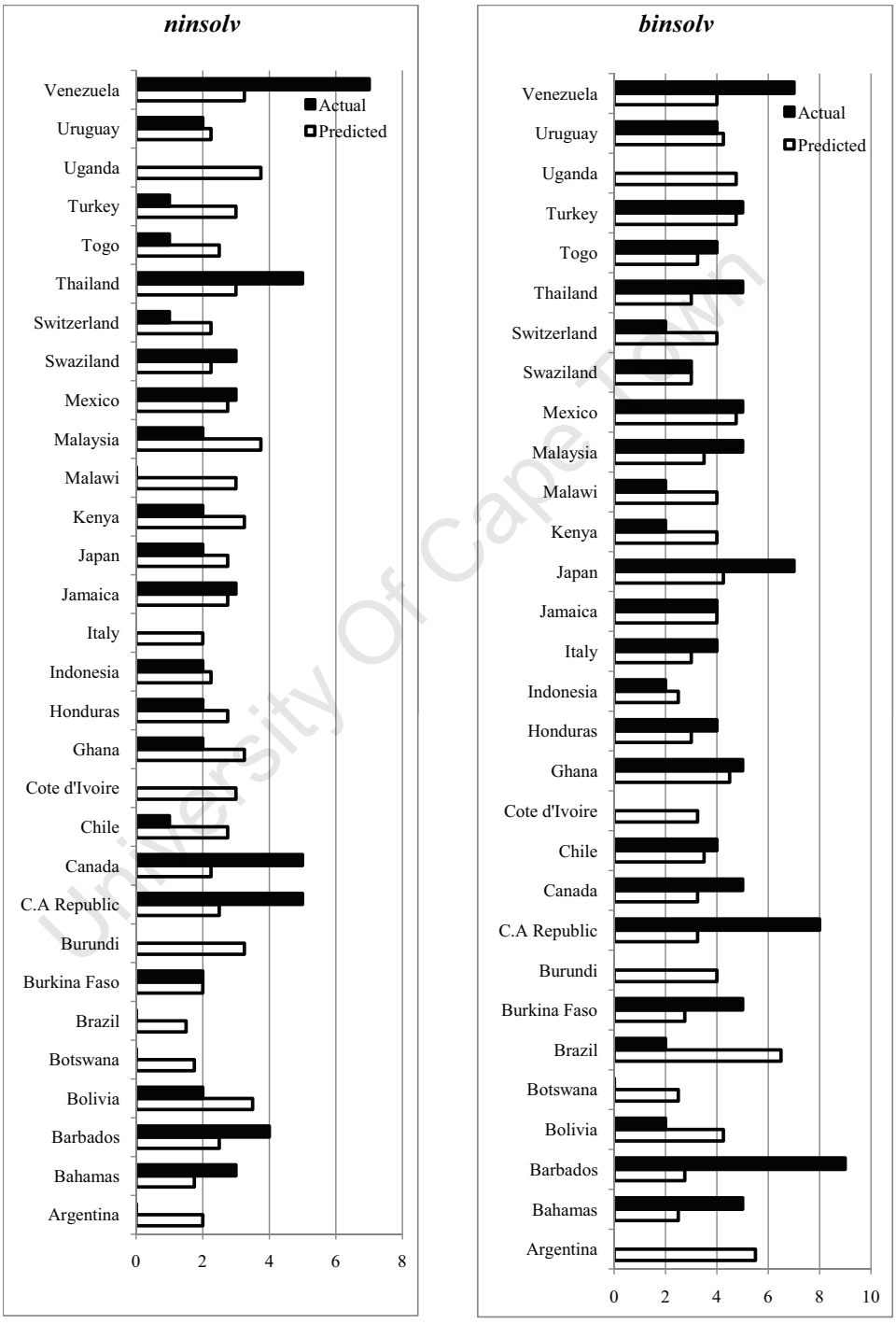

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Table B.28: Measured Bank Insolvency Versus Major Bank Insolvencies Identified by Caprio and Klingebiel (1997) in Selected Countries

	Mexico			Bolivia			Brazil			Chile			Central African Republic			Ghana			Kenya			Togo		
	ni	bi	ck	ni	bi	ck	ni	bi	ck	ni	bi	ck	ni	bi	ck	ni	bi	ck	ni	bi	ck	ni	bi	ck
1980																X	X							
1981			X									X			X									
1982		X	X								X	X		X	X	X	X	X						
1983												X	X	X	X		X	X						
1984				X	X										X			X						
1985														X	X			X			X			
1986		X		X	X	X									X			X			X			
1987	X	X				X												X			X		X	
1988											X						X	X			X		X	
1989								X			X							X			X			
1990			X					X	X	X	X				X									
1991			X										X	X	X									
1992													X	X	X				X	X	X			
1993														X	X				X	X	X	X	X	X
1994	X	X							X				X	X	X		X				X			X
1995	X	X	X						X				X	X	X						X			X
1996															X								X	X
1997																								X
1998																								X
1999																								X
2000																								X
2001																								X
2002																								X
2003																								X
2004																								

NOTE
ni: *ninsolv*
bi: *binsolv*
ck: Caprio and Klingebiel (1997)

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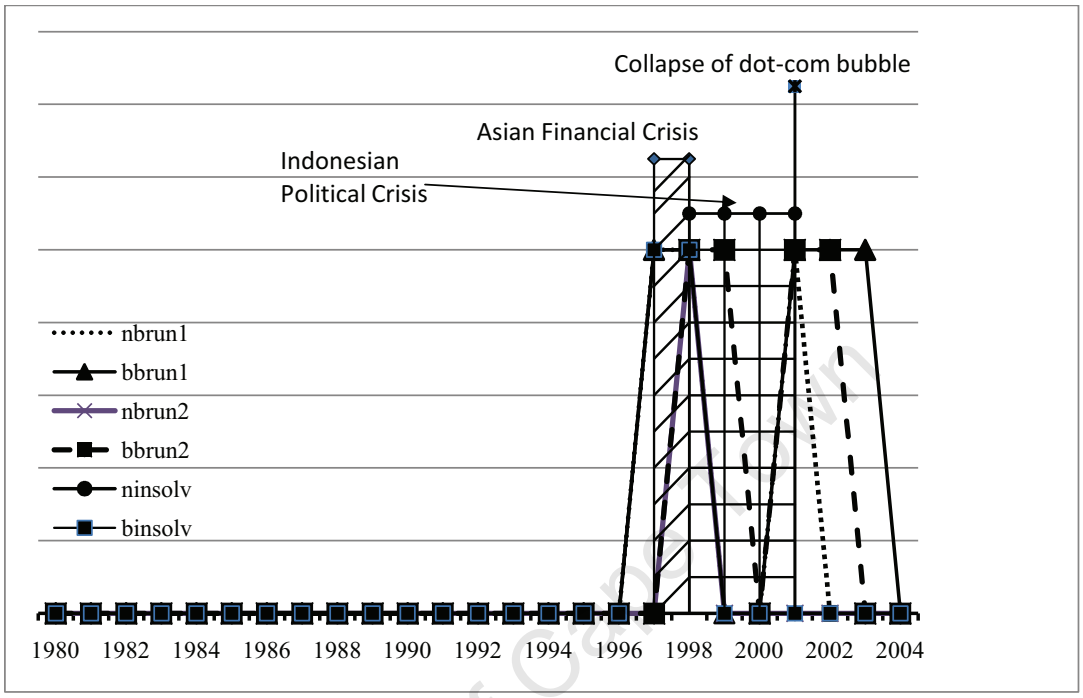
Figure B-4: Measured Indicators Versus Actual Cases of Bank Instability in Selected Countries (1980-2004)

1. Indonesia



2. Japan

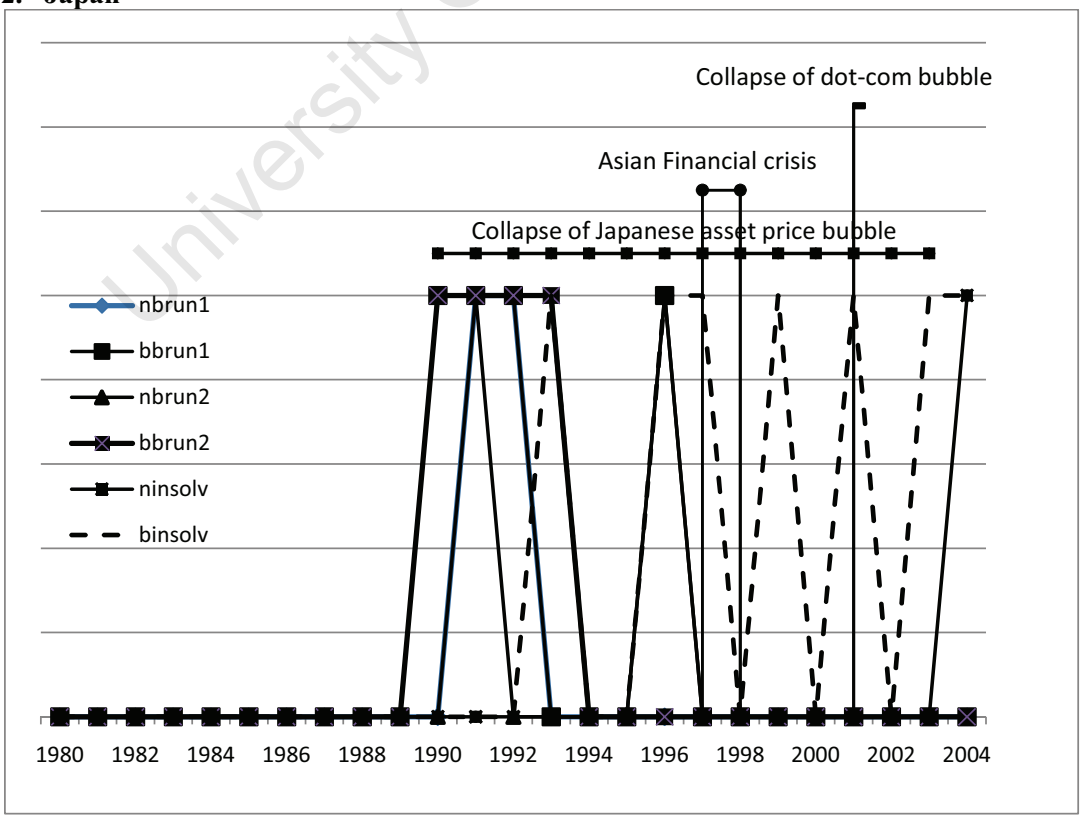


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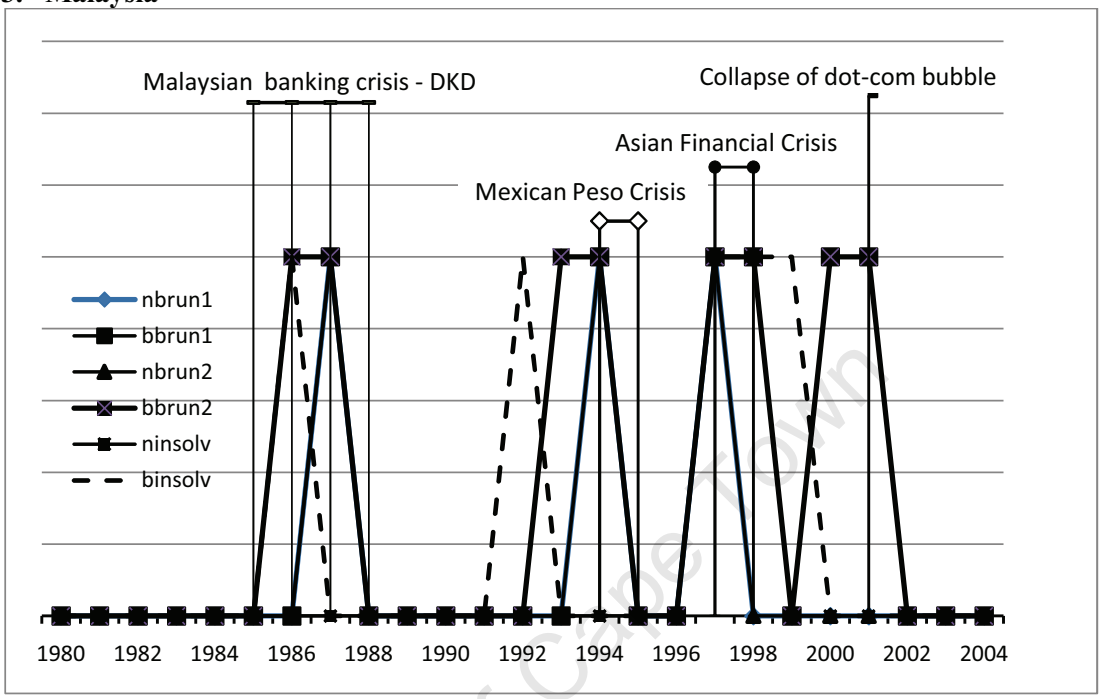
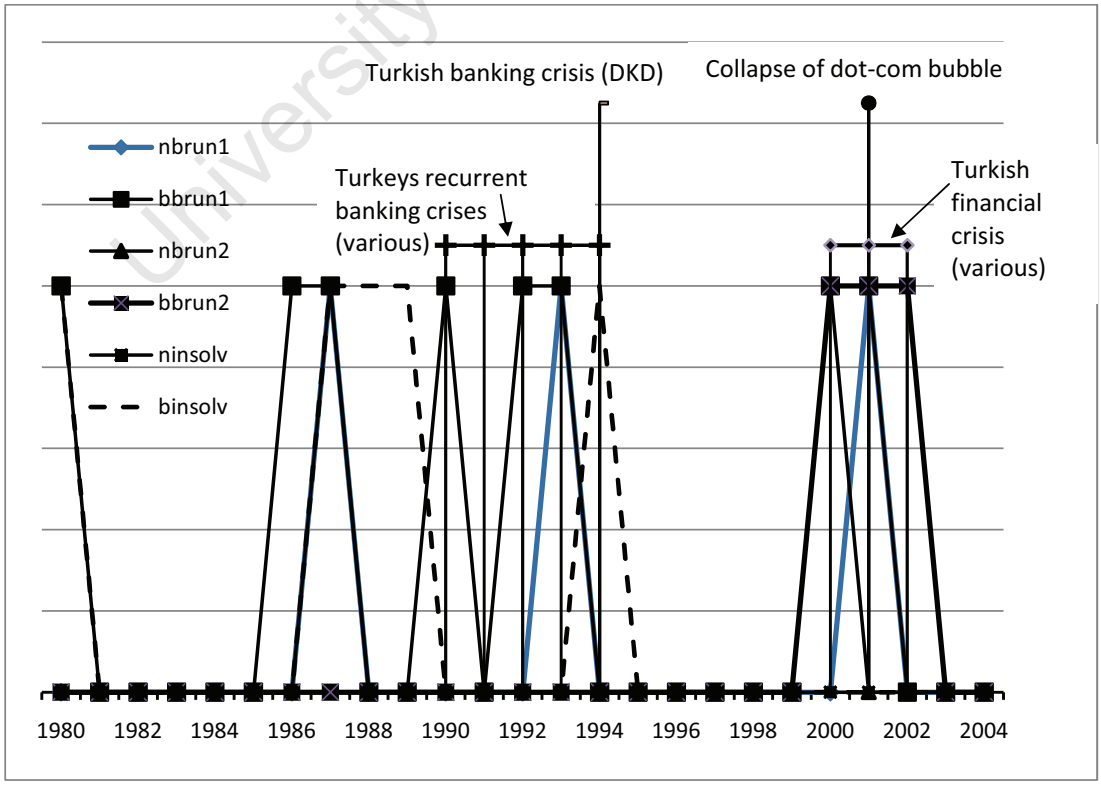
Figure B-5: Measured Indicators Versus Actual Cases of Bank Instability in Selected Countries (1980-2004)

3. Malaysia



4. Turkey



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