Essays on the effects of global liquidity, capital flows and monetary policy on the South African credit markets and macro-economy

By

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Declaration

I declare that this thesis presented for the degree of Doctor of Philosophy in Economics under the supervision of Professors Christpher Malekane and Kalu Ojah has been composed solely by myself and that it has not been submitted, in whole or in part for any other degree or professional qualification. I am aware of and understand the University's policy on plagiarism. I certify that this thesis is my own work, expect where indicated by referencing or acknowledgment. All data sources are explicitly referenced in the text.

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Abstract

This thesis consists of six self-contained empirical chapters that deal with different aspects of how global liquidity is transmitted into the South African economy. The chapters link excess global liquidity and risk shocks channels of transmission into the South African economy via aggregate and components of capital flow effects on domestic assets, money demand and credit growth. In addition, they link asset price cycles, financial conditions, labor market conditions and policy uncertainty to developments in household credit growth and household debt growth and how these affect the macro-economy. The chapters employ empirical approaches that range from the factor augmented sign restricted vector autoregressions (FAVAR) to properly identify structural shocks, threshold vector autoregressions (TVAR) to assess the asymmetric effects and non-linearities induced by the thresholds and vector error correction models to estimate the mechanisms that assist the economy to adjust from deviations from the long-run (equilibrium path).

The results in Chapter two show that all shocks to price and quantity measures of global liquidity lead to a significant increase in GDP growth and credit growth. However, inflation declines in response to price and quantity measures of global liquidity shocks consistent with the appreciation of the exchange rate exerting downward pressure on inflation. In addition, evidence in this chapter shows that the quantity measures of global liquidity, in particular asset purchases lead to higher peak responses in GDP growth. The inclusion of Japan data in the construction of the global liquidity factors results in higher peak responses in credit growth and GDP growth. Asset purchases by the Bank of Japan added to excess global liquidity and contributed to easier domestic credit and financial conditions. The responses of house price growth and equity price growth suggest that the effects of price and quantity measures of global liquidity result in much more pronounced effects on house price growth and equity price growth. Last, evidence in this chapter shows that the decline in global policy rates and investor risk perceptions coupled with an increase in the quantity measures of global liquidity loosened domestic financial conditions. The yield on the ten-year domestic government bond, the South Africa-United States (SA-US) yield spread, domestic sovereign credit risk across the five-year credit default swap (CDS) spreads and emerging market bond index (EMBI) spreads declined. This indicates that the lowering of global interest rates and the asset purchases loosened domestic financial conditions and the fiscal constraints.

In a nutshell, we establish that global risk, monetary and financial conditions do spill-over and are transmitted into the South African economy via several channels. Unconventional monetary policy

tools do indeed complement and reinforce the effects of conventional monetary policy interventions. Thus, our findings concur with several empirical studies in this area showing that unconventional monetary policy tools are a necessary addition to the monetary policy toolkit. Furthermore, unconventional monetary policy tools have implications for fiscal policy, exchange rates, monetary and financial stability mandates of central banks.

Chapter three presents evidence that across various specifications and capital inflow categories, capital inflow shocks are more persistent and induce more variability in credit growth, house price growth, equity price growth, investment growth, commodity price growth and the current account. The results in this chapter confirm that capital inflows shocks have persistent effects compared to monetary policy shocks. The data confirms the *"savings glut"* hypothesis, capital inflows have larger and more persistent shock effects on investment growth, commodity price growth and the current account. Furthermore, the results show that the composition of capital inflows matters. Credit growth and house price growth are more responsive to equity inflows compared to debt inflows. Capital inflow shocks, in particular, equity inflows shocks, were the key contributors to increases in commodity price growth during the 2004 commodity price boom. House price growth, equity price growth and commodity price growth present additional important channels through which accommodative monetary policy and positive capital inflow shocks are transmitted via different categories of capital inflows to domestic credit markets.

Therefore, we conclude that capital inflow shocks are more persistent compared to monetary policy shocks. Capital inflows, in particular equity inflows, induce more variability credit growth, house price growth, equity price growth, investment growth, commodity price growth and the current account. Although monetary policy shocks are transitory, by loosening the credit and financial constraints, they contribute to changes in sentiment and domestic supply and demand factors. The interaction of monetary and capital flow shocks affects asset price growth and real economic activity with implications for the exchange rate, price stability and financial stability mandates.

Chapters four and five find that real money balances are positively linked to real income and negatively linked to the interest rate spreads as predicted by theory. Augmenting the money demand function with asset price returns and financial and housing wealth variables, yields the desired results of lowering the point elasticity for GDP in the money demand function. This means that the augmented money demand functions are much more able to explain developments in monetary aggregates via the substitution and portfolio balance effects. The cointegration relations derived from the money demand functions augmented with asset price returns, interest rate differential, financial and housing wealth variables, are able to pick up the role of asset price returns and the interest rate differentials post-the financial crisis which is absent in the conventional money demand function as it still indicates a substantial and persistent money demand short-fall. We conclude that the inclusion of asset returns, interest rate differential, and financial and housing wealth variables in the behaviour of the money demand function explains the effects of constant structural changes and financial innovation in the South African economy. In addition, developments in asset price dis-equilibria can undermine macroeconomic stability. We therefore conclude that there is valuable, and policy relevant information contained in the augmented money demand functions.

Furthermore, evidence in Chapter five reinforces the idea that financial cycles take longer to adjust. This is contained in the evidence of the slow speed of adjustment in the money demand disequilibria in models augmented with real wealth and asset prices. This means that the money demand disequilibrium takes longer when considering the role of real financial wealth than is the case under the conventional money demand function. The inclusion of wealth and asset price variables matters for the economic and policy interpretation of the money demand function. The impact of positive shocks to real asset prices and real wealth, in particular equity prices, results in a higher decline in the demand for real money balances compared to, for example real house prices. From the interaction of monetary policy and financial stability perspective, the policy implication is that the augmented money demand function can capture aspects related to asset price inflation and wealth channels of the monetary policy transmission mechanism.

Chapter six estimates a financial conditions index for South Africa and uses it in the empirical estimations. We find that the constructed the financial conditions index (FCI) is positively related to lending conditions, meaning that tight financial conditions imply tight lending conditions. In addition, the FCI is negatively related to the consumer confidence and business confidence indices. Tight financial conditions lead to lower consumer and business confidence. Heightened policy and economic uncertainty as captured by the economic policy uncertainty index, leads to tight financial conditions for prolonged periods. Evidence shows that the loan supply and aggregate supply shocks played a dominant role in the evolution of total and sectorial credit growth. However, post-2009 aggregate supply shocks reinforced by loan supply shocks played a dominant role in depressing credit growth. Furthermore, tight financial conditions and heightened economic policy uncertainty shocks interact and are mainly transmitted via aggregate demand shocks as well. Tight financial conditions and heightened economic policy uncertainty shocks play a significant role in propagating adverse loan supply shocks and have depressing effects on aggregate demand and credit growth.

Furthermore, we establish the existence of the balance sheet channel of monetary policy via the housing market. Mortgage advances credit growth declines more due to a contractionary monetary policy shock and house price growth declines more in response to adverse aggregate supply shock. The implication of these results is that credit growth to the private sector declines more mainly due to the deterioration in balance sheets of households and the non-performing loans (NPLs) of banks compared to the shock effects of the decline in the demand for credit. This does not mean that there the absence of the traditional monetary transmission mechanism. Rather, that the response of mortgage advances credit growth, house price growth and NPLs suggests that, a contractionary monetary policy shock is propagated via the deterioration in the collateral values and the borrowers' net worth impact on the loan supply channel. The policy implication is that because housing plays an important role in the business cycle as a component of investment growth, wealth and demand via the consumption channel, policy interventions that support the banking system as well as the real economy need to be prioritized.

Chapter seven finds that adverse aggregate demand and loan supply shocks are mainly transmitted via the labor markets and are propagated by credit conditions. The simultaneous occurrence of positive employment growth, labor productivity growth and lower credit risk as captured by the non-performing loans shocks loosens the credit constraints and allows banks to supply more credit to meet aggregate demand. Furthermore, employment creation results in immediate responses in the household gearing as income shocks emanating from the labor market dynamics have an important relationship with credit growth, NPLs and the household debt growth burden in general. The vector error correction model (VECM) error correction terms suggest that currently household debt is in shortfall by as much as 10 per cent. The rate at which household debt growth adjusts from the disequilibrium position is terribly slow at less than one per cent per quarter.

The transition functions show that the household debt growth threshold occurs between 8.8 per cent and 13.4 per cent. Empirical evidence in this chapter shows that periods of high household debt growth regimes, GDP growth and employment growth are persistently high compared to periods of low household debt growth regimes. The implications of the findings for the price and financial stability mandates are that household debt growth levels matter for GDP growth. The channels of transmission are largely via the labor market and are amplified by prevailing credit conditions. The loan supply shocks act as amplifiers of aggregate demand shocks and induce asymmetric effects on the macro-economy. Therefore, both credit demand and supply hypothesis are confirmed by the data. But the credit supply hypothesis seems to have dominated the evolution of household debt growth pre-2009. Furthermore, loan supply shocks were propagated by heightened credit risk as NPLs made negative contributions to household debt. Increases in labor productivity growth, GDP growth, employment growth and household debt growth are the key variables that assist in the adjustment of household debt growth from the dis-equilibrium positions.

In addition, the decline in NPLs contributes more to the adjustment of household debt growth from the dis-equilibrium compared to the prime rate. This is because heightened credit risk limits the ability of banks to supply credit and widens the lending rate margins. The household debt growth dis-equilibrium positions, thresholds and the transition functions between the low and high regimes matter for the conduct of macro-prudential, monetary, and financial stability policies. The household debt growth dis-equilibrium positions convey information about the state of credit demand driven inflationary pressures, the concentration and build-up of financial risks. In addition, the household debt growth dis-equilibrium positions act as useful guides for the conduct of macro-prudential, monetary, and financial stability policies, over and above guiding the conduct of fiscal and macro-economic policy interventions.

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List of abbreviations

GDP	Gross domestic product
SA-US	South Africa-United States
CDS	Credit default swap
EMBI	Emerging market bond index
FCI	Financial conditions index
VECM	Vector error correction model
NPLs	Non-performing loans
FAVAR	Factor augmented vector autoregression model
UMPTs	Unconventional monetary policy tools
UK	United Kingdom
AEs	Advanced economies
EMEs	Emerging market economies
ECB	European Central Bank
US Fed	United States Federal Reserve Bank
BOE	Bank of England
BOJ	Bank of Japan
SARB	South African Reserve Bank
QE	Quantitative easing
LTV	Loan-to-value ratio
RTI	Repayment-to-income ratio
NCA	National Credit Act
G3	US Fed, ECB, and Bank of England
G4	US Fed, ECB, Bank of England, and Bank of Japan
VIX Index	Chicago Board Options Exchange (CBOE) Volatility Index
PCA	Principal component approach
ADF	Augmented Dickey–Fuller
PP	Phillips-Perron
KPSS	Phillips, Schmidt and Shin
AIC	Akaike Information Criteria
SBC	Schwarz information criterion
BIC	Bayesian Information Criteria
NEER	Nominal effective exchange rate
WGBI	World Global Bond Index

ECT	Error correction term
PE ratio	Price earnings ratio
NCD	Negotiable certificate of deposit
TVAR	Threshold vector autoregression model
FCI	Financial conditions index
LSTVAR	Nonlinear logistic smooth transition vector autoregressive model
STAR	Smooth transition models
TAR	Threshold autoregressive model
LSTAR	Logistic smooth transition autoregressive model
ESTAR	Exponential smooth transition autoregressive model

Chapter 1 Introduction

This thesis starts by exploring what the effects of excess global liquidity shocks on the South African economy are. Are there differential effects associated with price and quantity measures of excess global liquidity shocks on the South African economy? This chapter uses an open economy pure sign restricted factor augmented vector autoregression (FAVAR) models to identify unanticipated positive shocks to price and quantity measures of global liquidity and investor risk perceptions. The sign restricted FAVAR approach enables us to disentangle the impact of price and quantity measures of global liquidity on South African variables. The results show that all shocks to price and quantity measures of global liquidity result in a significant increase domestic GDP growth and credit growth. However, inflation declines in response to all price and quantity measures of global liquidity shocks consistent with the appreciation of exchange rates exerting downward pressure on inflation. The appreciation of the exchange rate also limits the rate at which the repo rate responds to inflationary pressures. Evidence also shows that global risk, global monetary conditions, and global financial conditions do spill-over into the domestic economy and are transmitted via several channels. Furthermore, unconventional monetary policy tools (UMPTs) do indeed complement and reinforce the effects of conventional monetary policy interventions. The findings in this this thesis concur with several empirical studies in this area showing that UMPTs are a necessary addition to the monetary policy toolkit. In addition, UMPTs have implications for fiscal policy, exchange rates, monetary and financial stability mandates of central banks.

Chapter three of the thesis explores whether the capital inflow shocks play a much larger role relative to monetary policy shocks in the transmission of positive global liquidity shocks. Moreover, it explores how persistent the effects of capital inflow and monetary policy shocks are? This chapter answered these questions by using the pure and penalty function approaches to sign restriction. For policy analysis, the chapter used the counterfactual scenarios and variance decompositions. We estimated various models based on different components of portfolio inflows and outflows to test for the robustness of our results and policy implications.

The results show that across various model specifications and capital inflow categories used in the estimations of the models, the capital inflow shocks are more persistent and induce more variability in credit growth, house price growth, equity price growth, investment growth, commodity price growth and the current account. Essentially, the results confirm that capital inflows shocks have persistent effects compared to monetary policy shocks. The data confirms the *"savings glut"* hypothesis. In this regard, the results show that during the credit growth and the house price boom in 2004Q1 to 2007Q4, monetary policy shocks made positive but very transitory contributions to credit growth and house price growth compared to capital inflow shocks. Furthermore, the capital inflows shocks have larger and more persistent shock effects on investment growth, commodity price growth and the current account. Within capital inflows, equity inflows, induce more variability credit growth, housing price growth, equity price growth, investment growth, commodity price growth and the current account. Although monetary policy shocks are transitory, by loosening the credit and financial constraints, they contribute to changes in sentiment, domestic supply, and demand factors. The interaction of monetary and capital flow shocks affects asset prices and real economic activity with implications for the exchange rate, price, and financial stability mandates.

Chapter four estimates the international portfolio balance approach to the South African money demand function via three VECM models representing the (i) conventional money demand function (ii) money demand function augmented with the South African and US asset price returns and interest rate differential (iii) money demand function augmented with the South African and United Kingdom (UK), Euro Area and Japan asset price returns and interest rate differentials. We find that real money balances are positively linked to real income and negatively to the interest rate spreads as predicted by theory. The augmented money demand functions with asset price returns yield the desired results of lowering the point elasticity for GDP. This means that they can explain developments in monetary aggregates via the substitution and portfolio balance effects.

The cointegration relations derived from the money demand function augmented with asset price returns and interest rate differential suggest that there has been a persistent money demand over-hang since 2008Q1 which has varied between 15 and 10 percent. In addition, the responses of M3 growth and inflation to different measures of the augmented money demand dis-equilibria indicate that the asset price induced money demand disequilibria are incompatible with the long-term inflation behaviour. This means that the inclusion of asset returns in the behaviour of the money demand explains the effects of constant structural changes and financial innovation. Furthermore, developments in the asset price induced money demand disequilibria can undermine macroeconomic stability. There is valuable and policy relevant information contained in the augmented money demand functions.

Chapter five assessed the applicability of the wealth and portfolio balance approach to money demand in South Africa. We find that the inclusion of wealth and asset price variables matters for the economic and policy interpretation of the money demand function. The extension of the money demand functions via the wealth and asset price variables is supported by the data. The impact of real asset price growth and real wealth growth, in particular equity price growth, results in a higher decline in the demand for real money balances compared to, for example real house price growth. In addition, the increase in the households' wealth and asset price growth money demand induced dis-equilibria results in a decline in the money demand. This means that the augmented money demand functions capture the substitution and wealth effects as postulated by the portfolio balance theory.

The slow speed of adjustment in the money demand dis-equilibria in models augmented with real wealth and asset prices growth means that the money demand dis-equilibrium takes longer to adjust, especially when considering the role of real financial wealth than is the case under the conventional money demand function. This is consistent with the recent empirical evidence showing that financial cycles take longer to adjust. Furthermore, shocks to the real money demand function induce non-linearities in the responses of economic activity and inflation. We find that positive shocks to the real money demand function below the threshold of 5.9 per cent result in lower GDP growth and inflation. The policy implication from the interaction of monetary policy and financial stability perspective, is that the augmented money demand function can capture aspects related to the asset price inflation and wealth channels of the monetary policy transmission mechanism. Evidence in this chapter reinforces the idea that financial cycles take longer to adjust. This is contained in the evidence of the slow speed of adjustment in the money demand equilibria in models augmented with real wealth and asset prices.

Chapter six explores whether there a balance sheet channel of monetary policy working via the housing market in South Africa. This chapter also explored the role of the concurrence of adverse monetary policy, loan supply, aggregate demand, and supply shocks. We used a penalty function approach to sign restriction to identify these four structural shocks. We construct the financial conditions index (FCI) to capture the role of diverse variables compared to just the analysis of the policy rate or lending rates. We find that the constructed FCI is positively related to lending conditions, meaning that tight financial conditions imply tight lending conditions. At the same time evidence suggest that the FCI is positively related to policy uncertainty. In fact, the cross correlations indicate that heightened policy uncertainty leads to tight financial conditions for prolonged periods.

The empirical analysis in this chapter suggests that loan supply and aggregate supply shocks played a dominant role in total growth, sectorial credit growth and GDP growth pre-2009 consistent with the house price growth, equity price growth and commodity price growth booms. However, post-2009 aggregate supply shocks reinforced by loan supply shocks played a dominant role in depressing credit growth. The impact of the adverse shocks was particularly severe on credit to companies relative to households. Furthermore, we establish that tight financial conditions and heightened policy uncertainty shocks interact and are mainly transmitted via aggregate demand shocks as well. Tight financial conditions and heightened policy uncertainty shocks play a significant role in propagating adverse loan supply shocks and have depressing effects on aggregate demand and credit growth.

Furthermore, we establish the existence of the balance sheet channel of monetary policy via the housing market. Mortgage advances credit growth declines more due to contractionary monetary policy shocks and house price growth declines more in response to adverse aggregate supply shock. The implication of these results is that credit growth to the private sector declines more mainly due to the deterioration in balance sheets of households and NPLs of banks compared to the decline induced by the demand for credit shocks. However, this does not mean that there the absence of the traditional monetary transmission mechanism. Rather, that the response of mortgage advances credit growth, house price growth and NPLs suggests that a contractionary monetary policy shock is propagated via the deterioration in collateral values and borrowers' net worth impact on the loan supply channel. This means that housing plays an important role in the business cycle and policy interventions that support the banking system as well as the real economy need to be prioritized.

Chapter seven concludes the thesis by investigating whether the level of household debt growth impacts GDP. If so, whether there is a threshold of household debt growth that induces non-linear GDP growth responses. We establish that adverse aggregate demand and loan supply shocks are mainly transmitted via the labor markets and are propagated by credit conditions. Furthermore, employment creation results in immediate responses in household gearing as income shocks emanating from the labor market dynamics have an important relationship with credit growth, NPLs and the household debt burden in general. The error terms from the VECM suggest that currently household debt is in shortfall by as much as 10 per cent. In addition, the rate at which household debt growth adjusts from a dis-equilibrium position is terribly slow at less than one per cent per quarter.

The threshold techniques used in this chapter establish that the household debt growth threshold occurs between 8.8 per cent and 13.4 per cent. In addition, the transition functions suggest that the distance from the threshold and the sign away from the threshold matter for the response of GDP and employment growth. In periods of high household debt regimes, GDP growth and employment growth are persistently high compared to periods of low household debt regimes. The implications of these findings for the price stability and financial stability mandates are that household debt growth levels matter for GDP growth. The channels of transmission are largely via the labor market and are amplified by credit conditions. Loan supply shocks act as amplifiers of aggregate demand shocks and induce asymmetric effects on the macro-economy. But the credit supply hypothesis seems to have dominated the evolution of household debt growth pre-2009. Furthermore, loan supply shocks were propagated by heightened credit risk as NPLs made negative contributions to household debt growth. Increases in labor productivity growth, GDP growth, employment growth are the key variables that assist in the adjustment of household debt growth from the dis-equilibrium positions.

In addition, the decline in NPLs contributes more to the adjustment of household debt growth from the dis-equilibrium compared to the prime rate. This is because heightened credit risk as captured by the NPLs, limits the ability of banks to supply credit and widens the lending rate margins. The household debt growth dis-equilibrium positions, thresholds and the transition functions between the low and high regimes matter for the conduct of macro-prudential, monetary, and financial stability policies. They convey information about the state of credit demand driven inflationary pressures, the concentration and build-up of financial risks. They act as useful guides for the conduct of macro-prudential, price stability and financial stability policies, over and above guiding the conduct of fiscal and macro-economic policy interventions.

Chapter 2 Global liquidity as a driver of credit, output growth and sovereign yields

2.1 Introduction

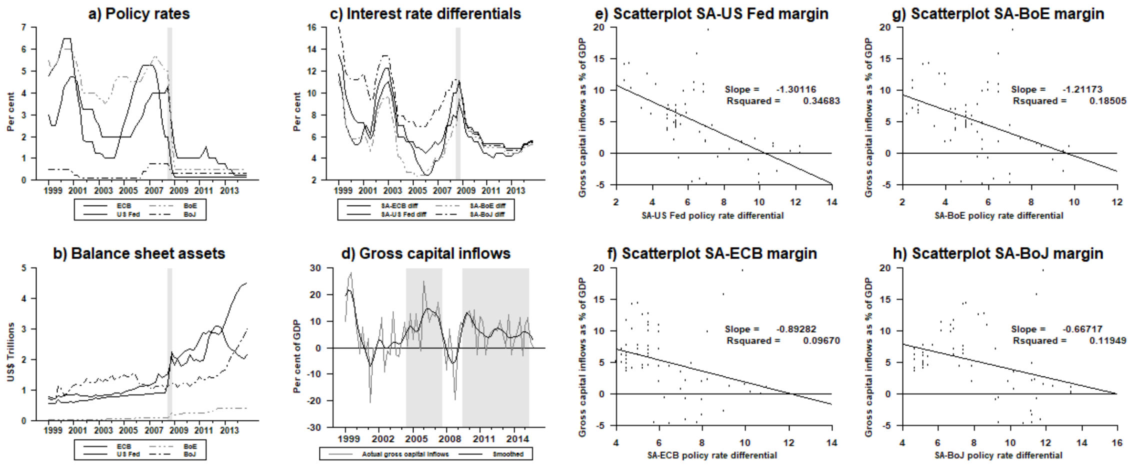
Subsequent to the 2007 global financial crisis, key central banks in advanced economies (AEs) embarked on conventional and unconventional accommodative monetary policies thus contributing to a surge in global liquidity. Furthermore, the interest rate differentials between AEs and South Africa widened due to policy rates in these economies hitting the zero-lower bound as shown in Figure 2.1. The interest rate differential between the South African policy rate and that of the European Central Bank (ECB), United States Federal Reserve Bank (US Fed), Bank of England (BOE) and the Bank of Japan (BOJ), increased from a low level recorded pre-2009 to an average of 6 per cent across all measures as shown in Figure 2.1(c) between 2008Q3 and 2014Q4. This widening in the interest rate differential and the injection of global liquidity in financial markets through the increase in the balance sheets of central banks in AEs was channeled to emerging market economies (EMEs) including South Africa via the capital inflow surges episode as shown by the shaded areas in Figure 2.1(d). The grey shaded areas in Figure 2.1(d) show periods during which gross capital inflows as a per cent of GDP were consistently above 5 per cent.[1] Furthermore, the scatterplots in Figures 2.1 (e, f, g and h) show that there is a negative (inverse) relationship between the policy interest rates of various AEs central banks and that of South Africa, albeit at varying degrees. The high R-square for the bilateral relationship between the SA-US policy rate margin and the capital inflows into South Africa relative to those of other countries is consistent with vast literature that shows that changes in global risk perceptions due to pure financial shocks and the US monetary policy shocks have the largest impact on the global configuration of capital flows (Habib and Venditti, 2019). In this regard, (Carstens, 2015) argues that excess global liquidity associated with the conduct of unconventional monetary policies in AEs resulted in substantial distortions, particularly in EMEs. The size of capital flows into EMEs was much larger than the capacity these countries could absorb without having distortionary effects on the central bank mandates of price and financial stability.

Against this background, this chapter explores whether positive global liquidity shocks result in distortions in some South African macro-economic variables? If so, are there any distortionary effects and policy dilemmas posed by excess global liquidity, global risk perceptions and its impact on the direction of capital flows in South Africa as reported in other emerging market economies?

[1] We used the Henderson 4-quarter moving average technique to smooth the actual gross capital inflows time series.

It is important to explore these questions because excess global liquidity, global risk perception and its impact on the direction of capital flows largely through the exchange rate channel and yields have an impact on the government debt financing conditions, price stability and financial stability mandates of the South African Reserve Bank (SARB). The understanding of the manner in which positive global liquidity shocks drive house price growth and equity price growth contributes to the design of macro-prudential policy tools that can be used to mitigate financial stability risks emanating from excess global liquidity shocks".

Figure 2.1 Selected central bank policy rates and balances sheets[2]



Source: IMF IFS and South African Reserve Bank database.

Note: The grey shaded area in (a, b and c) denotes the start of the period of a synchronized decline in central bank policy rates and the increase in the levels of the central bank balance sheets in advanced economies. The grey shaded area in (d) shows the period during which gross capital inflows as er cent of GDP averaged 5 per cent.

This chapter contributes to literature by examining these questions and assesses how positive global liquidity shocks are transmitted into the domestic financial markets and real economy. The main hypothesis being assessed in this chapter is that low policy rates and asset purchases (quantitative easing) contributed to a surge in global liquidity. In turn, excess global liquidity largely transmitted via global investor risk appetite and capital flows exerted different effects on South African sovereign yields, equity price growth, house price growth, credit growth and GDP growth. Both mandates of the SARB, namely, price stability and financial stability were impacted by the

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2 The US Fed, BoE, ECB and the BoJ collectively referred to as the G4 central banks have since the onset of the global financial crisis through the conduct of unconventional monetary policy injected liquidity to the amount of US$10 trillion as at February 2015, up from US$5 trillion as at June 2007. Furthermore, Cerutti et al (2014) show that G4 economies are key financial centers. The international banks in the G4 countries intermediate much of cross-border credit between countries. The international banks impact global funding conditions and ease of credit conditions

transmission of excess global liquidity into the South African economy. We assess the impact of the different effects exerted by the policy rates and liquidity injections by the US Fed, BoE, ECB and the BoJ. But because the BoJ embarked on liquidity injection later than the other central banks, we separate its effects to assess whether the additional injection of liquidity had an impact on the South African economy.

2.2 What is global liquidity and how is it broadly defined?

First, this chapter takes a view that global liquidity refers to (i) the availability of funds for the purchase of goods or assets and (ii) the ease of global financing conditions (CGFS, 2011).[3] Are there discernible and statistically significant differences between different variables that capture the essence of global liquidity? Yes, there are. As a result, to comprehensively capture the idea, essence and definition of global liquidity conditions this chapter aggregates selected financial data for the G4 economies, namely (i) policy rates (ii) overnight rates (iii) long-term government bond yields (iv) asset purchases by central banks (v) broad money supply and (vi) credit aggregates. These financial variables capture the price and quantity definitions for global liquidity.[4] Thereafter, global factors for quantity and price measures for global liquidity are constructed using the individual variables from G4 group of countries.

How potent and persistent are the effects of price global liquidity shocks compared to quantity global liquidity shocks? The disaggregation of global liquidity into price and quantity measures captures the essence of the challenge faced by AEs as policy rates hit the zero-lower bound. The conduct of unconventional monetary policy tools (UMPTs) and quantitative easing (QE) became complementary tools to reinforce the easy monetary policy conditions as policy rates were stuck at the zero-lower bound. The distinction of price and quantity measures of global liquidity measures is therefore necessary to fully capture the cross-border transmission of monetary policy actions. With the policy rates reaching zero and in some instances going negative, the accommodative monetary policy stance which is captured by the price measures of global liquidity, was complemented and reinforced through the use of various UMPTs including QE which is

[3] See http://www.bis.org/statistics/gli.htm

[4] Literature shows that there is not a single variable or indicator that best captures monetary policy and global liquidity. Canova and Nicolo (2002) use the slope of the yield curve and Leeper et al (1996) use a combination short-term interest rates and money supply. Christiano et al (1998) find that the estimates of monetary policy shocks for output fluctuations are extremely sensitive to the way monetary policy is measures. As a result, they conclude that short-term interest rates are the best measures of the monetary policy stance. Chen et al. (2012) and Eickmeier et al. (2014) present several financial variables that capture the essence of quantity and price measures for global liquidity.

captured by the quantity measures of global liquidity.

To the best of our knowledge this is the first paper to adopt the disaggregation of price and quantity measures of global liquidity approach in South Africa. Furthermore, contrary to Eickmeier et al. (2014), Djigbenou and Park (2015), Choi et al. (2014) this chapter considers variables that are directly and indirectly under the control of the policymakers. Hence, the measures of global liquidity used in this chapter contribute to literature. They offer a better reflection of the variables central banks used to inject liquidity directly and indirectly.

Second, academic and policy debates have been grappling with risks posed by excess or ample global liquidity. Theoretically, the availability of ample global liquidity can be an important factor in the build-up of financial imbalances and risks to financial stability. One channel of transmission of global liquidity into the domestic economy is via its impact on changes in global investor risk appetite, a surge in capital inflows and cross-border bank lending effects on domestic equity price growth, house price growth, credit growth, government bond yields and GDP growth. Vast literature, such as IMF GFSR (2016), Brana and Prat (2016), show that global liquidity can encourage investors to take on too much risk, lower yields and drive up asset prices. Furthermore, literature shows that global excess liquidity is a positive determinant of asset prices in EMEs, particularly when there is high investor risk appetite.

Contrary to the studies by Saxegaard (2006), Khemraj (2013) and Primus et al (2014), this chapter explores the channels through which positive global liquidity shocks are transmitted into the South African economy. These studies raise an important aspect of how excess domestic bank liquidity measured in the form of banks' holdings of non-remunerated liquid assets in excess of the statutory requirements weakens the monetary policy transmission mechanism and the ability of monetary authorities to influence demand conditions in the domestic economy. Furthermore, with respect to South Africa, Gumata and Ndou (2017) show that excess capital adequacy ratio (alternatively, the countercyclical capital buffer) and excess liquid asset holding of banks as financial regulatory and macroprudential tools play an important role in complementing the monetary policy stance and impact credit conditions and credit driven demand inflationary pressures in the macro-economy. In addition, Gumata and Ndou (2017) show that macroprudential tools such as the loan-to-value ratio (LTV), repayment-to-income ratio (RTI) and the National Credit Act (NCA) play an important role in complementing monetary policy and other financial regulatory tools in curbing excess risk taking in the banking sector, dampening the impact of credit driven demand inflationary pressures and thus contribute to the achievement of the price stability and financial stability mandates of the SARB.

To capture the risks and distortionary effects of global liquidity on macroeconomic and financial stability, the analysis in the chapter includes the impact of global liquidity on house and equity prices. We dedicate a section that asks: Did positive global liquidity shocks impact domestic house price growth and equity price growth? The study determines the responses of house price growth and equity price growth to persistent positive excess global liquidity shocks and assesses whether they pose threats to financial stability. We use the counterfactual scenario approach and the historical contributions of positive global liquidity shocks to identify periods during which global liquidity shocks contributed to the acceleration in house price growth and equity price growth. The understanding of the manner in which positive global liquidity shocks drive house price growth and equity price growth contributes to the design of macro-prudential policy tools that can be used to mitigate financial stability risks emanating from excess global liquidity shocks.[5] We are not aware of any studies in South Africa that have explored these aspects.

Furthermore, the international transmission of central bank QE and global liquidity works through lowering investor uncertainty and risk appetite which in turn lower long-term yields and credit risk. We dedicate a section in this chapter and ask: Did global liquidity shocks impact South African government ten-year yields? Did they lower South African sovereign credit risk thus easing the financial constraints on government finances? We use credit default swap (CDS) spreads and the South African and United States (SA-US) ten-year yield spread to assess the impact of global liquidity shocks of sovereign yields and risk.

Last, Japan relative to the other G3 economies has battled with the zero-lower bound for a relatively longer period. The BoJ initially implemented QE from 2001 to 2006 and resumed in 2012. Therefore, to assess the impact of additional liquidity injected by the BoJ, we ask: Did the conduct of QE by the BoJ have a different impact on global liquidity and in turn South African credit growth and real economic growth? We separate the role of the effects of additional QE stimulus by the BoJ and assess its impact on the South African macro-economic variables. We explore whether additional global liquidity injected by the BoJ exerted any statistically significant results in terms of magnitudes and the direction on the South African economy.

The chapter uses a sign restricted factor-augmented VAR (FAVAR) to identify global liquidity shocks and investor risk shocks. We use the counterfactual scenarios and historical contributions approaches to derive policy implications of the different impact of price and quantity measures of

[5] For instance, Borio and Zhu (2008), Psalida and Sun. (2011) and Bridges and Thomas (2012) show that global liquidity affects global and domestic financial markets through capital inflows and risk appetite from international investors searching higher yield.

global liquidity shocks. The sign restricted FAVAR approach is particularly useful when estimating the dynamic responses of many home (domestic) variables to foreign shocks. Mumtaz and Surico (2009) show that the sign restricted FAVAR approach allows researchers to incorporate a large amount of information in the model in a remarkably simple manner. In the sign restriction approach, global liquidity shocks, global risk aversion shocks and domestic macroeconomic variables are restricted to conform to *apriori* theoretical predictions. The responses of the variables of interest, namely credit growth, house price growth, equity price growth and GDP growth are left unrestricted.

The results show that all shocks to price and quantity measures of global liquidity lead to a significant increase in GDP growth and credit growth. However, inflation declines in response to price and quantity measures of global liquidity shocks consistent with the appreciation of exchange rates exerting downward pressure on inflation.

Which global liquidity shock has potent effects on credit growth and GDP growth? Evidence in this chapter shows that quantity measures of global liquidity, in particular asset purchase lead to higher peak responses in GDP growth. The inclusion of Japan data in the construction of the global liquidity factors results in higher peak responses in credit growth and GDP growth. This means that asset purchases by the Bank of Japan added to excess global liquidity and contributed to easier domestic credit and financial conditions. The responses of house price growth and equity price growth suggest that the effects of price and quantity measures result in much more pronounced effects on house price growth and equity price growth.

How did global liquidity lower domestic government yields and risk? Evidence shows that the decline in global policy rates and investor risk perceptions coupled with an increase in the quantity measures of global liquidity loosened domestic financial conditions. The yield on the ten-year domestic government bond, the SA-US yield spread, domestic sovereign credit risk across the five-year CDS and emerging market bond index (EMBI) spreads declined. This indicates that the lowering of global interest rates and the asset purchases loosened domestic financial conditions and the fiscal constraints.

Overall, we establish that global risk, global monetary and global financial conditions do spill-over and are transmitted into the South African economy via several channels. Unconventional monetary policy tools do indeed complement and reinforce the effects of conventional monetary policy interventions. The findings in this chapter concur with several empirical studies in this area showing that unconventional monetary policy tools are a necessary addition to the monetary policy toolkit. Furthermore, unconventional monetary policy tools have implications for fiscal policy, exchange rates, price stability and financial stability mandates of central banks.

The rest of the study is structured as follows: section three presents the literature review. This is followed by the discussion of the econometric approaches used in the chapter, the data, stylized facts between the estimated global factors and selected domestic variables; and the sign restriction identification scheme followed in the chapter. Section six presents the empirical results, followed by the robustness analysis, conclusion, and policy implications.

2.3 Literature Review

Theoretically, QE is transmitted through the signaling, confidence, expectations, and portfolio rebalancing effect channels. Asset purchases are intended to alter investor risk perceptions to affect asset prices, bank lending, output growth and inflation. The signal sent by the central bank conducting QE results in a change in market expectations about the future course of monetary policy. However, Fratzscher (2011) and Chudik and Fratzscher (2012) show that these channels work in parallel and are not mutually exclusive.

Empirical literature documenting the channels of transmission of asset purchases, global liquidity shocks and capital flows from large economies such as the US, Euro Area and other advanced economies emphasizes the role of global financing conditions, capital flows, asset prices and the amplifying role of collateral values on households and firms' borrowing capacity. Favilukis et al (2012); and Krishnamurthy and Vissing-Jorgensen (2011) show that US QE was mainly transmitted to financial markets by lowering liquidity risk, including long-term rates, default rates and the mortgage repayment risks. Fratzscher et al (2013) find that the ECB asset purchases resulted in a strong decrease in investor uncertainty and risk aversion thus exerting a positive impact on equity prices in the Euro Area and G20 members. In addition, bank and sovereign CDS spreads declined and had a positive impact on sovereign and bank credit risk. They conclude that the ECB asset purchases affected global investor risk perceptions and spilled over to into global equity markets implying that they play a meaningful role on the global financial cycle.

Christensen and Krogstrup (2016) decompose the impact of central bank asset purchases into the supply-induced portfolio balance effects and the reserve-induced portfolio balance effects. They argue that central bank asset purchases can result in both effects especially in cases such as the US, UK and ECB and Japan where central banks conducted QE predominantly via the purchase of long-term bonds. The authors decompose the portfolio balance effect into (i) the traditional supply-induced portfolio balance effect associated with the decrease in yields due to the shortage (reduction in supply) of long-term bonds. The decline in the supply of long-term securities occurs via the signaling channel and when central banks conduct QE through the purchase of long-term securities. The reserve-induced portfolio balance effect occurs due to the increase in the supply of bank reserves that accompanies asset purchases. They show that the Swiss central bank conducted a QE program without any purchase of long-tern assets but managed to lower long-term yields.

Claessens et al (2011) find that in response to excess global liquidity, exchange rates were overvalued and accompanied by excessive credit growth in EMEs. Bruno and Shin (2014) establish a similar transmission mechanism in southern Europe during the 2007 financial crisis. Chudik and Fratzscher (2012) distinguish between (i) the portfolio rebalance which is identified as a negative correlation between returns and investment flows into a given asset conditional on risk shocks and (ii) the return or yield chasing motives which are identified as a positive correlation between returns and investment flows into a financial asset conditional on risk shocks during the 2007-08 financial crisis and the 2010-11 European sovereign debt crisis. They find that the portfolio rebalancing motive explains the huge outflow of capital from EMEs into advanced economies' bonds during the 2007-08 financial crises. This contrasts with a large outflow of capital from EMEs in 2007-08 that was characterized by the flight to safety. In addition, they establish that shocks to global liquidity and risk had larger effects on asset prices and capital flows during the 2007-08 financial crises compared to the 2010-11 European sovereign debt crises. On the other hand, Cetorelli and Goldberg (2010) show that adverse global liquidity shocks affected the loans supply to EMEs via three key channels namely, (i) a contraction in direct cross-border lending by foreign banks (ii) a contraction in local lending by foreign banks' affiliates located in EMEs and (iii) the funding shock on the balance sheets of local banks due to a decline in interbank cross border lending.

Empirical studies on the transmission and role of global liquidity in influencing macro-financial developments use different data sets and various econometric approaches. The quantitative approaches are applied on small and large time series and panel data sets. The quantitative approaches range from simple, structural and factor augmented VAR models. In turn, the approaches to identify structural shocks and channels of transmission use the Choleski (recursive) approach, sign restriction, event study and a combination of these approaches. We present a review of the empirical evidence on global liquidity and asset purchases using various data sets and quantitative approaches in the sub-sections below.

2.3.1 Evidence from FAVARs with small datasets

Several studies show that global liquidity conditions, in particular demand shocks to liquidity are important for the stability of the financial and real economic activity. Chen et al. (2012) distinguish between price and quantity measures of global liquidity. They find that both measures of global liquidity exert a positive impact on the GDP growth in the receiving countries. Choi et al (2017) and D'Agostino and Surico (2007) established that US expansionary monetary policy induces global booms via changes in global real interest rates. Similarly, Choi and Lee (2010) show that expansionary monetary policies in advanced economies resulted in persistently positive and strong output growth and inflation in Asian emerging economies. On the other hand, literature connecting the global liquidity to equity and other asset prices such as Baks and Kramer (1999) and IMF (2010) show that global liquidity is negatively correlated with interest rates but positively related to equity returns. This means that global liquidity expansion tends to be associated with a rise in equity returns and a decline in real interest rates in liquidity receiving economies.

On the economic factors that are key and persistent drivers global liquidity and capital flows, literature is mixed. For instance, Forbes and Warnock (2011) establish that changes in global risk is a consistent and significant factor in driving all types of capital flow episodes i.e. capital flow surges, sudden stops, flight and retrenchments. Cerutti et al. (2014) find that several global liquidity factors such as G4 money growth, VIX[6], the slope of the US yield curve, dealer bank leverage and real interest rates drive cross-border bank flows. Furthermore, financial conditions captured by bank leverage and TED[7] spreads in the US, UK and the Euro Area drive cross-border bank flows and affect global financial conditions.

Matsumoto (2011) uses international reserves and VIX as quantity and price measures of global liquidity, respectively. The author shows that EMEs are most affected by the risk premium and the availability of funds for risky assets. In addition, positive global liquidity shocks tend to generate lower interest rates, more appreciated exchange rates, higher equity returns and higher output growth in EMEs. Similarly, Bekaert et al (2010) find that accommodative monetary policy leads to a decline in risk aversion and that it is possible that changes in global risk might be

[6] VIX Index is the Chicago Board Options Exchange (CBOE) Volatility Index, see http://financial-dictionary.thefreedictionary.com/VIX for further details.
[7] The TED spread is the difference between the 3-month Treasuries and the interest rates on interbank loans at the London Interbank Offered Rate (LIBOR). The TED spread is a proxy of the short-term credit risk or default premium and changes in the TED spread indicates risk perception and pricing when lending to other financial market participants. The TED spread is also seen as an indicator of the state of credit markets.

capturing the lagged effect of changes in monetary policy. Glocker and Towbin (2012) classify liquidity created by central banks as public liquidity and liquidity created by financial institutions as private liquidity. They study the effects and importance of both public and private liquidity shocks in determining overall global and domestic liquidity conditions. Their results indicate that both public liquidity and private liquidity shocks have positive effects on financial and macroeconomic conditions. However, private liquidity shocks have a substantially larger effect in the short run. Sousa and Zaghini (2003) find that changes in global liquidity explain an important share of the Euro Area price and output fluctuations. Ruffer and Stracca (2006) establish that positive shock to global excess liquidity[8] lead to a significant rise in domestic real output and price level for the Euro Area and Japan. Furthermore, Darius and Radde (2010); Bridges and Thomas (2012) and Psalida and Sun (2011) find that G4 liquidity expansion has an impact on global asset and commodity prices.

2.3.2 Evidence from FAVARs with large datasets

Eickmeier et al. (2014) construct global liquidity indicators based on financial and macroeconomic variables of 24 AEs and EMEs. They find that dynamics in financial variables are driven by three common global factors, namely, (i) monetary policy (ii) global credit supply and (iii) credit demand. Thus, global liquidity cannot be summarized in a single indicator. Furthermore, they establish that a sustained increase in global liquidity supply and accommodative global monetary policy conditions played a significant role in loose global credit supply conditions in the period preceding the financial crisis in 2007.

Choi et al (2014) use a panel comprising 19 EMEs. They find that additional global liquidity tends to boost EMEs macro-economic conditions and results in the appreciation of their currencies in the short run. This is reversed when global investor risk aversion is elevated and results in the withdrawal of foreign liquidity from EMEs, thus having the opposite effect on economic activity and currencies. Cesa-Bianchi et al (2015) use aggregate bank-to-bank cross border flows as a measure of the global liquidity shock and compare the house price behavior in AEs and EMEs. They find that the global liquidity shock has a stronger impact on house price growth, consumption growth and the current account in EMEs compared to AEs. Furthermore, the effects of the global liquidity on collateral valuation effects linked to house price and exchange rate changes on

[8] Ruffer and Stracca (2006) define excess global liquidity is defined as the ratio between broad money to nominal GDP.

consumption are more pronounced in EMEs.

2.4 Methodology: sign restricted FAVAR model

This chapter models the transmission and impact of different measures of global liquidity on the South African economy by using the factor-augmented vector autoregression (FAVAR) approach. The FAVAR approach developed by Forni et al. (2000); Bernanke et al (2005), and Stock and Watson (2005) provides a parsimonious and effective framework of analysis by incorporating information from many economic time series. FAVARs extract common factors from a large set of data and use them in the vector autoregression (VAR) models. FAVARs allow the researcher to introduce more relevant information into economic estimations compared to standard VAR methods. In addition, FAVARs minimize the loss of degrees of freedom associated with the reduced dimension of the estimated systems. This characteristic enables FAVARs to deal with the "curse of dimensionality" that small scale VARs suffer from. Bernanke and Boivin (2003) emphasize that the central bank is likely to consider more information when making policy decisions. Therefore, FAVAR models assist decision making in a data-rich environment.

Furthermore, FAVARs lessen the problem of an arbitrary selection of observable series that capture theoretical concepts. Several studies establish robust findings that FAVAR impulse responses result in significantly reduced-price puzzles and counter-intuitive responses that are common in standard VARs. In this regard, Forni et al (2000) show that FAVARs reduce the un-fundamentalness risk and improve the explanatory power of the model.

There are two approaches used to estimate FAVAR models, namely, (i) the one-step approach and (ii) the two-step approach. Stock and Watson (2002, 2005) and Bernanke et al (2005) use the two-stage stage method where in the first step common factors are computed. In the second stage, the VAR system is estimated using standard time series methods. The extracted common factors are treated as other endogenous time series variables in the model. The one-step approach simultaneously estimates the unobserved factors and the VAR coefficients. Otrok and Whiteman (1998), Kose et al. (2003) and Bernanke et al (2005) and conclude that the two-step and one-step approaches produce similar results. Furthermore, Mumtaz and Surico (2009) show that the one-step approach comes at a cost of computational burden particularly in exceptionally large models and this can be inefficient in large cross-sectional estimations.

2.4.1 The estimation of common factors by PCA

This study uses the principal components analysis (PCA) approach to extract the common factors. The PCA method has the advantage in that it enables the summarizing of a large information set into a single indicator. Johnson and Wichern (1992) and Helbling et al (2011) show that by design factors extracted via PCA capture the maximum variance and that the global factors obtained with a dynamic factor model are not qualitatively different to those derived via the *first* PCA. The PCA methodology extracts a common factor F_t that captures the greatest common variation in a group of P variables X_t. The variable $X_{it}$is a sum of two orthogonal unobservable components that are linked by a linear relationship. The linear relationship can be decomposed into (i) a common component χ_{it} and (ii) an idiosyncratic component ξ_{it} as in Equation 2.1.

$$X_{it} = \chi_{it} + \xi_{it} \qquad (2.1)$$

The common components are driven by $q$macro-shocks, u_t is a linear combination of factor F_t as shown in Equation 2.2.

$$X_t - \mu = \beta F_t + U_t \qquad (2.2)$$

Where μ is a $p \times 1$ vector of the variables' means, β is a $p \times m$ matrix of coefficients, and F_t is a vector of $m \times 1$ unobserved common factors, and U_t is a $p \times 1$vector of errors. The model assumes that errors are orthogonal to the common factors $[E\,(FU') = 0]$ and the common factors have zero mean $E(F) = 0$. This means that X_t is only affected by its own idiosyncratic shock and all other idiosyncratic shocks will not have any effect across horizons. This means that quantity and price measures of global liquidity estimated in this chapter are a function of a F_t which can be consistently estimated by extracting principal components from a matrix M_t.

$$M_t = \{y_{1t}^1, \ldots\ldots, y_{1t}^n, \ldots\ldots, y_{Nt}^1 \ldots\ldots, y_{Nt}^n\}. \quad (2.3)$$

Where, M_t includes G4 central bank asset purchases, monetary aggregates, credit extension to the private sector, policy rates, overnight interest rates and long-term bond yields. The global factors exclude South African data. The extracted common factors F_t from the G4 countries' variables can explain the highest proportion of correlation among the different economies. To determine the optimal number of factors, the Bai and Ng (2002) approach proposes the minimization of the information criterion in Equation 2.4.

$$r = Arg_t \min(\ln{(V_r)} + r\,.\,g\,(N\,,T\,)) \qquad (2.4)$$

$$Where, \quad V_r = \frac{1}{NT} \sum i\,,t\ \xi_{t\,,i}^2$$

In Equation 2.4, r is the optimal number of factors, V_r is the average residual variance when r factors are estimated, g is a penalty function, N and T are the cross sections and the time dimensions of the panel. Bai and Ng (2002) propose three penalty functions which define three information criteria with different properties in finite samples which are asymptotically equivalent to Equation 2.5.

$$g_1(N\,,T\,) = \frac{N+T}{NT} \ln\,(\frac{NT}{N+T})$$

$$g_2(N\,,T) = \frac{N+T}{NT} \ln(\min(\sqrt{T}\,,\sqrt{N}))$$

$$g_3(N,T) = \frac{\ln\,(\min(T,N))}{\min(T,N)} \qquad (2.5)$$

The criteria in Equation 2.5 depend on the trade-off between good fit and parsimony. We apply the PCA to the entire set of variables in X_t in Equations 2.1 and 2.2 with the number of factors r chosen by the Bai and Ng (2002) information criteria. The common factors correspond to the r principal components associated with the r largest eigenvalues. The cutoff point for the significance of the number of factors based on the scree plot of the eigenvalues is one.

2.4.2 The FAVAR model

The second stage of the estimation includes the estimated price, quantity and risk global factors in F_t (F_t^{PR}, F_t^{OR}, F_t^{LR}, F_t^{AP}, F_t^{MA}, F_t^{CA}, F_t^{Risk}) as summaries of blocks of exogenous variables representing global policy rates (F_t^{PR}), overnight rates (F_t^{OR}), long-term-rates (F_t^{LR}), asset purchases (F_t^{AP}), monetary (F_t^{MA}) and credit aggregates (F_t^{CA}) and risk (F_t^{Risk}) into a VAR model. Thus, results in a factor augmented VAR. Like Mumtaz and Surico (2009), we refer to these factors as the foreign block of factors. The set up for the FAVAR model in Equation 2.6 allows $X_t = \left[\,X_{1t,\dots,}X_{Nt}\right]'$ be an N- dimensional vector of stationary time series variables observed for $t = 1, \dots, T$. So that if the number of common factors is q, the FAVAR can be expressed as:

$$X_{it} = \tau_i(L) f_t + e_{it} \qquad (2.6)$$

$$f_t = \emptyset\,(L)\, f_{t-1} + \eta_t \qquad (2.7)$$

Where, $f_t$is the $q \times 1$vector of common factors at period t, the factors for series i are in $\tau_i\,(L)$ consisting of a $1 \times q$ vector lag polynomial, $n_t$is a q-dimensional innovation for factors at time $t$and e_{it} is the idiosyncratic shock for series i at period t. If $\tau_i(L)$ has a finite degree, p_0 then the factor can be defined as:

$$\left[F_t = f_t' \, f_{t-1}' \dots f_{t-p0}'\right]' \qquad (2.8)$$

Where the dimension of F_t is $r \times 1$. The FAVAR can be represented as:

$$X_t = \Lambda F_t + e_t \qquad (2.9)$$

$$F_t = \Phi(L)F_{t-1} - G\eta_t \qquad (2.10)$$

Where, A is the factor loading matrix for $F_t, e_t = [e_{1t}, \dots, e_{Nt}]', \Phi(L)$ is $r \times r$ matrix lag polynomial and $G$is $r \times q$ matrix of zeros and ones. If e_{it} is modeled as an autoregressive process:

$$e_{it} = \delta_i(L)e_{it-1} + \vartheta_{it} \qquad (2.11)$$

$$Let\ D(L) = \begin{bmatrix} \delta_1(L) & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \delta_N(L) \end{bmatrix}, and\ \vartheta_t = [\vartheta_{1t}, \dots, \vartheta_{Nt}]'$$

$$e_t = D(L)e_{t-1} + \vartheta_t \qquad (2.12)$$

Equations 2.9, 2.10 and 2.12 can be combined and re-written in a VAR (P) form and the FAVAR equation represents the joint dynamics of factors.

$$\begin{bmatrix} F_t \\ X_t \end{bmatrix} = \begin{bmatrix} \Phi(L) & 0 \\ A\,\emptyset\,(L) - D(L)A & D(L) \end{bmatrix} \begin{bmatrix} F_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{F_t} \\ \varepsilon_{X_t} \end{bmatrix} \qquad (2.13)$$

$$where, \begin{bmatrix} \varepsilon_{F_t} \\ \varepsilon_{X_t} \end{bmatrix} = \begin{bmatrix} I \\ \Lambda \end{bmatrix} G\eta_t + \begin{bmatrix} 0 \\ \vartheta_t \end{bmatrix} \qquad (2.14)$$

2.4.3 Identification with sign restriction in FAVARs

The estimated global liquidity factors discussed in the previous section do not have a structural interpretation of the transmission into the South African economy. We need an encompassing model to estimate the transmission and impact of these global shocks on the South African economy. The identification of these global shocks, their transmission and impact of on the South African economy can be done in a number of ways, including (i) the Cholesky decomposition or simple recursive ordering (ii) a non-recursive scheme that allows for more general contemporaneous interactions among the variables in the model (iii) a structural FAVAR based on reasonable assumptions about the interaction between global and domestic variables (iv) imposing theoretically motivated sign restrictions on the factor loadings.

We use the Mountford and Uhlig (2009) sign restriction approach to simultaneously identify the global price, quantity, and risk factors. This means that the three shocks are identified by orthogonal impulse vectors which obey the imposed sign restrictions. In addition, the identifying sign restrictions distinguish the idiosyncratic and common components of the factors. Helbing et al (2011) show that the individual identification of shocks one at a time does not guarantee the orthogonality of the shocks. Hence it is difficult to argue that the identified shocks are truly structural when they are identified individually. For FAVAR models, the number of structural shocks $\vartheta_u$and the number of identifying restrictions do not change as the number of series in the data series n increase. Furthermore, the sign restriction identification approach as opposed to the recursive scheme allows us to be agnostic about the impact of structural shocks on the key variables of interest in the study. At the same time, the sign restriction approach imposes a more theoretically sound structure relative to the Cholesky decomposition.

We identify the structural shocks by imposing sign restrictions on the impulse responses of the variables of interest for a specified horizon $K = 4$. The sign restriction is not affected by the ordering of the variables such as in the Cholesky or recursive VAR whose results are order dependent (Uhlig, 2005). In Equation (2.14) $\vartheta_t \sim N(0, Q_u)$ where, ϑ_t is the reduced form shock and Q_u is the factor error covariance matrix and is of full rank. $\emptyset_p$ are the $p - lag$ coefficient matrices with $[K \times 1]$, $[K \times 1]$and $[K \times K]$, respectively. The total number of factors is $K = n_f + n_y$. VAR literature assumes that the shocks are mutually orthogonal and normalized to be of variance one. Therefore, the reduced form shocks u_t of the FAVAR in Equation 2.13 is $u_t = Av_t$ and the matrix A is an orthogonal invertible matrix of dimension $[K \times K]$ satisfying $Q_u = AA$.

The $\vartheta_t$are uncorrelated and of unit variance $E\,[v_t\, v_t'] = I_K$. The J_{th} column of matrix A represents the impulse vector of a one standard error innovation to the J_{th} structural shocks and is the J_{th}element of ϑ.The impulse matrix of rank n is a $n \times m$ sub-matrix of some $m \times m$ matrix A such that $AA' = \sum$. An impulse vector a is an impulse matrix of rank 1. This means that a vector $a \in \mathbb{R}^m$ and that there exists some matric A where a is a column of A such that, $AA' = \sum$.

If $\sum$ is regular and a given impulse matrix $\left[a^{(1)}, \ldots.., a^{(n)}\right]$ of size $n$be a sub-matrix of two $m \times m$ matrices $A, \acute{A}$ with $AA' = \acute{A}\acute{A}' = \sum$. Let, $\vartheta_t = A^{-1}u_t, \acute{\vartheta}_t = \acute{A}^{-1}\,u_t$. Let $\vartheta_t^{(1)}, \ldots\ldots, \vartheta_t^{(n)}$ resp. $\acute{\vartheta}_t^{(n)}, \ldots\ldots, \acute{\vartheta}_t^{(n)}$ be the entries in ϑ_t resp. $\acute{\vartheta}_t$ corresponding to $a^{(1)}, \ldots.., a^{(n)}$. If $a^{(1)}$is the third column of A, then $\vartheta_t^{(1)}$is the third entry of ϑ_t. Then, $\vartheta_t^{(i)} = \acute{\vartheta}_t^{(i)}$ for all $i = 1, \ldots.., n.$

According to VAR literature, we should identify all m structural shocks and characterize the entire A matrix. This requires imposing $m(m-1)/2$ restrictions on the A matrix. Since we are using the Uhlig (2005) to identify at most three structural shocks, we need to characterize an impulse matrix $\left[a^{(1)},\ a^{(2)},\ a^{(3)}\right]$ of rank 3. This means that by construction, the covariance between the structural shocks $\vartheta_t^{(1)}, \vartheta_t^{(2)}\ and\ \vartheta_t^{(3)}$ corresponding to $a^{(1)}, a^{(2)}, a^{(3)}$ is zero and that these structural shocks are orthogonal.

For example, to identify the impulse matrix $\left[a^{(1)},\ a^{(2)},\ a^{(3)}\right]$ where the first shock is a global quantity liquidity shock, the second shock is the global investor risk and the third shock is the global liquidity price shock. We first identify the global quantity liquidity shock $a^{(1)} = \acute{A}q^{(1)}$, then the global investor risk shock $a^{(2)}$and the global liquidity price shock $a^{(3)}$. The minimization problem is stated as below:

$$a = argmin_{a=Aq, Rq=0, q'q^{(1)}, q'q^{(2)}, q'q^{(3)}=0}\Psi(a) \qquad (2.15)$$

By imposing additional orthogonality to the shocks, the three restrictions $R_q = 0, q'q^{(1)}q'q^{(2)}q'q^{(3)} = 0$ can be jointly written as:

$$0 = \tilde{R}_q \qquad (2.16)$$

Where, $\widetilde{R'} = [q^{(1)}, R', q^{(2)}, R', q^{(3)}, R']$. This means that the impulse vector of the shock of interest is an impulse vector that minimizes a criterion $\Psi_{(a)}$, which penalizes the responses of the variable in the system that do not obey the imposed sign restrictions over the horizons of the imposed shock $k = 0, 1, 2\ and\ 3$. It is a penalty criterion function which rewards impulse responses in the direction of the imposed sign restriction but penalizes the wrong signs.

For the Bayesian FAVAR (BFAVAR) the computations are performed using a Bayesian approach in Uhlig (2005). The Bayesian analysis treats the parameters of the model as random variables. The Gibbs sampling samples the factors and other parameters in the model based on the data. We take the number of draws using the identification scheme imposed on the variables. From the posterior draws and for each draw of the VAR coefficients and the variance-covariance matrix $\sum$, the impulse responses and confidence bands can be plotted.

2.4.4 The counterfactual scenario approach

In this chapter we use the counterfactual analysis based on the historical decompositions which shuts-off the role of the variable of interest in the model. A historical decomposition approach separates the contributions of shocks on the variable of interest into the base forecast (or trend), own contributions and contributions from other variables. To accomplish this, the model is re-estimated but the effect of the shock of interest is shut-off from being active or kept constant in the model. When the effect of the shock is shut-off or held constant, the difference between the baseline and the counterfactual is the response of the variable of interest in the absence of the shock of interest. The counterfactual response of the variable of interest is derived from the subtraction of the contribution of the shock of interest to the variables of interest. The counterfactual response of the variable of interest can be compared to that derived when the shock is active in the model. The difference between the impulse responses is then interpreted as the role attributed to the shock of interest.

2.5 Data and descriptive statistics

The data used in the empirical analysis is on a quarterly basis (Q) for the sample starts in 2000Q1 to 2014Q4. We start the sample in 2000 largely on account of the availability of data for the ECB. The data was sourced from the US Fed, ECB, Bank of England, Bank of Japan, South African Reserve Bank, IMF, and the Bank for International Settlements databases. South African variables included in the model are GDP growth, credit growth, repo rate, inflation, house prices growth, equity prices growth, sovereign credit default swap (CDS) spreads, yield on the ten-year government bond and the SA-US ten-year bond yield spread.

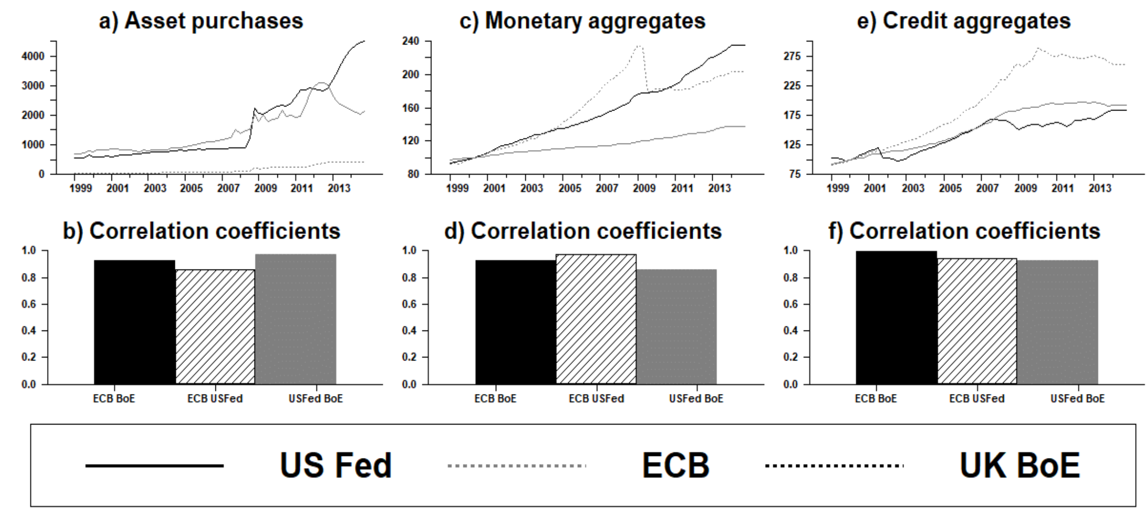
This section starts with the discussion of (i) the data and trends used to estimate factors for quantity and price measures of global liquidity and global investor risk perceptions (ii) the analysis and interpretation of the constructed factors and (iii) the stylized facts between the constructed global factors and selected domestic variables.

2.5.1 Quantity and price measures of global liquidity

The period of the zero-lower bound of the policy rates was followed by central banks embarking on unconventional monetary policy measures, alternatively, asset purchases or quantitative easing measures (QE).[9] The intention of QE was to reinforce or propagate the monetary accommodation impact of policy rates on financial markets and real economic activity. Hence, the impact of the transmission of QE to other segments of the financial variables can inferred from monetary and credit aggregates. For instance, Ruffer and Stracca (2006) show that the growth rate of monetary and credit aggregates are good complements to interest rates variables as quantity measures of liquidity. Matsumoto (2011) constructs a global liquidity proxy by adding up the monetary base of the United States and the world (excluding the US) total reserves. In this sense, this variable of global liquidity proxy captures all funds available in perceived safe assets.

In this chapter, we use asset purchases by central banks, money supply and credit aggregates for the G4 economies as factors that are more relevant quantitative indicators of banks' funding liquidity conditions. Eickmeier et al., (2014) argue that changes in banks' funding practices suggest that credit aggregates are more suitable measures of liquidity conditions, particularly from a financial stability perspective. Figure 2.2 shows all the variables used to construct the quantity measures of the global liquidity index.[10]

Figure 2.2 Quantity measures of global liquidity



Source: IMF IFS and author's calculations

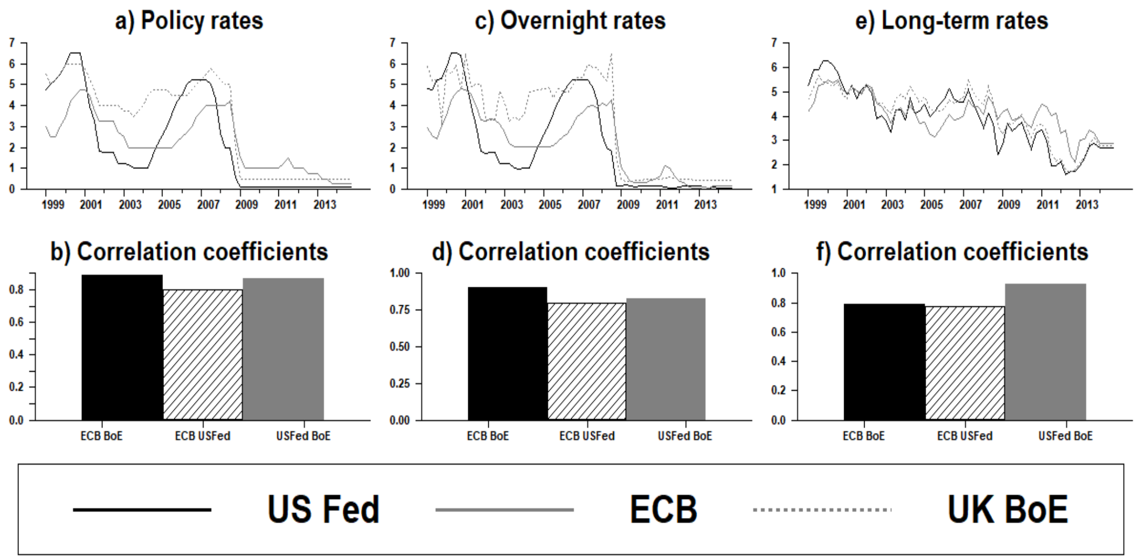
Figure 2.2(a) and (b) show assets for the US Fed, ECB, and the BoE. It is evident that prior to the

[9] For instance, the US Fed embarked on various rounds of QE since November 2008 and ended in October 2014. The BOE started with various rounds of the QE programme in March 2009. The ECB started with LTROs in 2009 and paused but embarked on further asset purchases starting in March 2015. The BOJ also started with QE in 2011.
[10] We stated earlier that Japan has been in an environment of the zero lower bound and had used quantitative easing techniques in the 1990s but paused and has since resumed in 2011. As a result, to capture the additional effects of the QE by Japan, we use data including Japan in the robustness analysis to assess whether it results in significantly different results.

2007 global financial crisis the use of balance sheets as a monetary policy tool by these central banks was extremely limited. The spike in the increase in central bank assets starts off as policy makers were confronted with nominal policy rates that had hit the zero-lower bound. Even though the policy rates were at the zero-lower bound the financial conditions had not eased considerably in response to the massive decline in the policy rates. The correlation coefficients between the G4 central banks data are above the minimum 30 per pent co-movement required between variables to construct a factor.

Interest rates provide a good measure of global liquidity conditions given that at the short-term level, they are determined by central banks. They are an important determinant of financing costs, financial conditions and in turn form an integral part of understanding global liquidity conditions. Central bank policy rates influence the interbank rates. Through expectations for growth and inflation, policy rates they also influence the yield curve. Figure 2.3 shows the data underlying the various price measures of global liquidity.

Figure 2.3 Price measures of global liquidity



Source: IMF IFS and author's calculations

The trends show that the policy rates declined to the zero-lower bound in 2008. In line with the monetary policy transmission mechanism, overnight rates also declined significantly. Long-term bond yields responded to easing in policy rates and QE by central banks.

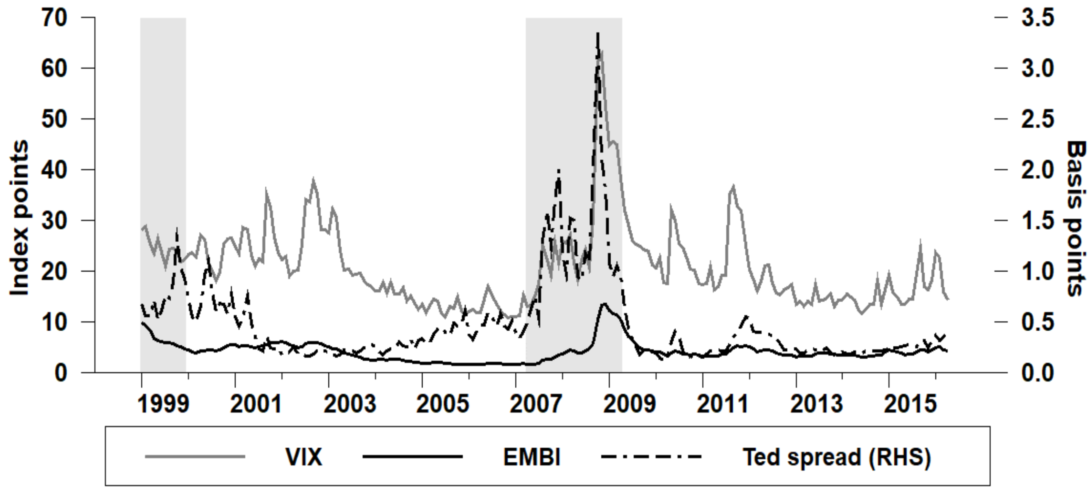
2.5.2 Measures of global risk

Policy rates and QE interventions used by central banks have an influence on investor risk perception risk. Matsumoto (2011) reports that periods characterized by ample liquidity tend to be associated with elevated risk appetite driven by the search for yield. As a result, changes in global investor risk appetite are potential global liquidity push factors related to market sentiments. We use the VIX index, the TED spread and the EMBI index to approximate aspects of global investor sentiment. The VIX index is constructed on the basis of implied volatilities of a wide range of options of the S&P 500. Theoretically, the VIX index is an indicator of risk seen as appealing as it captures both the perceived price and level of uncertainty of future stock price movements by investors. The VIX index is expected to increase as global investors become averse to risk. The increase in global investor risk aversion is expected to lead to a decline in capital flows into EMEs especially, portfolio flows. The decline in capital flows then results in an increase in EMEs sovereign bond spreads. The reverse is expected to occur when global investor risk appetite decreases. There is therefore a link between market risk aversion, various measures of global liquidity and depending on the severity of the shock it may exert different effects on asset prices and real economic activity (Bekaert et al, 2010).[11]

However, Gonzales-Hermosillo (2008) and Fratzscher et al (2013) propose to supplement the traditional risk measures such as the VIX index with the TED spread. Bruno and Shin (2014) show that the TED spread is a good proxy for leverage. At the same time, Matsumoto (2011) shows that while VIX, the TED spread and the EMBI index tend to be correlated, they do not measure the same market developments. For example, the EMBI index is directly dependent on the countries' probability of default. Figure 2.4 shows the evolution of VIX, TED spread and the EMBI index. The grey areas correspond to the start of the global financial crisis in 2007M8, the start of the euro area sovereign debt crisis in 2010M4 and the escalation of the euro area sovereign debt crisis and the start of QE easing by the US Fed.

Figure 2.4 Measures of global investor risk perception

[11] Recent empirical studies on banking and bond inflows flows to emerging market economies show that VIX as a measure of risk appetite of global investors. See also Miranda-Agrippino and Rey, (2015), Forbes and Warnock (2011), Chung et al (2014) and Bruno and Shin (2014), Cerutti et al. (2014) and Eickmeier et al., (2014).



Source: Fred data

The trends in Figure 2.4 show that these measures of global investor risk perceptions can capture periods of heightened investor uncertainty such as the global financial crisis and the euro area sovereign debt crisis. Thus, including these variables in the empirical estimations will improve the estimations and the influence of global liquidity and changes in global investor risk perceptions on domestic variables.

2.5.3 Data transformation and factor loadings

Prior to the constructing factors, the data for asset purchases, money supply, credit growth, policy rates, interbank rates, ten-year government bond yields, VIX and the TED spread is de-trended. Literature suggests several methodologies for estimating the number of statistic factors r and dynamic factors q. For statistic factors, the Bai and Ng (2002) information criteria and the Catell (1966) scree plots diagnostic tests are used. On the other hand, the Hallin and Liska (2007) frequency domain procedure, the Bai and Ng (2007) test and the Amenguel and Watson (2007) estimator are commonly used. We use the Bai and Ng (2002) largest r eigenvalues information criteria and the scree plots of the ordered eigenvalues of $\widehat{\sum}_X$against the rank that eigenvalues. The scree plots show the marginal contribution of the i^{th} principal component to the $R^2$of the regression of X_t against the first i principal components.

2.5.3.1 Price and quantity measures of global liquidity

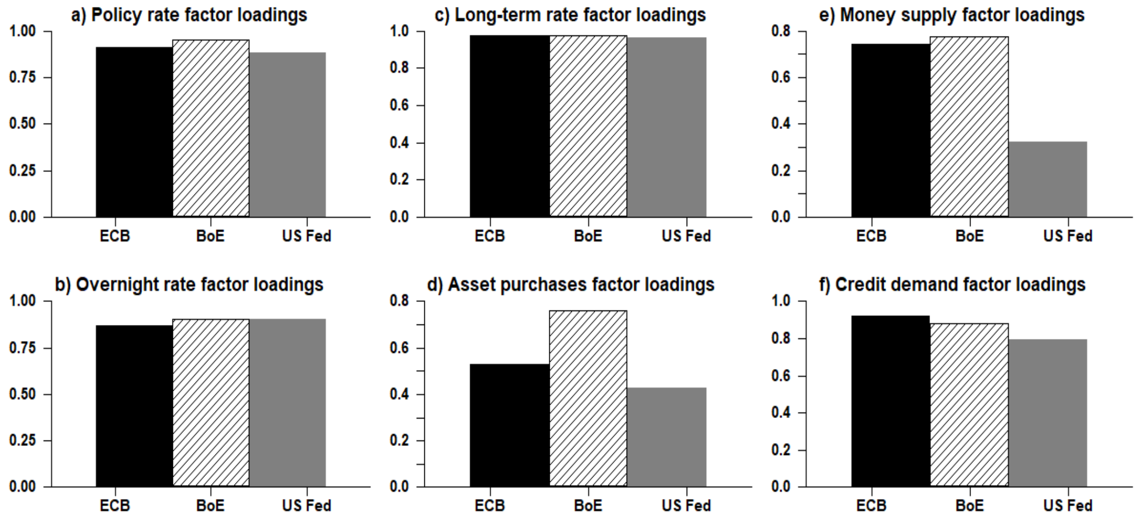
The set of variables are divided into different categories to estimate each common factor separately. Bernanke and Boivin (2003) and Bagliano and Morana (2009) indicate that this approach gives economic meaning to each of the common factors. In addition, the approach of extracting common factors from each group helps to avoid contamination from other series that are unrelated to the measurement of the phenomenon of interest. If other series are included to the key set of variables, they can introduce noise and decrease the average size of the common factors.

The variables are grouped into seven blocks of price, quantity measures of global liquidity and global investor risk perception as shown in Figure A2.1 in the appendix: (i) global policy rates (ii) global overnight rates (iii) global long-term yields (iv) global liquidity (v) global monetary aggregates (vi) global credit aggregates and (vii) VIX index, EMBI and the TED spread. The scree plots of the eigenvalues for price and quantity measures of global liquidity and global investor risk perception reported in Table A2.1, Table A2.2, Figure A2.2 and Figure A2.3, respectively in the appendix. The Bai and Ng (2002) information criterion indicates that in all instances the largest r eigenvalues are associated with one factor. Beyond this threshold increasing the cross-sectional dimension of the information set does not add much value and can adversely affect the explanatory power of the factors and the model. This means that one common factor can represent common movements in each of the variables that capture quantity and price measures of global liquidity.

2.5.4 Factor loadings for price and quantity measures of global liquidity

Figure 2.5 shows that the factor loadings are not necessarily dominated by the big economies such as the euro area and the US. The results show that in most instances the UK factor loadings are larger than those of the two big economies in the sample. This is the reflection of key attractive property of the PCA approach as it does not automatically give a large weight to big countries such as the euro and the US. The PCA approach accounts for the sizeable fraction of the variation in each aggregate variable used.

Figure 2.5 Factor loadings for price and quantity measures of global liquidity



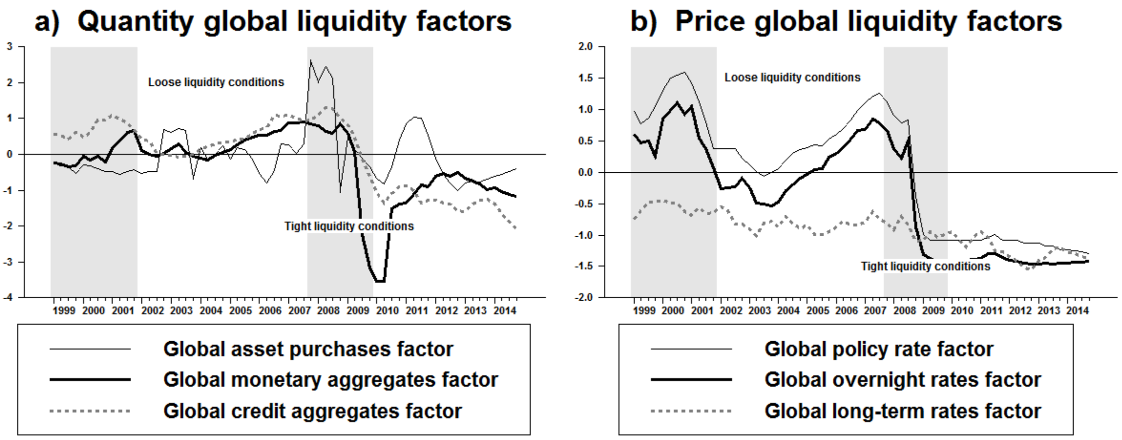
Source: Author's calculations

For the price measures of global liquidity in Figure 2.5(a), (b) and (c) the factor loadings are largely evenly distributed but the variation due to UK data is allocated the largest loading. Similarly, in Figure 2.5(d), (e) and (f) for the quantity measures of global liquidity the variations due to the euro area and the UK get the largest factor loadings. The factor loadings for global risk in Figure A2.2 in the appendix show that the largest factor loadings are due to VIX and the EMBI compared to the TED spread.

2.5.5 The estimated price, quantity global liquidity factors and risk factors

Figure 2.6 and 2.7 show the estimated price and quantity measures of global liquidity and the global risk factor. The interpretation of the estimated factors is that (i) a negative (positive) sign means that the global liquidity conditions as measured by the price factor are loose (tight) (ii) in the case of the quantity measure of global liquidity, a negative (positive) sign indicates tightening (loosening) as the liquidity is either declining (increasing) or unwound (rolled over) and (iii) with respect to the risk factor, a negative (positive) sign implies risk appetite (aversion).

Figure 2.6 Estimated factors for price and quantity measures of global liquidity



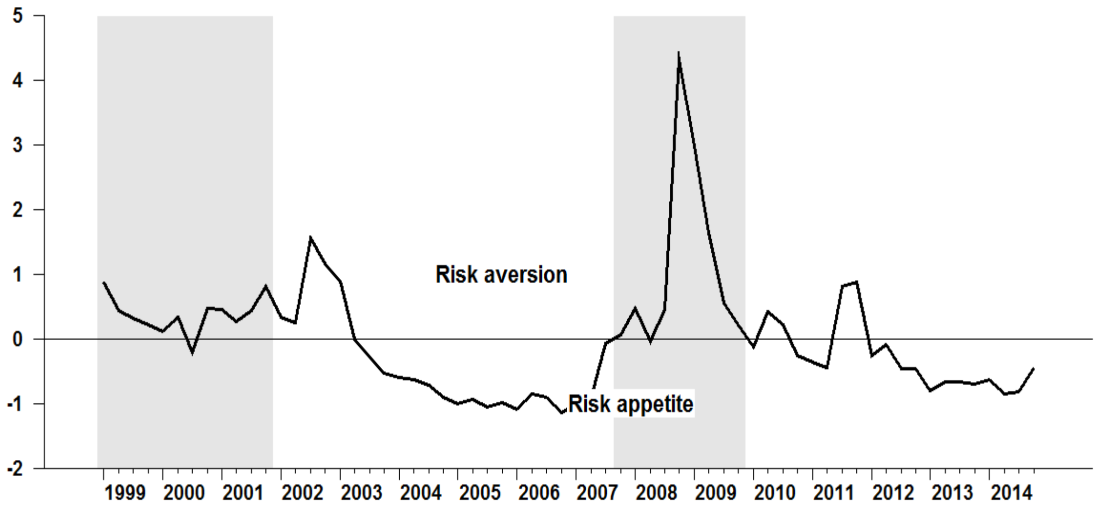
Source: Author's calculations

Figure 2.6(a) shows that the estimates of the price measure of global liquidity indicate that global liquidity conditions have been 2008Q3 have been very loose by historical standards. This is in line with the lowering of policy rates to the zero-lower bound. On the other hand, long-term yields declined further post-2009. Long-term bond yields have been on what has become known as the secular decline since the 1990s. However, it is evident that after hitting the policy rate zero lower-bound, long-term yields declined even further as central banks engaged in asset purchases (QE) to lower and further ease the financial conditions.[12]

The trend of the asset purchases shows two distinct periods of loose liquidity conditions post-2007 associated with (i) the first episode of asset purchases (QE1) in 25 November 2008 and other central banks followed and (ii) the second round (QE2) began in 3 November 2010 and the third round (QE3) later in September 2012. The several rounds of asset purchases by central banks were based on the expectations that they will narrow the spread between long and short-term instruments. The narrowing of the spread between long and short-term instruments in turn would in turn ease financial conditions by reducing the borrowing costs for the private sector and therefore support economic activity. Bernanke (2006) and Baumeister and Benati (2013) show that when spending is largely dependent on long-term interest rates, any macroeconomic factors that lower the spread between short-term and long-term rates should stimulate aggregate demand.

Figure 2.7 Estimated global investor risk perception factor

[12] See Rachel and Smith (2015) amongst others on the discussion of the circular decline in global long-term bond yields. See Figure A2.4 for the graphical representation of the aggregated global liquidity and risk factors.



Source: Author's calculations

It is evident that the global risk factor in Figure 2.7 can capture episodes of elevated global investor appetite. Global investor risk perceptions increased between 2008Q2 and 2009Q4 but have since declined in line with central bank policy interventions. The low global risk perception is aligned with the easing of financial conditions.

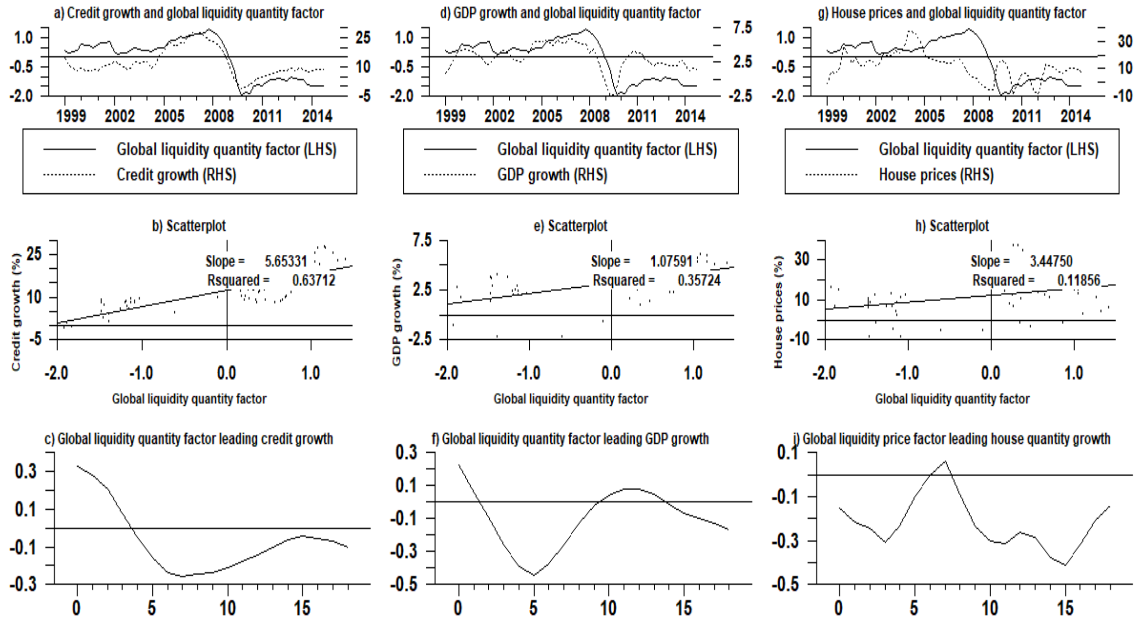
2.5.6 Stylized facts

Figure A2.3 shows the evolution of the South African variables used in the empirical estimations. For the stylized facts of the relationships between the estimated global factors and selected domestic variables we also conduct cross correlations. The entire cross correlations between variables in this section are computed as:

$$\rho_i = corr\left(Y_{i,t}, X_{i,t\pm n}\right) \qquad n = 0, 1, \dots, 4 \qquad (2.17)$$

Where $Y_{i,t}$ is the quarterly growth rate of the global liquidity factor variable of interest and $X_{i,t}$ is the domestic variable of interest and *n* is the lead or lag. In all the Figures that follow, we show the direction of the relationship, its strength as measured by the R-squared and what happens to South African GDP growth, credit growth, equity prices and house prices when they are preceded by the estimated (i) price measures of global liquidity (ii) quantity measures of global liquidity and (iii) global investor risk perception. Figure 2.8 starts with the analysis of the asset purchases global factor with domestic variables. Figure 2.8(a), (b) and (c) show that domestic credit growth is positively related with global asset purchases. An increase in global asset purchases leads domestic credit rises but declines in four quarters. A similar positive relationship exists between global asset purchases and domestic GDP growth.

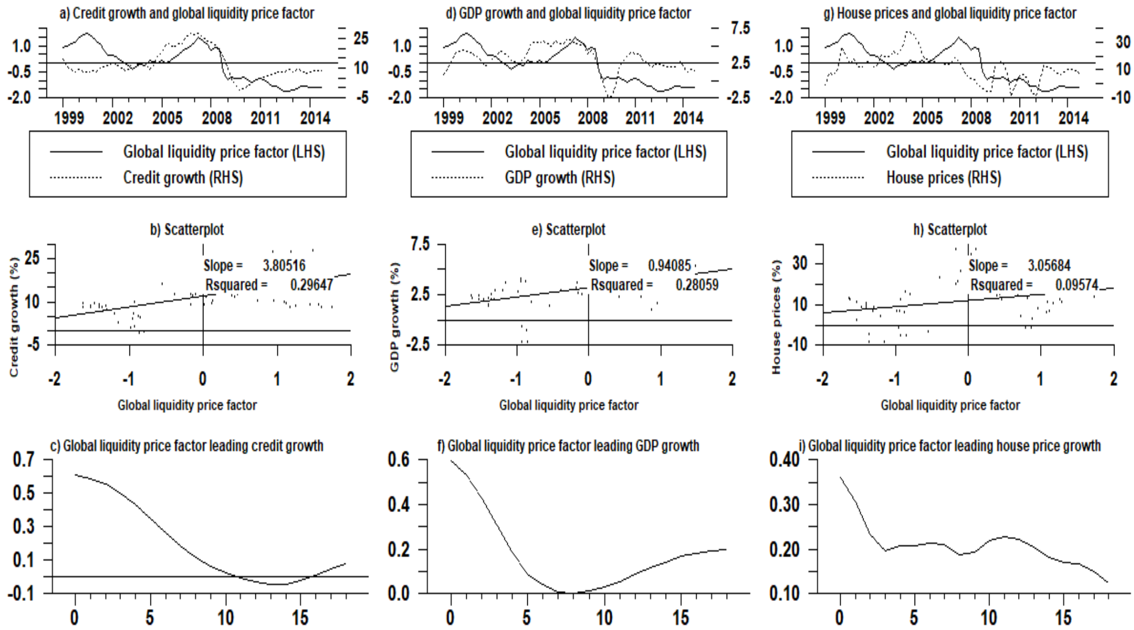
Figure 2.8 Global liquidity quantity factor and selected domestic variables



Source: Author's calculations

What about prices measures of global liquidity? We show the relationship with global policy rates in Figure 2.9. A positive relationship exists between all the domestic variables and the global policy rates meaning that the loosening of global monetary policy results in an increase domestic credit growth, house price growth and GDP growth. Equity price growth is positively affected although the sensitivity of the relationship is flat.

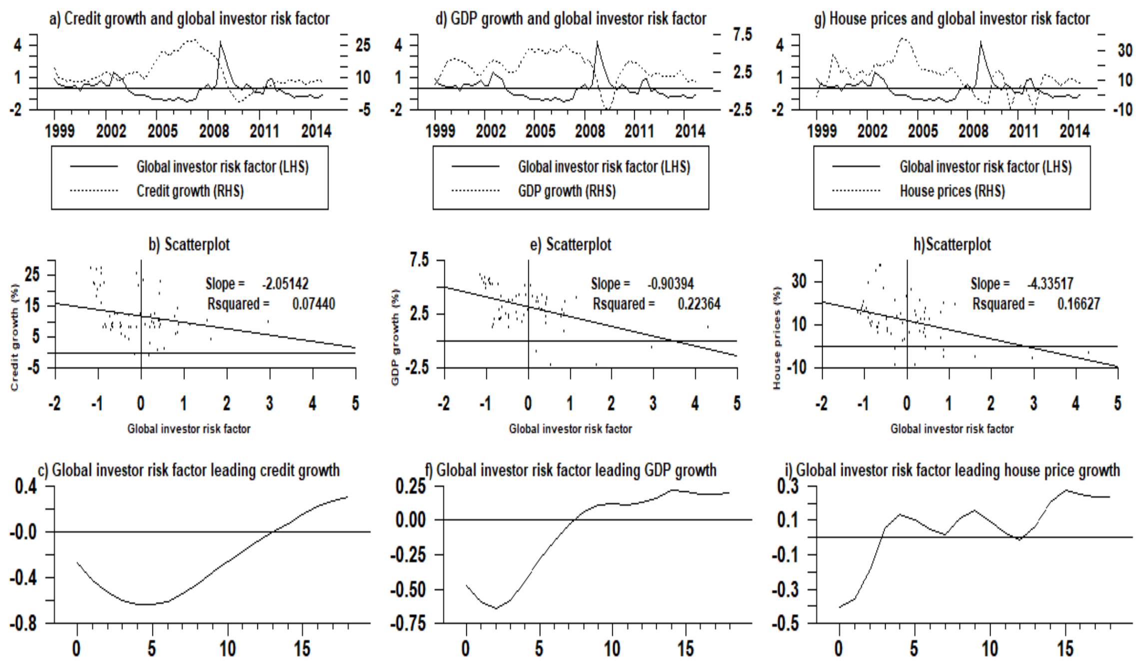
Figure 2.9 Global liquidity price factor and selected domestic variables



Source: Author's calculations

The relationships of domestic variables with changes in global investor risk perception in Figure 2.10 all suggest a negative relationship as predicted by theory. An unexpected decline (increase) in global investor risk perceptions results in an increase (decline) in net purchases by non-residents in the domestic market and the exchange rate appreciates (depreciates). However, the interaction between changes in global risk and capital flows goes beyond the effects on the exchange rate. The drivers of capital flows include positive GDP growth, positive real interest rate differential and other country characteristics.

Figure 2.10 Cross correlations between global investor risk and selected domestic variables



Source: Author's calculations

2.5.7 Causality tests

The stylized facts shown in the previous sections are informative and tell us about the signs we should expect in the relationships when we conduct the empirical analysis. However, they do not tell us about the expected direction of causality. Hence, in this section we conduct the Granger causality tests. First, Table 2.1 indicates that global policy rates and interbank rates are causally linked to the South African credit growth and GDP growth developments compared to global long-term rates.

Table 2. 1 Granger causality tests for price measures of global liquidity

Null Hypothesis:	F-Statistic	Prob.	Decision
PR does not Granger cause GDP	4.43	0.01**	Reject
PR does not Granger cause credit	3.82	0.02**	Reject
PR does not Granger cause JSE	0.06	0.95	Accept
PR does not Granger cause HP	0.53	0.59	Accept
IR does not Granger cause GDP	2.24	0.11*	Reject
IR does not Granger cause credit	3.03	0.05**	Reject
IR does not Granger cause JSE	0.10	0.91	Accept
IR does not Granger cause HP	0.04	0.96	Accept
LY does not Granger cause GDP	0.93	0.40	Accept
LY does not Granger cause credit	0.54	0.59	Accept
LY does not Granger cause JSE	0.93	0.40	Accept
LY does not Granger cause HP	0.38	0.69	Accept

Note: Significance at 5 per cent **, at 10 per cent*. PR means policy rates, IR means interbank rates and LY means long-term yields, JSE means equity prices, HP means house prices. Source: Author's calculations

We fail to establish a direct causal link between all the price measures of global liquidity and South African equity and house prices. The implication is that the channels of transmission to these variables occur indirectly via other channels hence it is necessary to conduct a multivariate empirical analysis.

On the other hand, Table 2.2 shows that all the quantity measures of global liquidity are causally linked to domestic variables. The direction of causality goes from global to domestic variables and not the other way round.

Table 2.2 Granger causality tests for quantity measures of global liquidity

Null Hypothesis:	F-Statistic	Prob.	Decision
QE does not Granger cause GDP	0.45	0.64	Accept
QE does not Granger cause credit	0.46	0.63	Accept
QE does not Granger cause JSE	0.63	0.54	Accept
QE does not Granger cause HP	0.09	0.91	Accept
MA does not Granger cause GDP	0.27	0.77	Accept
MA does not Granger cause credit	0.47	0.63	Accept
MA does not Granger cause JSE	0.10	0.90	Accept
MA does not Granger cause HP	1.47	0.24	Accept
CA does not Granger cause GDP	0.41	0.67	Accept
CA does not Granger cause credit	0.21	0.81	Accept
CA does not Granger cause JSE	0.18	0.84	Accept
CA does not Granger cause HP	0.43	0.66	Accept

Note: Significance at 5 per cent **, at 10 per cent*. QE means asset purchases, JSE means equity prices, HP means house prices, MA means monetary aggregates and CA means credit aggregates. Source: Author's calculations

Similarly, the results for global investor risk in Table 2.3 show that there is a direct causal link but can only be established for equity prices. The other variables require a multivariate model to establish the various channels of transmission.

Table 2.3 Granger causality tests for global risk

Null Hypothesis:	F-Statistic	Prob.	Decision
GR does not Granger cause GDP	3.137	0.05**	Reject
GR does not Granger cause credit	5.550	0.00**	Reject
GR does not Granger cause JSE	0.271	0.764	Accept
GR does not Granger cause HP	4.442	0.01**	Reject

Note: Significance at 5 per cent **, at 10 per cent. GR means global risk, JSE means equity prices, HP means house prices. Source: Author's calculations

2.5.7 Stationary tests

Generally, factor models require stationary data hence we conduct the unit root tests for the variables to be used in the empirical estimations. However, Rafiq and Mallick (2008) show that the sign restriction approach is robust to the presence of non-stationarity. In addition, the imposed sign restrictions are restricted to last for a certain period implying that no long run cointegration is imposed between the variables. Nonetheless, this does not mean that the existence of a long run cointegrated relationship is precluded. Rather, the long-run effects between the relationships are left open to be determined by the data.

Most of the unit root and stationarity tests provide conflicting results hence we choose to use the Augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1979). and Kwiatkowski, Phillips-Perron (PP) (Phillips and Perron, 1988) and Phillips, Schmidt, and Shin (Kwiatkowski, Schmidt and Shin, 1992.) test. The ADF and the PP tests the null hypothesis that variables have unit roots. The KPSS tests the null hypothesis that variables are stationary. Table 2.4 shows the unit root test results.

Table 2.4 Unit root tests for domestic and global factors

	KPPS	ADF	PP	KPPS	ADF	PP
Variable		**Level**			**First difference**	
Asset purchases	0.14	-3.36	-3.50	0.02**	-9.36**	-9.37**
Monetary aggregates	0.10	-1.97	-2.45	0.06**	-5.46**	-5.49**
Credit aggregates	0.17	-1.01	-1.57	0.06**	-4.29**	-4.40**
Policy rates	0.10*	-1.51	-2.11*	0.06**	-4.55**	-4.60**
Overnight rates	0.08**	-1.29	-1.70	0.09**	-7.11**	-7.13**
Long-term yields	0.09**	-1.33	-1.33	0.11*	-8.40**	-8.40**
Global risk	0.09*	-3.10*	-3.15*	0.09*	-7.91**	-9.00**
GDP growth	0.11	-2.29	-2.87	0.04**	-4.26**	-4.30**
House price growth	0.13	-3.24	-3.25	0.11*	-6.34**	-6.85**
Equity price growth	0.05**	-6.07**	-5.92	0.00**	-10.51**	-33.11**
Credit growth	0.14*	-1.09*	-1.74	0.08**	-4.54***	-4.55**

Note: Significance at 5 per cent **, at 10 per cent* Source: Author's calculations

The application of the KPPS, ADF and the PP tests shows that the tests results are mixed (conflicting) with respect to the interest rates, equity prices and credit growth. Thus, we conclude that quantity, price and domestic variables are I(1) stationary or integrated of order one I(1), whereas, the global risk variable is I(0) stationary.

2.5.8 The identification schemes

In order to have a structural economic meaning, estimate the transmission and impact of the global liquidity and risk factors on South African variables, we use the sign restrictions approach. This approach enables us to disentangle the impact of price and quantity measures of global liquidity on South African variables. The cross correlations and causal relationships discussed in the earlier sections have set the foundations to enable us to correctly identify shocks in the empirical model. In Table 2.5 a positive shock to the quantity measures of global liquidity is identified as a rise in the global liquidity factors which leads to a decline in global investor risk perceptions and has a positive impact on South African equity prices. Similarly, a decline in the price measures of global liquidity result in lower levels of risk perception and has a positive effect on equity prices.

Table 2.5 Identifying sign restrictions

	Global variables		South African variables					
Measures of global liquidity	Global liquidity factor	Global risk factor	GDP	Credit	Repo rate	CPI	House prices	Equity prices
Quantity	+	-	?	?	?	?	?	+
Price	-	-	?	?	?	?	?	+

In the estimations, the effects of the shock last for four quarters ($k = 4$) following the shock. We impose no restrictions on the variables of interest, namely, GDP growth and credit growth. These are left unconstrained and the data can determine their responses. To capture the macroeconomic and financial stability aspects of risks associated with excess global liquidity we include house and equities prices in the empirical estimations. The aim is to determine the responses of these variables to persistent excess global liquidity and assess whether they pose threats to financial stability.

The FAVAR model we estimate in the empirical section is shown in Equation 2.18. The model includes the external variables captured in the factors for various measures of global liquidity and investor risk perception. The rest of the variables are domestic.

$$Y_t \quad \text{Gliq Grisk GDP credit repo rate cpi house prices equity prices} \tag{2.18}$$

In addition, we assess the sensitivity of the estimated model to the change in the specification. We include other key financial channels of the transmission of global liquidity shocks that are immediately affected and have an impact on credit and GDP growth. Government bond yields matter more for the real economy and the role of fiscal policy for macro-economic stabilization. Government bond yields directly impact the cost of funding for government. Furthermore, the market perceptions about the probability of government defaulting on its debt obligations can propagate the risk shocks and affect real economic activity and financial stability (Fratzscher et al., 2008).

We alter the specification of the FAVAR in Equation 2.18 to that shown in Equation 2.19.

$$Y_t \quad \{Gliq\ Grisk\ GDP\ Credit\ EMBI\ 5CDS\ SAyields\ SA\ USspread\} \qquad 2\,19$$

Whereas in the earlier estimations Gliq represents the various price and quantity measures of global liquidity, Grisk represents the global risk factor, credit is credit growth, EMBI is the emerging market bond index, the 5CDS is the five-year SA government credit default swap spread, SAyields is the yield on the ten-year government bond and the SA-USspread is the spread on the SA and U.S ten-year government bond yields. These variables are used to assess the extent to which global liquidity and investor risk perceptions impacted the domestic financial conditions as measured by the government yields and CDS spreads over and above the earlier impact on the repo rate.[13]

Like the identification scheme in Table 2.6, we leave the variables of interest, namely credit and GDP growth unrestricted in Table 2.7. We only place the restrictions on the responses of the various measures of global liquidity and the SA-US yield spread. The rationale being that when the U.S. Fed embarked on various rounds of unconventional monetary policy, it communicated expectations that they will narrow the spread between long and short-term instruments. This in turn would ease financial and credit conditions by reducing the borrowing costs for the private sector and therefore support economic activity. Furthermore, Baumeister and Benati (2013) show that in cases when spending is largely dependent on long-term interest rates, any macroeconomic factor that lowers the spread between short-term and long-term rates should stimulate aggregate demand.

Table 2.6 Identifying sign restrictions

	Global variables		South African variables					
Measures of global liquidity	Global liquidity factor	Global risk factor	GDP	Credit	EMBI SA	5 CDS	SA yield	SA-US yield spread
Quantity	+	-	?	?	?	?	?	-
Price	-	-	?	?	?	?	?	-

All the variables enter the VAR in growth rates except for the global factors and interest rate variables. The lag structure of the models is determined by the AIC, SBC, and BIC information criteria. For all impulse responses, the shock is a one-standard deviation in the variable of interest. The error bands for the impulse responses refer to the 16th and 84th percentiles median impulse response functions. Sims amd Zha (1995) show that the 16th and 84th percentiles give better (normal distribution) representation of the impulse responses compared to the one and two standard deviation bands. The error bands are calculated from the postrior distribution identfying

[13] We show the evolution of these variables in Figure A2.4 in the appendix.

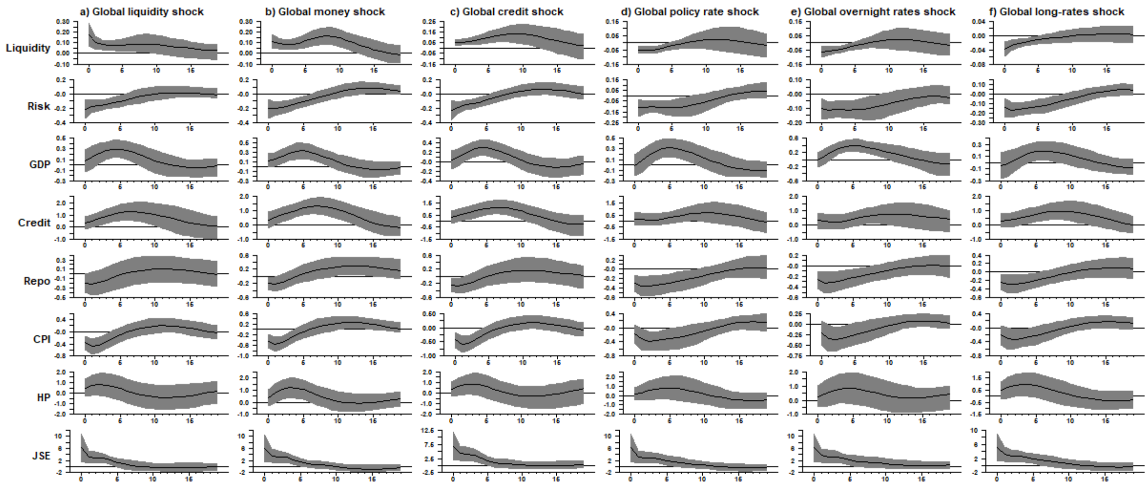
the shocks using Monte Carlo simulations using 10 000 draws.

2.6 The empirical results

This section discusses the results of global liquidity shocks based on quantity and price measures. We use two lags in the estimations as determined by the AIC, SBC, and BIC information criteria. The sign restrictions distinguish between quantity and price base measures of liquidity shocks. A positive shock to the quantity measure of global liquidity raises the three factors. For the price measures of global liquidity, a positive shock results in a decline in the interest rate factors. This is consistent with theoretical models which show that liquidity injection as a stimulus that increases the level of global liquidity, while lower interest rates provide monetary policy stimulus as well.

The results of the quantity and price liquidity shocks are shown in Figure 2.11. The estimations included inflation and the repo rate in the benchmark model to assess their responses to global liquidity. We find that the model obeys the imposed restrictions. The quantity-based liquidity shocks shown in columns (a) to (c) result in an increase in global liquidity. The price measure of global liquidity shock shown in columns (d) to (f) lowers interest rates measures of global liquidity.

Figure 2.11 Response to quantity and price-based measures of global liquidity shocks



Source: Author's calculations

In all instances of the price and quantity measures of global liquidity, global investor risk aversion measured by the risk factor tends to fall significantly for nearly five quarters after the shocks, irrespective of the shock. In addition, equity prices tend to rise significantly for at least six quarters due to positive global liquidity shocks and a decline in global investor risk perception. The variables which were left unrestricted respond in a similar way to all six shocks albeit at varying magnitudes.

All shocks to price and quantity measures of global liquidity result in a significant increase GDP growth, credit growth and house price growth. But in some instances, the responses of house prices are insignificant. This is consistent with the influence of various channels such as the collateral and wealth effects associated with the increase in house prices on residential investment and credit growth. In addition, the increase in equity prices can also raise the profitability of projects and the market value of assets over the replacement costs via the Tobin's q channel thus leading to higher investment growth, credit growth and GDP growth.

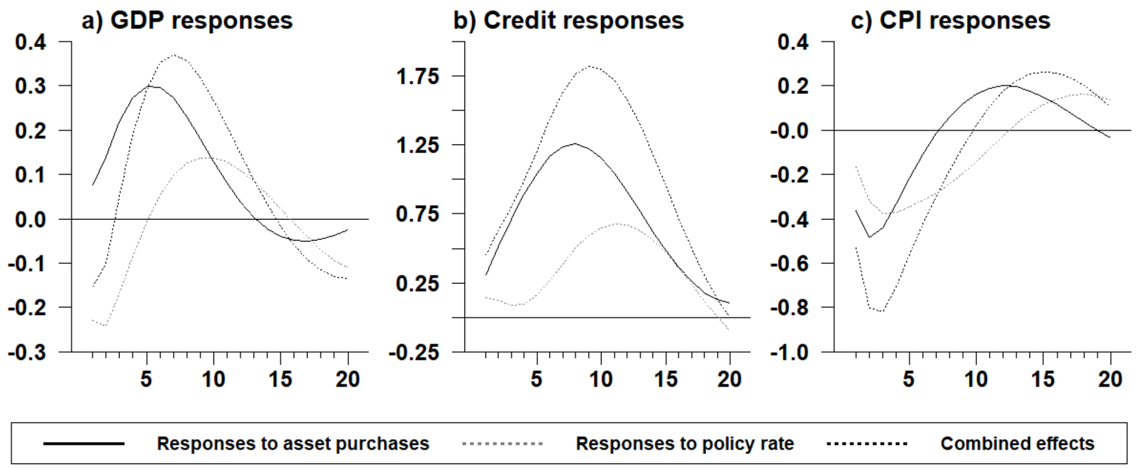
We find that inflation declines in response to all shocks. As a result, the repo rate is accommodative as there are no immediate inflationary pressures. This result is consistent with the recent experience following massive injections of global liquidity by central banks and the absence of inflationary pressures. In the earlier stages of the implementation of QE, the surge in capital flows to EMEs resulted in the appreciation of exchange rates exerting downward pressure on inflation. This is consistent with Choi et al (2014) who show that additional global liquidity resulted in the appreciation of EME currencies in the short run.

2.6.1 How different are the responses credit and output growth to different measures of global liquidity shocks?

The key variables of interest in this study are credit and GDP growth responses to the different measures of global liquidity shocks. We stated earlier that for policy analysis and implications it necessary to ascertain the way these variables respond to prices and quantity measures of global liquidity shocks. Which global liquidity shock has potent effects on credit and GDP growth? To consider the implications for monetary policy and financial stability, Figure 2.12 shows a comparison of the responses of credit growth, GDP growth and inflation to the different measures of global liquidity shocks. However, because the implementation of QE occurred simultaneously with zero lower bound policy rates, we also consider the combined impact by summing up the responses of the variables of interest to both shocks.

The responses show that quantity measures of global liquidity, in particular asset purchases lead to higher peak responses in GDP growth. On the other hand, the global policy rate effects on credit and GDP growth are delayed and are much lower. The combined effects of price and quantity measures do indeed reinforce each other and result in better outcomes at peak response. The responses of CPI show that quantity measures tend to result in a more pronounced decline compared to price measures. As mentioned earlier, this is most probably due to the impact of quantity measures on the exchange rates of EMEs and in turn the lower exchange rate pass-through to inflation.

Figure 2.12 Comparison of inflation, credit growth and output growth responses to various global liquidity shocks



Source: Author's calculations

Overall, we find that credit growth, GDP growth and CPI are more responsive to positive shocks to quantity measures of global liquidity. However, the combined responses to both price and quantity measures result in better outcomes. In addition, the net effects of the impact of these positive price and quantity measures indicate that in the absence of QE, the positive effects on the variables of interest rate very muted.[14] Nonetheless, we supplement these results in the next section by looking at various counterfactual scenarios.

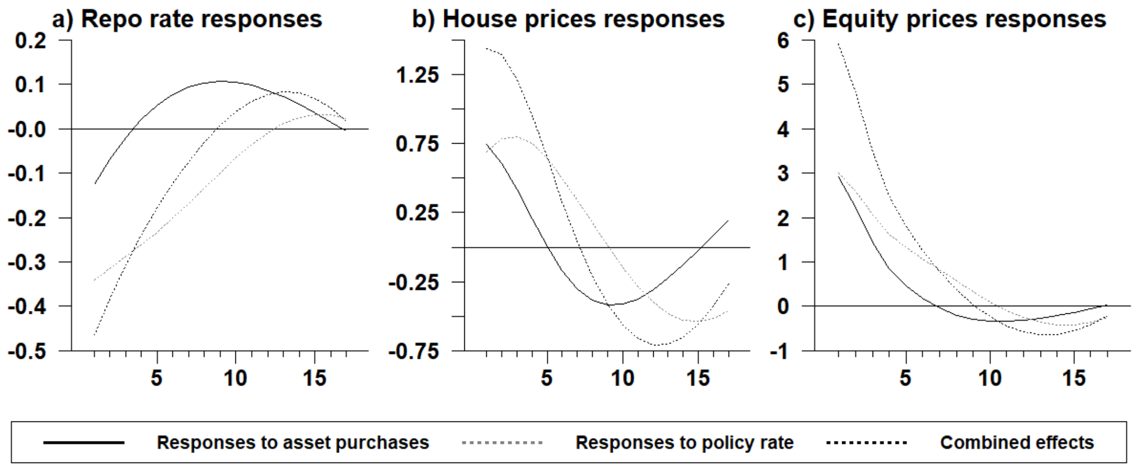
2.6.2 What about asset price responses to quantity and price liquidity measures?

We stated in the introduction that one of the objectives of the chapter is to assess the implications of quantity and price-based measures of global liquidity for monetary policy and financial stability. To this end, we assess the responses of the repo rate, house price growth and equity prices in Figure 2.13. The responses of the repo rate suggest that the policy rate declines more in response to a decline in the global policy rates compared to QE. This further affirms the synchronization of policy rates for large part of the period subsequent the global financial crisis. Secondly, the responses of house and equity prices suggest that individually assessed, price and quantity measures lead to comparable magnitudes and trajectories although the persistence of the shocks differs. However, it is unambiguously evident that the effects of both price and quantity measures results

[14] The results are not shown here but can be availed to the reader upon request.

in much more pronounced effects on house and equity prices.

Figure 2.13 Comparison of repo rate, house price growth and equity price growth responses to various global liquidity shocks



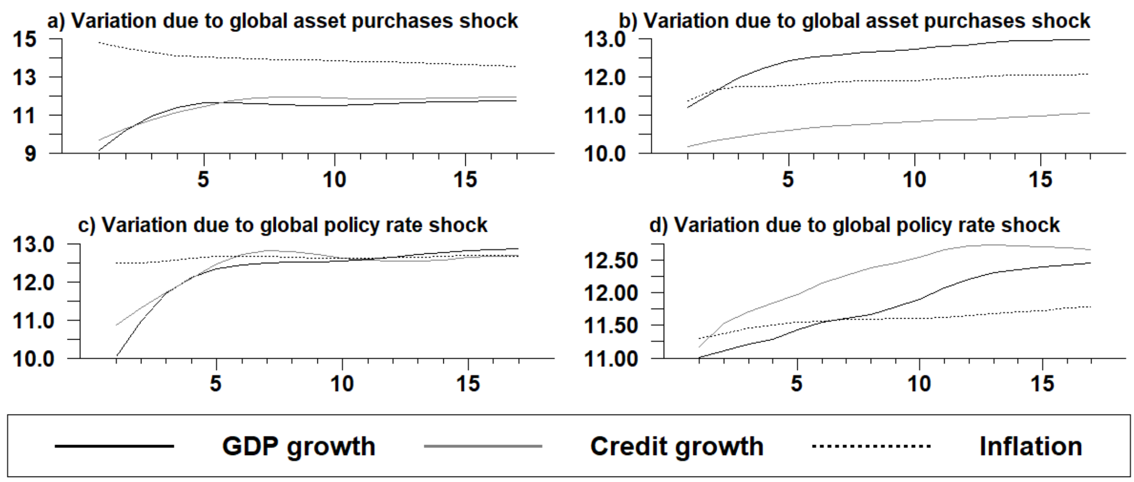
Source: Author's calculations

2.6.3 Variance decomposition due quantity versus price-based measures of global liquidity shocks

Which shocks between quantities and price-based measures of global liquidity explain more fluctuations in economic growth and credit growth? We use the variance decompositions to assess the contributions of global liquidity shocks to fluctuations in GDP growth and credit growth. The results of the variance decompositions are over the horizon of 20 quarters. Figure 2.14 shows that on impact and cross the entire forecast horizon, asset purchase shocks explain a high variation in inflation compared to price measures of global liquidity. However, price measures explain more variation in credit growth and GDP growth on impact compared to asset purchase shocks. Nonetheless, the impact of asset purchases increases over the forecast horizon and is comparable to the variation induced by price measures of global liquidity. Like the inflation, asset purchases explain the largest variation in the repurchase rate compared to the price measures. This contrasts with the house and equity prices. Shocks to asset purchases explain much of the variation in house and equity prices across horizons.

These findings suggest that the sustained rise in house and equity prices linked to exceptionally low levels of policy rates and asset purchases may poses financial stability risk through excessive risk taking via the wealth and collateral channels. This is particularly risky given the impact of both price and quantity measures of global liquidity on inflation and the repo rate. Vast literature shows that the period prior to the global financial crisis was characterized by exceptionally low inflation which masked excessive risk taking.

Figure 2.14 Variance decompositions of GDP growth and credit growth in response to shocks in quantity global liquidity shocks



Source: Author's calculations

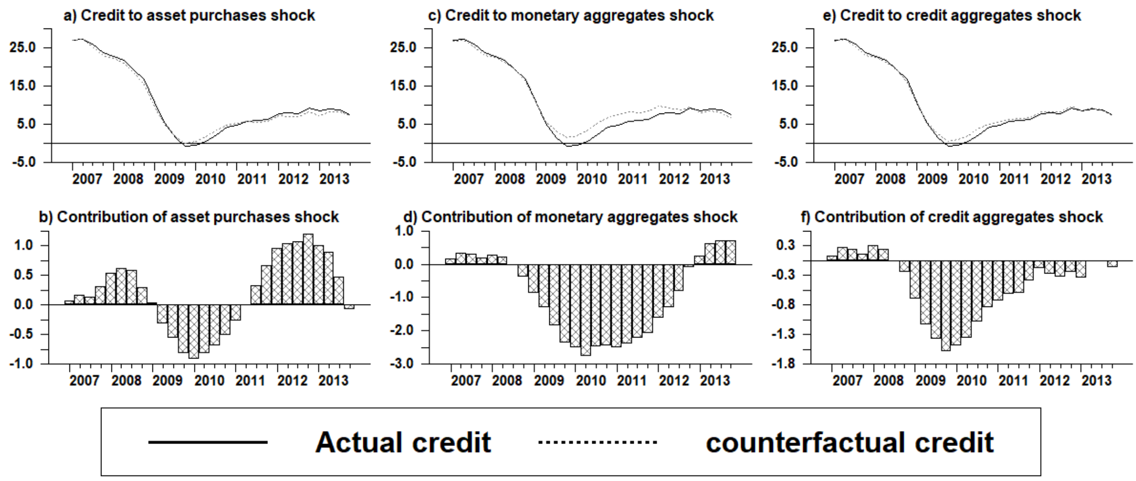
2.6.4 Counterfactual analysis: To what extent have global liquidity shocks impacted credit and growth dynamics during and post the financial crisis?

How important were global liquidity shocks during the recent global financial crisis and domestic recession? We use the counterfactual scenario approach in this section to determine the extent to which positive price and quantity global liquidity shocks uplifted or dragged economic and credit growth in South Africa post-2007. The counterfactual scenarios represent simulations where the structural shock of interest is set to zero over the relevant period. For example, this means that we set the global liquidity shocks to zero starting 2007Q1 to 2015Q4 to assess how GDP growth and credit growth would have evolved in the absence of these structural shocks.

This means that the counterfactual scenarios of GDP and credit growth in the absence of global liquidity shocks reflect situations when GDP and credit growth are responding to other shocks. In these scenarios, global liquidity shocks are not the sources of recessions or downturns in the case of GDP growth. In the case of credit growth, the credit channel is still operational but global liquidity shocks are not the source of credit supply and demand shocks (Helbing et.al, 2011).

We examine the contributions and effects of global asset purchase shocks on inflation, credit growth and GDP growth in Figure 2.15.[15] The contributions of asset purchase shocks are given by the gaps between the actual and the counterfactual responses of the respective variables. We are only interested in the role of asset purchases for the period 2007Q1 to 2013Q4. The start of QE by the U.S Fed was during 2008Q4 and the other central banks followed thereafter.

Figure 2.15 Actual and counterfactual responses of credit growth based on quantity measures of global liquidity shock



Source: Author's calculations

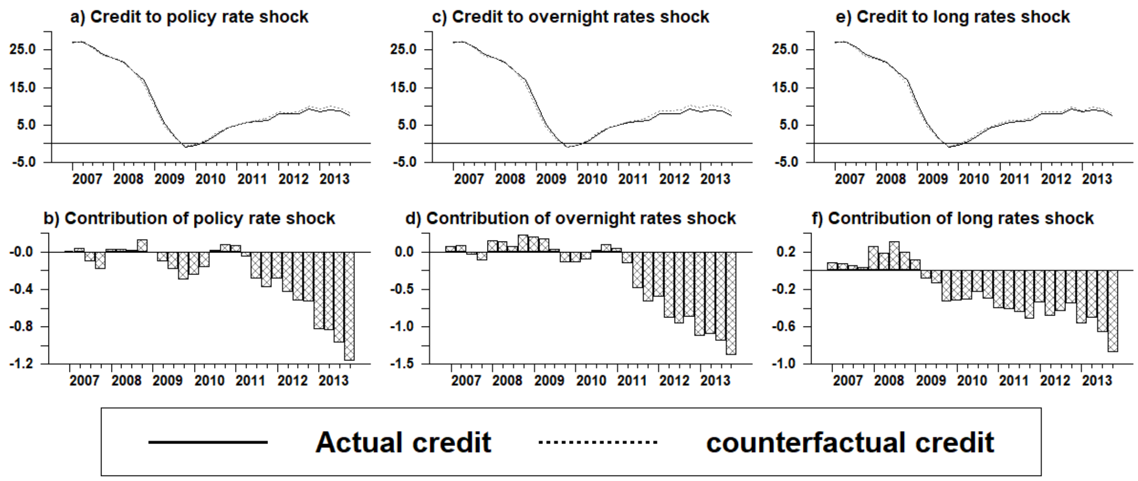
The results suggest that during 2009 asset purchases contributed in different directions to inflation, credit growth and GDP growth. For instance, asset purchases contributed to the decline credit and GDP growth but an increase in inflation. However, this was reversed in 2010 to 2012 when asset purchases contributed to the decline in inflation. At the same time the positive asset purchase contributed positively to credit and GDP growth.

What about the impact of price measures of global liquidity? The counterfactual scenarios in Figure 2.16 suggest that the direction of the impact was like that of quantity measures during 2009. However, the magnitudes of the impact are much lower when compared to those exerted by the quantity measures. The contrast in the contributions of price and quantity shocks is clear post 2010. Shocks to price measures of global liquidity have clearly not resulted in any positive growth in credit growth and GDP growth. However, the price measure of global liquidity has made positive contributions to inflation between 2010 and 2012.

15 The contributions of the other quantity-based measures are not shown here but can be availed on request.

How is it possible that economic growth remained subdued in the presence of excess global liquidity? The results suggest that it is possible that positive global liquidity shocks have potent effects during periods of great economic stability such as those that existed pre-2007. In addition, the period post-2007 did not only witness a slow recovery but also the euro area sovereign debt crisis and heightened policy uncertainty. These factors might have neutralized the ability of asset purchases to raise credit and economic growth.

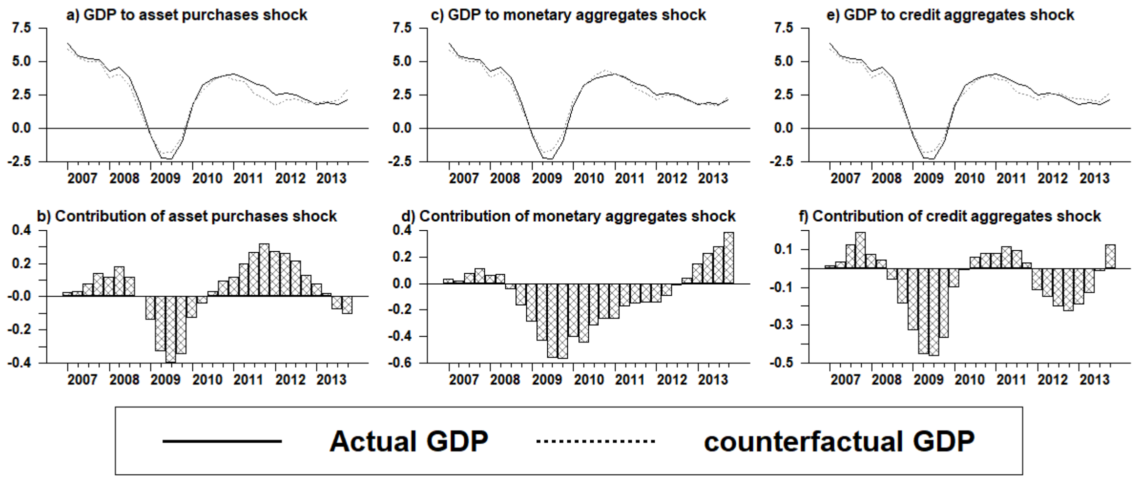
Figure 2.16 Actual and counterfactual of credit growth based on price measure of global liquidity shock



Source: Author's calculations

In nearly all cases actual credit growth and GDP growth are below their counterfactual credit growth. This means that that the evolution of domestic credit growth would have been much better in the absence of the financial crisis and the shocks to various measures of global liquidity. Thus, the contraction credit growth and GDP growth would have been less severe in the absence of the global financial crisis and shocks to global liquidity.

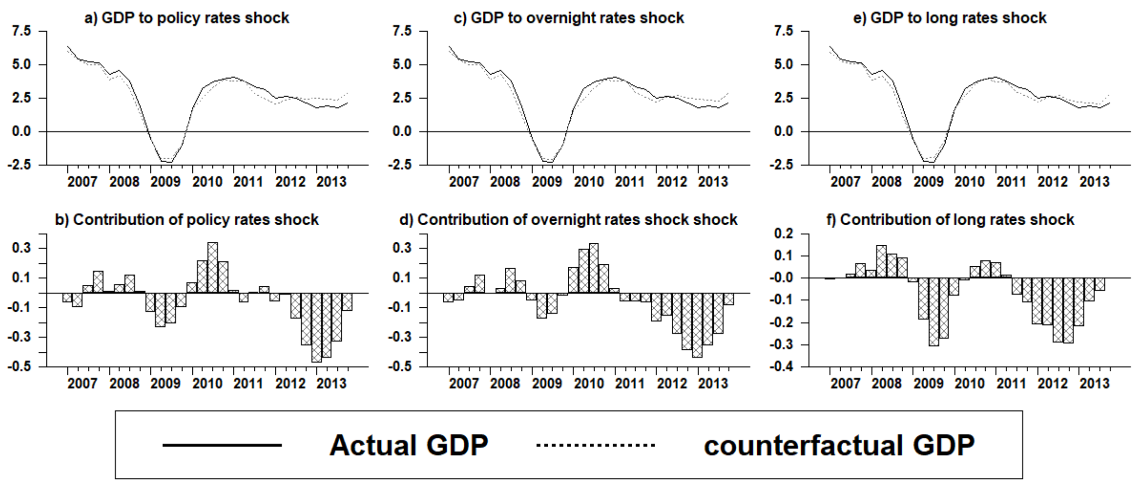
Figure 2.17 Actual and counterfactual responses of GDP growth based on quantity measures of global liquidity shock



Source: Author's calculations

These results corroborate and are consistent with a large body of empirical research findings that although policy rates were lowered and hit the lower bound in 2008, the stimulatory effects were not enough to result in highly easy financial conditions and stimulate growth, hence central banks had to engage in unconventional monetary policy actions (Bernanke (2006) ; Baumeister and Benati (2013).

Figure 2.18 Actual and counterfactual responses of GDP growth based on quantity measures of global policy rate shock



Source: Author's calculations

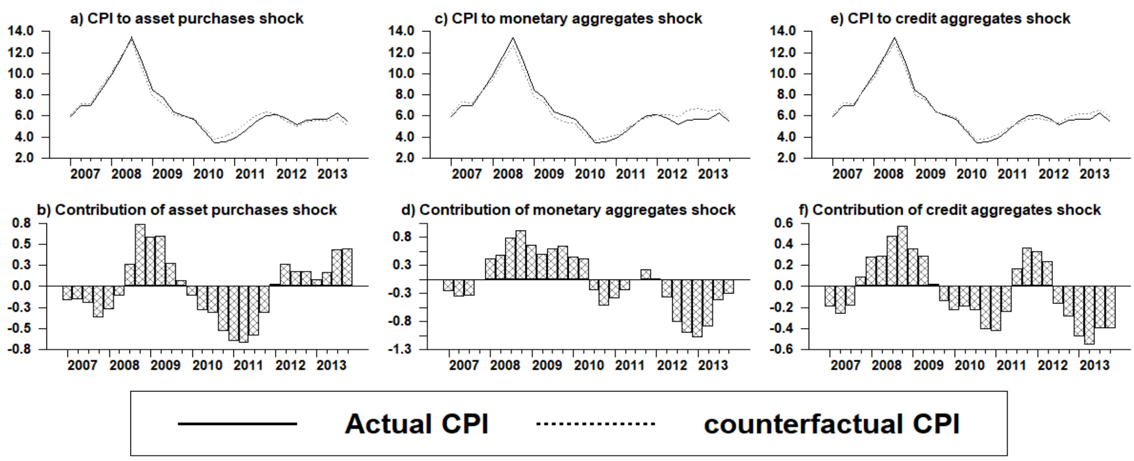
The differences in the contributions of quantity and price measures global liquidity shocks to inflation, credit and GDP growth suggest that policy makers should take cognizance of the origin of global liquidity shocks. It visible that global policy shocks have less adverse effects even at the peak effects than the effects linked to balance sheet expansion of central banks. Thus, we conclude that quantity-based measures of global liquidity lead to more slowdown in economic growth than the effects linked to price-based measures of global liquidity. This therefore means that indeed quantity measures do impact prices. Then, what does this means for price stability? The responses of the repo rate indicate that global liquidity impacted the domestic financial conditions.

2.6.5 What about other unrestricted variables in the model such as CPI inflation?

Various studies such as Hristov et al., (2012), Peek et al, (2003), Peersman (2005) explore the role of adverse financial shocks and credit supply shocks on real economic activity. They establish that adverse credit supply shocks lead to a decrease in the quantity of credit, while simultaneously increasing credit spreads or lending rates. Their evidence shows that financial shocks are a substantial source of macroeconomic fluctuations and adverse credit supply shocks. Adverse financial shocks and credit supply shocks induce a persistent decline in output and inflation.

What does the evidence suggest is the impact of global liquidity shocks on domestic inflation? Figure 2.19 show that quantity measures of global liquidity have generally contributed to the lower level of domestic inflation post 2009. This is particularly the case for global monetary and credit aggregates. This means that the low level of global demand has assisted in putting downward pressure on domestic inflationary pressures.

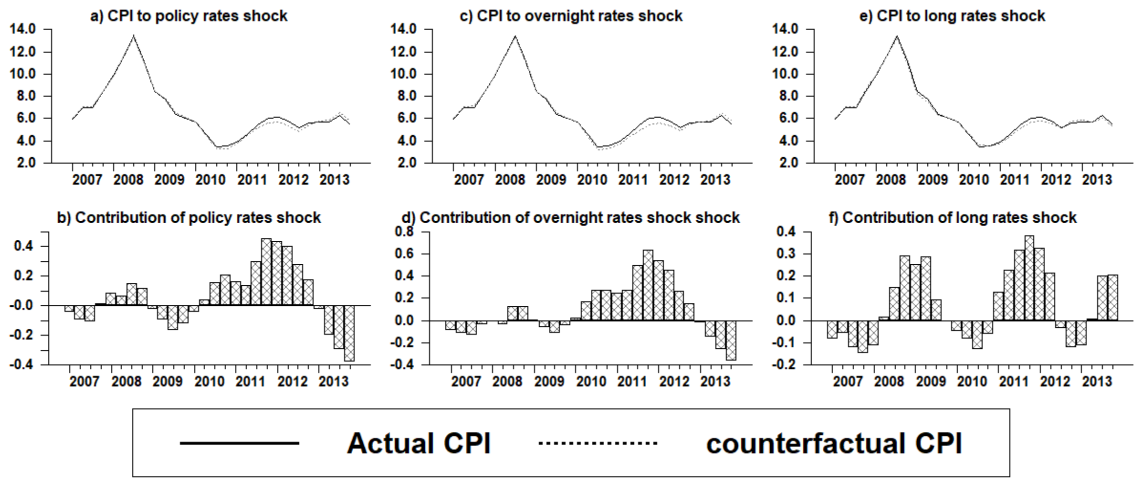
Figure 2.19 Actual and counterfactual responses of CPI based on quantity measures of global policy rate shock



Source: Author's calculations

A similar trend of contributions is evident for all price measures of global liquidity in Figure 2.20. All policy measures of global liquidity, in particular policy rates have exerted downward pressure on domestic inflation. As a result, they exerted a downward pressure on the repo rate, alternatively, the repo rate did not increase as it would have in the absence of global liquidity injections. Figure A2.7 shows that positive shocks to global liquidity exerted downward pressure on the repo rate as the actual repo rate is lower than the counterfactual repo rate that would prevail in the absence of positive global liquidity shocks.

Figure 2.20 Actual and counterfactual responses of CPI based on quantity measures of global policy rate shock

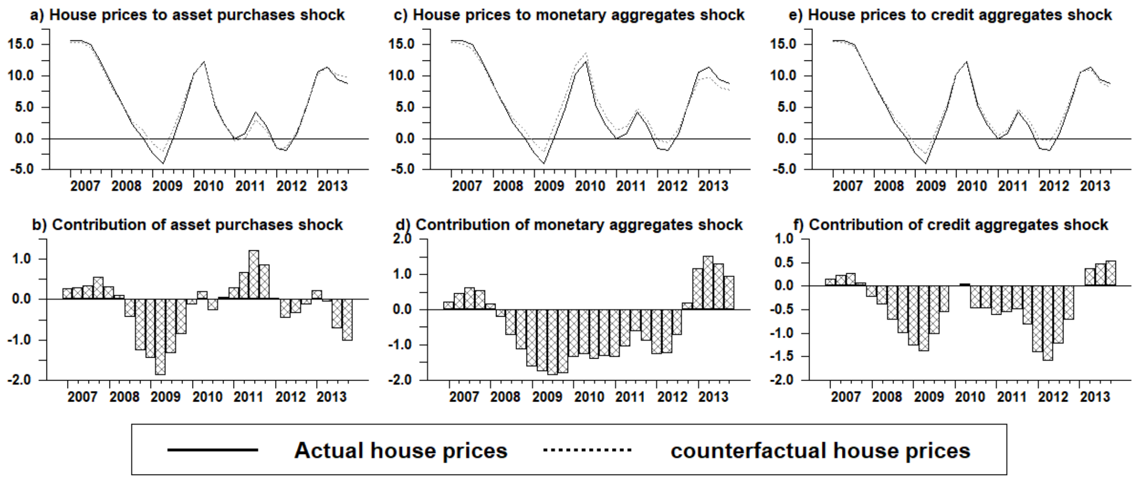


Source: Author's calculations

2.6.6 How did global liquidity impact the evolution domestic house prices?

What about house price inflation? How did global liquidity impact the evolution domestic house prices? Figures 2.21 and 2.22 show that quantity measures of global liquidity have exerted downward pressure on domestic house prices for most of the period since the 2009.

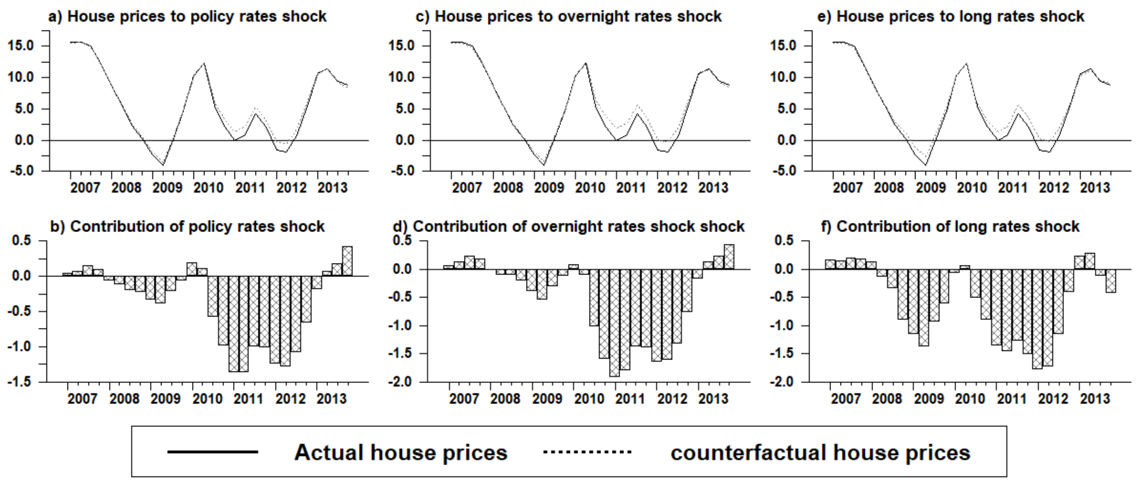
Figure 2.21 Actual and counterfactual responses of house prices based on quantity measures of global policy rate shock



Source: Author's calculations

In addition, the extraordinarily low policy rates have not contributed positively to domestic house prices either.

Figure 2.22 Actual and counterfactual responses of house prices based on price measures of global policy rate shock

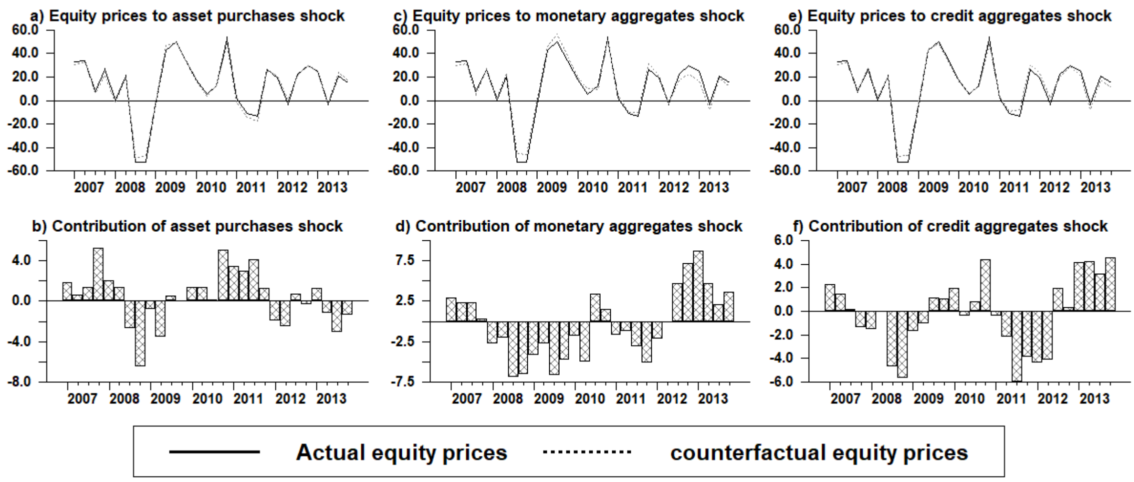


Source: Author's calculations

2.6.7 Is the contribution of quantity and price measures of global liquidity on equity prices different to that on house prices?

It is an undeniable fact that domestic equity prices rebounded from the severe slump experienced during the global financial crisis and recession. So, what does our model suggest the relative contributions of quantity and policy measures of global liquidity are? Figures 2.23 and 2.24 show that compared to price measures, quantity measures of global liquidity particularly asset purchases contributed positively to domestic equity prices.

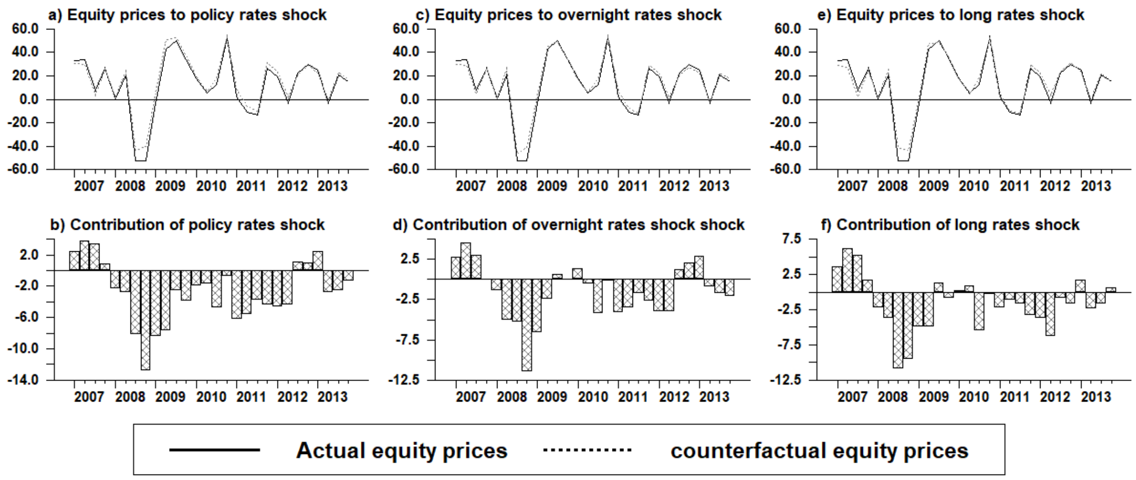
Figure 2.23 Assessing actual and counterfactual responses of equity prices based on quantity measures of global policy rate shock



Source: Author's calculations

In comparison, price measures of global liquidity have not made much positive contributions to domestic equity prices. These results imply that there are noticeable different effects of the two policy tools, and they exert different effects.

Figure 2.24 Actual and counterfactual responses of equity prices based on price measures of global policy rate shock



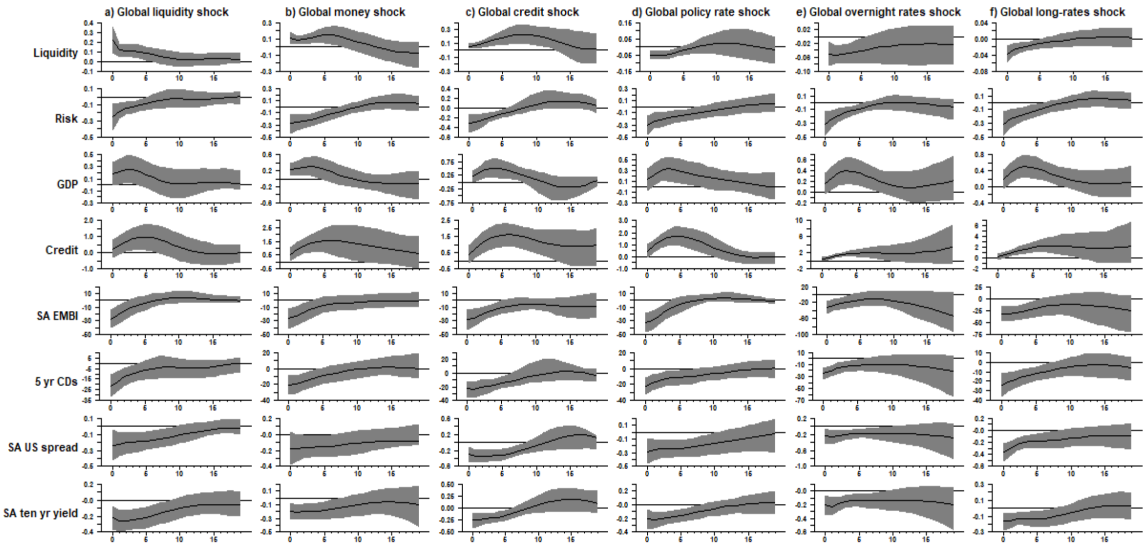
Source: Author's calculations

2.7 Robustness analysis: global asset purchases impact on domestic sovereign credit risk and borrowing costs

This section conducts the robustness analysis by assessing the sensitivity of the responses of credit and GDP growth to the change in the specification of the model. We assess the sensitivity of the variables of interest to the changes in the variables included in the model based on the specification in Equation 2.19. We stated earlier that the international transmission of asset purchases and global liquidity works through lowering investor uncertainty to lower investor risk appetite, long-term yields, and credit risk. How did global liquidity impact South African government ten-year yields? Did they lower domestic sovereign credit risk as measured by the EMBI and CDS spread? Did they lower the SA-US ten-year yield spread easing financial constraints on government finances?

Figure 2.25 shows that indeed, a decline in price measures of global liquidity and investor risk perceptions coupled with an increase quantity measures of global liquidity loosed financial conditions and resulted in a decline in the SA sovereign credit risk across the five-year CDS and EMBI spreads.

Figure 2.25 Responses to quantity and price-based measures of global liquidity shocks

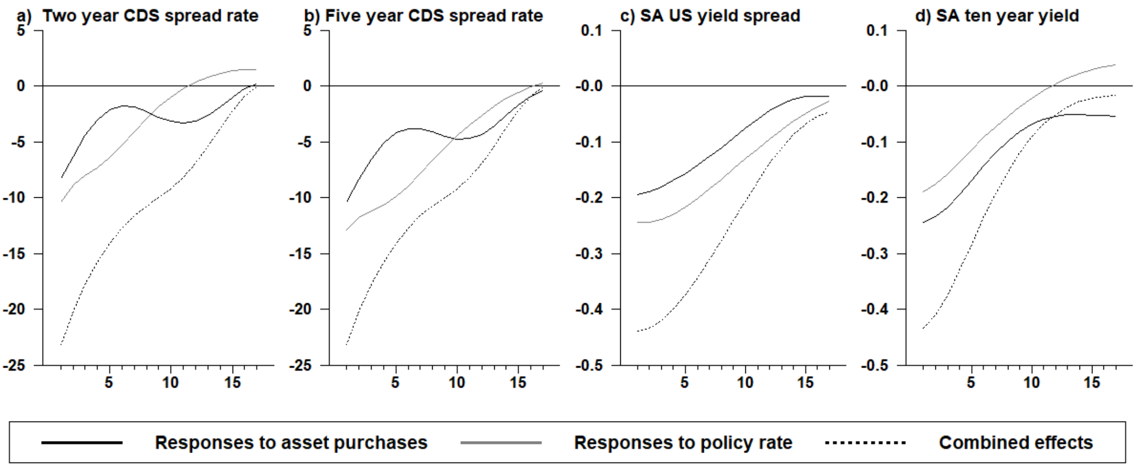


Source: Author's calculations

Similarly, the yield on the ten-year SA government bond yield declined as did the SA-US yield spread indicating that the lowering of global interest rates and the asset purchases loosened domestic financial conditions. In addition, the results show that the responses of the variables of interest, namely credit and GDP growth are comparable to the benchmark model. GDP and credit growth increase in response to shocks to price and quantity measures of global liquidity. This implies that the specification of our model is robust to changes in the specification.

Furthermore, Figure 2.26 shows that the combined effects of zero lower bound interest rates and asset purchases by central banks resulted in bigger declined in the CDS spreads, government yields and the yield spread.

Figure 2.26 Responses to quantity and price-based measures of global liquidity shocks



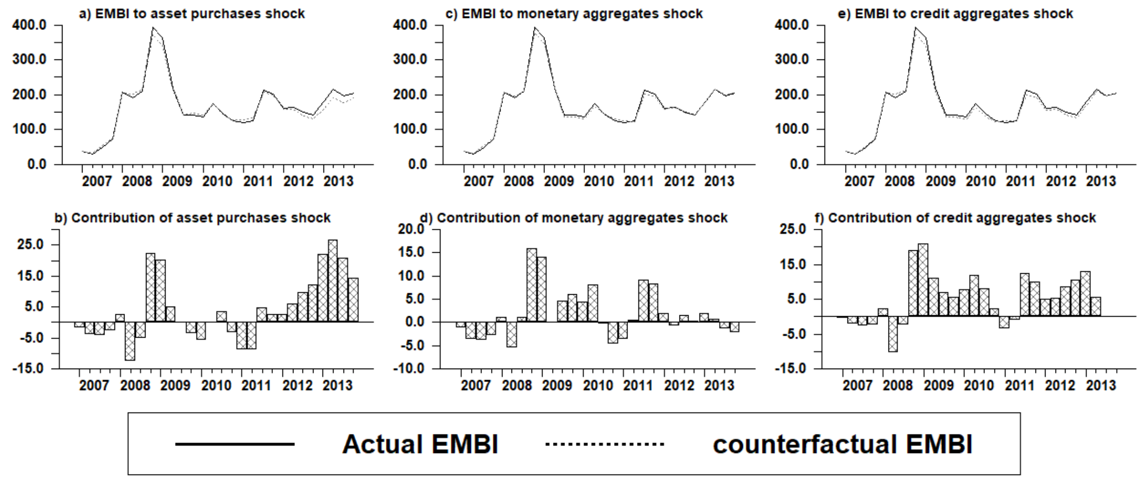
Source: Author's calculations

It is also evident in Figure 2.26(d) that the yield on the SA ten-year government bonds declined more due to asset purchases than just lower global policy rates. This means that the combined effects of lower global interest rates and asset purchases lowered SA sovereign credit risk and loosened government financial conditions.

2.7.1 What would the South African sovereign credit risk and yields be in the absence of global asset purchases shocks?

We use the counterfactual scenario and historical decompositions approach to answer this question. In particular, this chapter pays attention to the historical contributions of asset purchases by central banks post 2007 in Figure 2.27 and Figure 2.28 since policy rates have not changed much. The results show that for the largest period post-2009, asset purchases contributed to lowering the domestic sovereign credit risk. The sovereign credit risk remained low and narrowed by between 5 and 10 basis points on average post 2009. But the depressing effects of asset purchases turned positive since the beginning of 2011Q1 coinciding with the tapering pf asset purchases by the US Fed. As a result, all the quantity measures of global liquidity have made positive contributions to SA EMBI spread.

Figure 2.27 Actual and counterfactual EMBI spreads responses to asset purchases shock

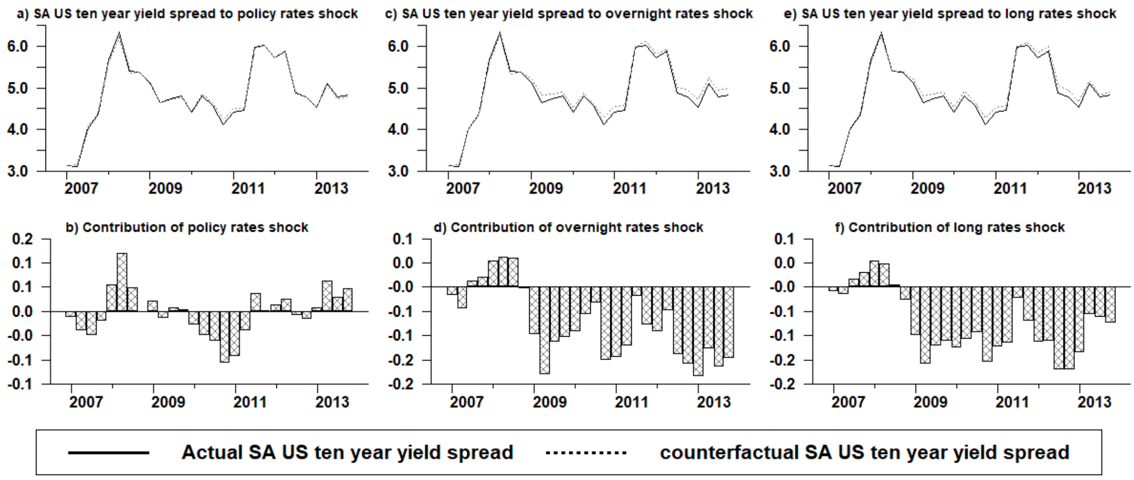


Source: Author's calculations

The depressing effects of asset purchases are particularly evident in the yield on the ten-year government bond spreads in Figure 2.28. Quantity measures of global liquidity contributed to lowering the SA US ten-year government bond yields spread by between 0.5 and 0.30 percentage points, respectively.

Central bank liquidity injections play an important role in market liquidity conditions and market risk appetite influences the flows in global liquidity. Excess global liquidity and lower investor risk perceptions are expected to have a positive correlation with EMEs interest rate spreads as captured by the EMBI. In addition, Borio and Zhu (2008), Psalida and Sun (2011) and Bridges and Thomas (2012). show that global liquidity affects global and domestic financial markets through capital inflows and risk appetite from international investors searching higher yield. It is evident in Figure 2.28 that excess global liquidity does contribute to the narrow EME market interest rate spreads.

Figure 2.28 Actual and counterfactual SA ten-year yield and SA US yield spreads responses to asset purchases shock

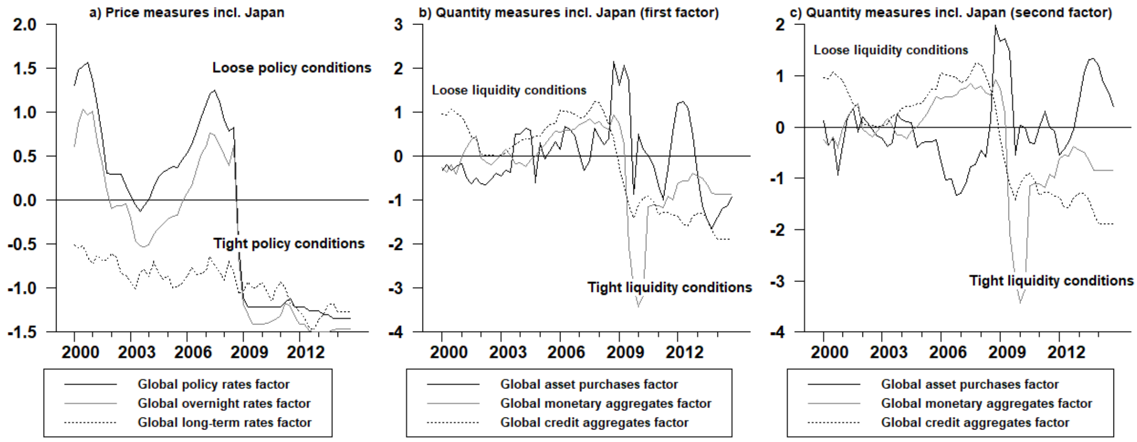


Source: Author's calculations

2.8 Robustness analysis: Does the inclusion of Japan have an influence on economic and credit growth responses?

The second approach for robustness analysis assesses the sensitivity of the responses of the GDP growth and credit growth to model size. In this section we assess the stability of the GDP growth and credit growth responses to the inclusion of Japan in the estimated quantity and price measures of global liquidity. We stated earlier that the Japanese economy has been in a deflationary environment since the 1990s and the monetary policy settings have been at historic lows, contributing to easy global liquidity and influencing the market risk perceptions. The Bank of Japan embarked on QE in the early 2000s and paused. After the global financial crisis, the Bank of Japan embarked on a new phase of quantitative easing, joining other central banks. We re-estimate the global liquidity factors and include data for Japan. We establish two factors for asset purchases when we include Japan in the estimations, and these are shown in Figure 2.33.

Figure 2.29 Estimated factors for price and quantity measures of global liquidity including Japan



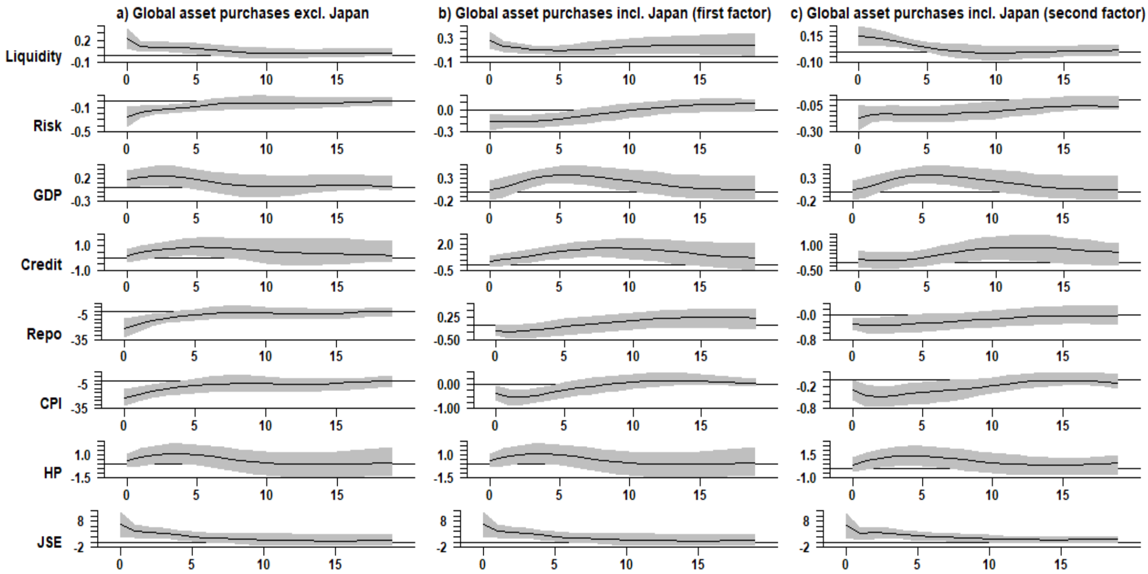
Source: Author's calculations

It is evident that the main differences relate to the quantity measures of global liquidity as opposed to the price measures. Within quantity-based measures, the inclusion of Japan impacted the asset purchases measure the most. The trends in the asset purchases including Japan suggests that asset purchases by central banks resulted in much easier financial conditions as opposed to the measure that excludes Japan. However, there are visible differences in the estimated asset purchases factors shown in Figure 2.29(b) and (c). It is clear in Figure 2.29(c) that between 2005 and 2008 global liquidity conditions inferred from central bank asset purchases resulted in tighter global liquidity compared to the loose conditions shown in Figure 2.29(b) and neutral trends in Figure 2.7(b). As a result, to assess for the robustness of the earlier results and the consistency of the responses with theoretical prescriptions, we use the two estimated factors for the asset purchases including Japan and compare the responses of SA variables to the asset purchases excluding Japan used in the benchmark model. We keep the FAVAR specification and identification scheme like that in Equation 2.18 and Table 2.5. We only assess the responses of South African variables to the three measures of global liquidity conditions due to central bank asset purchases.

2.8.1 How potent are the effects of global asset purchases including Japan?

To answer this question, we re-estimate the FAVAR in the benchmark model but change the global liquidity conditions based on central bank asset purchases in the three different models. The results in Figure 2.30 show that the responses of the South African variables to the asset purchase measure excluding Japan in column (a) the first factor including Japan (b) and the second factor including Japan in (c) result in similar responses in the two variables of interest, namely GDP and credit growth although the magnitudes and speed differs.

Figure 2.30 Response to global asset purchases shocks including Japan



Note: HP = House prices; Risk= VIX, JSE = Johannesburg Stock Exchange all-shares price index.

Source: Author's calculations

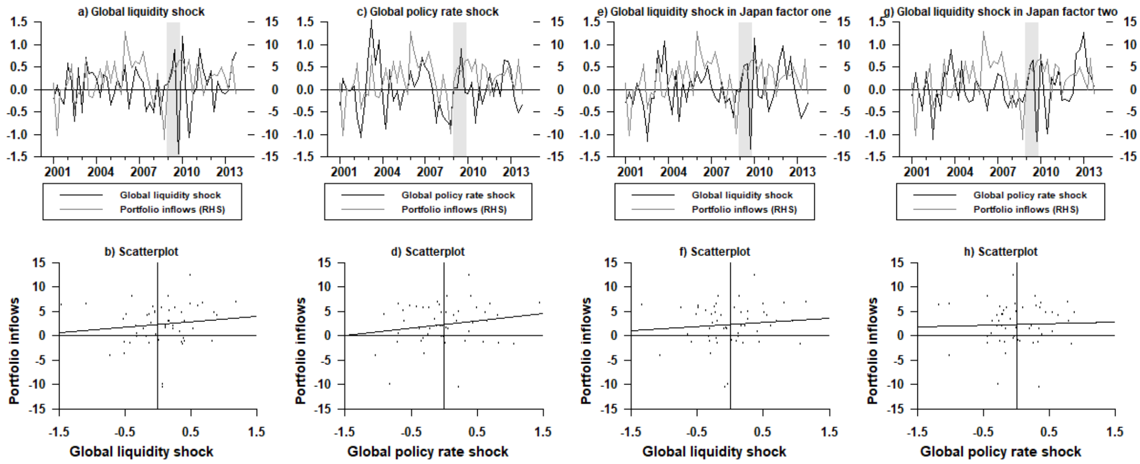
The inclusion of Japan data in the construction of the global liquidity factors results in higher peak responses in credit and GDP growth. This means that asset purchases by the Bank of Japan add to excess global liquidity and contribute to easier domestic credit and financial conditions.

2.8.2 How reasonable and plausible are the global liquidity shocks?

So far, the analysis has in the chapter has concentrated on the quantitative magnitudes of correctness of the impulse responses in assessing the reasonableness of the identification scheme. However, Faust (1998) and Uhlig (2005) show that a reasonable analysis of the identification schemes and validation of the structural shocks can also be conducted by extracting the shocks and assess whether their association with other macro-economic variables produces reasonable relationships. Reasonable is interpreted to mean that the relationships adhere to conventional wisdom and theoretical predictions.

We assess the plausibility of the global liquidity shocks used in the empirical sections by assessing their relationships with other macro-economic variables not included in the various models. First, in Figure 2.31 we show the relationship between the asset purchase and policy rate global liquidity shocks extracted from the benchmark model and the asset purchases liquidity shocks extracted from the model including Japanese data. We expect that the increase in asset purchases and a decline in the policy rate shock to be positively associated with capital inflows.

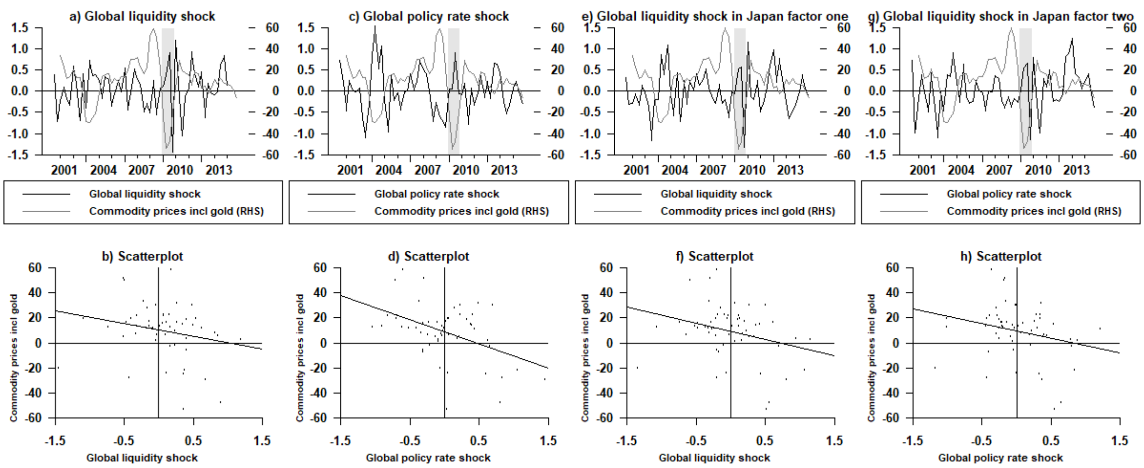
Figure 2.31 Global liquidity shocks and portfolio flows



Source: Author's calculations

Indeed, the relationships in Figure 2.31 show positive associations with capital inflows. In turn Figure 2.32 shows that all the measures of the global liquidity shocks are negatively related with Rand commodity prices including gold. This means that as global liquidity conditions are inversely related Rand commodity prices. This trend is also evident between the Rand per US dollar exchange rate and the global liquidity shocks shown in Figure 2.33.

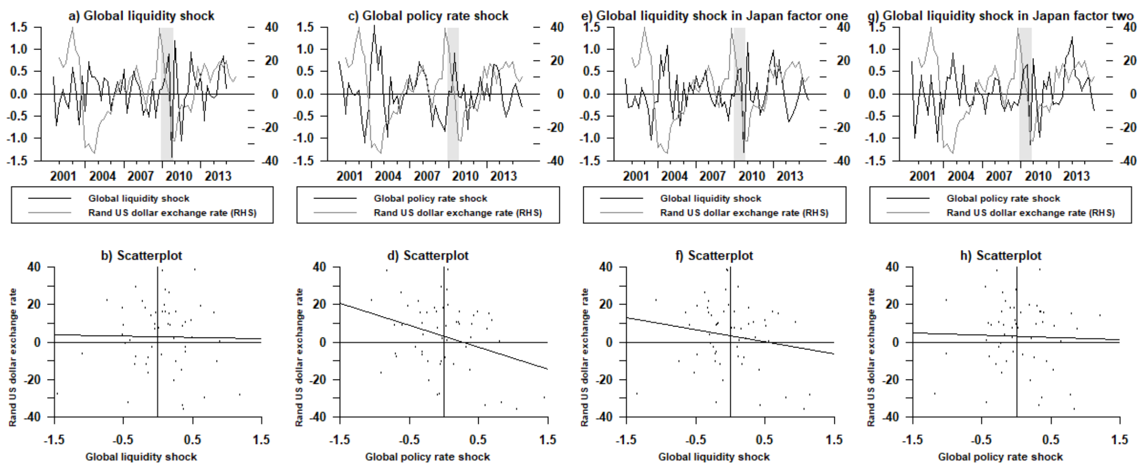
Figure 2.32 Relationship between global liquidity shocks and commodity prices



Source: Author's calculations

Albagli (2015) arrives at similar conclusions regarding the inflation experience by emerging market economies during the QE period. Most emerging market economies have experienced inflationary pressures despite large negative output gaps and low demand. He concludes that, external shocks resulted in large declines in commodity prices and exchange rate depreciations.

Figure 2.33 Relationship between global liquidity shocks and Rand US dollar exchange rate



Source: Author's calculations

The reasonableness tests presented above clearly indicates that the identified global quantity liquidity shocks and to a lesser extent price measures of global liquidity shocks are important drivers of fluctuations in financial and real economic activity.

2.8 Conclusion and policy recommendations

This chapter explores the impact of global liquidity on the South African economy. To this end, we constructed six measures of global liquidity which are categorized as price and quantity measures of global liquidity. The price measures of global liquidity are derived from policy rates, overnight interest rates and long-term yields. Whereas quantity measures are based on asset purchases by central banks, monetary and credit aggregates. We distinguish between price and quantity measures of global liquidity to account for the fact that post 2007 central banks in AEs hit the zero-lower bound for policy rates and used asset purchases to ease the policy settings further. We also estimated a broader measure of global investor risk perceptions, based on VIX, EMBI and the TED spread. All the constructed global factors enter the VAR model as external variables.

For the empirical analysis, we used the sign restricted FAVAR approach to assess the impact of multiple shocks emanating from global risk, price, and quantity measures of global liquidity on the South African economy. For policy analysis and implications, we used the historical decompositions of counterfactual scenarios.

We find that all shocks to price and quantity measures of global liquidity result in a significant increase GDP and credit growth. The responses of the increase in house prices are consistent with the influence of various channels such as the collateral and wealth effects associated with the increase in house prices on residential investment and credit growth. In addition, the increase in equity prices suggest improved profitability of projects and the market value of assets over the replacement costs via the Tobin's q channel thus leading to higher investment, credit growth and GDP growth.

However, inflation declines in response to all price and quantity measures of global liquidity shocks. We conclude that this result is consistent with the recent experience following massive injections of global liquidity by central banks and the absence of inflationary pressures. In the earlier stages of the implementation of QE, the surge in capital flows to EMEs resulted in the appreciation of exchange rates exerting downward pressure on inflation. Furthermore, the responses of inflation quantity measures of global liquidity shocks show that inflation tends to decline compared to responses to price measures.

Which global liquidity shock has potent effects on credit and GDP growth? A comparison of the impact of the quantity and price measures of global liquidity shocks indicates that quantity measures of global liquidity, in particular asset purchase lead to higher peak responses in GDP growth. On the other hand, the global policy rate effects on credit and GDP growth are delayed and much lower. However, because the implementation of QE occurred simultaneously with zero lower bound policy rates, the results show that the combined effects of price and quantity measures do indeed reinforce each other and result in better outcomes at peak response. The responses of the repo rate suggest that the policy rate declines more in response to a decline in the global policy rates compared to QE. This further affirms the synchronization of policy rates for large part of the period subsequent the global financial crisis. The responses of house and equity prices suggest that the effects of both price and quantity measures results in much more pronounced effects on house and equity prices.

Which shocks between quantities and price-based measures of global liquidity explain more fluctuations in economic growth and credit growth? The results indicate that price measures explain more variation in credit and GDP growth on impact compared to asset purchase shocks. However, the impact of asset purchases increases over the forecast horizon Shocks to asset purchases explain much of the variation in house and equity prices across horizons. The policy implication of these findings suggests that the sustained rise in house and equity prices linked to exceptionally low levels of policy rates and asset purchases may poses financial stability risk through excessive risk taking via the wealth and collateral channels.

The counterfactual scenarios show that during 2009 asset purchases contributed in different directions to inflation, credit growth and GDP growth. Asset purchases contributed to the decline credit and GDP growth but an increase in inflation. However, this was reversed in 2010 to 2012 when asset purchases contributed to the decline in inflation. Furthermore, the magnitudes of the impact of price measures are much lower when compared to those exerted by the quantity measures. The contrast in the contributions of price and quantity shocks is clear post 2010. Shocks to price measures of global liquidity have clearly not resulted in any positive growth in credit and GDP growth.

The results show that a decline in global policy rates and investor risk perceptions coupled with an increase quantity measures of global liquidity loosed financial conditions and resulted in a decline in the SA sovereign credit risk across the five-year CDS and EMBI spreads. The yield on the ten-year SA government bond yield declined as did the SA-US yield spread corroborating the findings that the lowering of global interest rates and the asset purchases loosened domestic financial conditions.

Last, we establish that the inclusion of Japan data in the construction of the global liquidity factors results in higher peak responses in credit and GDP growth. This means that asset purchases by the Bank of Japan add to excess global liquidity and contributed to easier domestic credit and financial conditions. The policy implications are that global liquidity conditions do spill-over into the domestic economy and impact credit and financial conditions. Positive global liquidity shocks and conditions via their impact on the exchange rate impact the pass-through to inflation. In addition, the responses to price and quantity measures of global liquidity indicate that in cases where monetary policy actions are highly coordinated as monetary policy itself can be become a source of business cycle fluctuations. Co-ordinated monetary policy actions can increase the occurrence of common monetary shocks and result in accentuated business cycle fluctuations.

Appendix

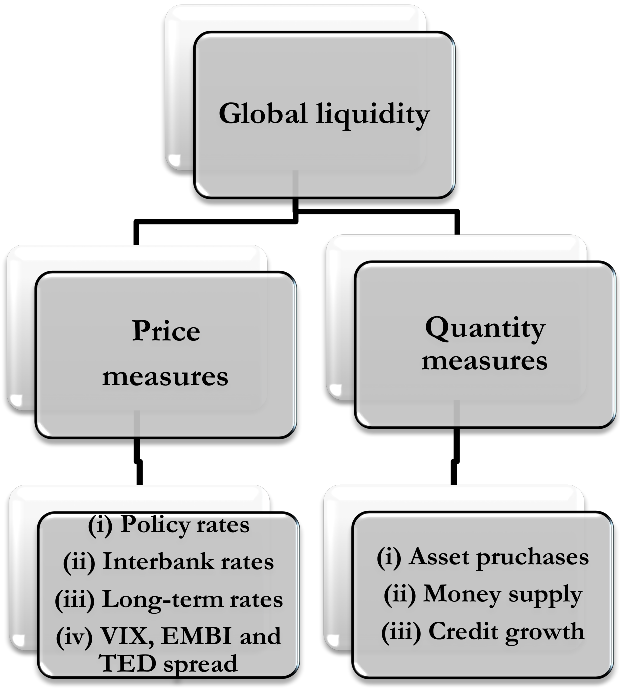
Table A2. 1 The Bai and Ng (2002) criteria for the selection of the number of factors: Price and quantity measures of global liquidity

Number of factors	Eigenvalues	Proportion of variation explained
Global policy rates		
1	2.710	0.903
2	0.199	0.066
3	0.091	0.030
Global overnight rates		
1	2.670	0.890
2	0.201	0.067
3	0.128	0.043
Global long-term yields		
1	2.907	0.969
2	0.058	0.019
3	0.036	0.012
Global liquidity		
1	1.672	0.557
2	0.996	0.332
3	0.332	0.111
Global monetary aggregates		
1	1.829	0.610
2	0.857	0.286
3	0.314	0.105
Global credit aggregates		
1	2.547	0.849
2	0.314	0.105
3	0.139	0.047

Note: The criteria to select the number of factors is described in Equations 4 and 5.

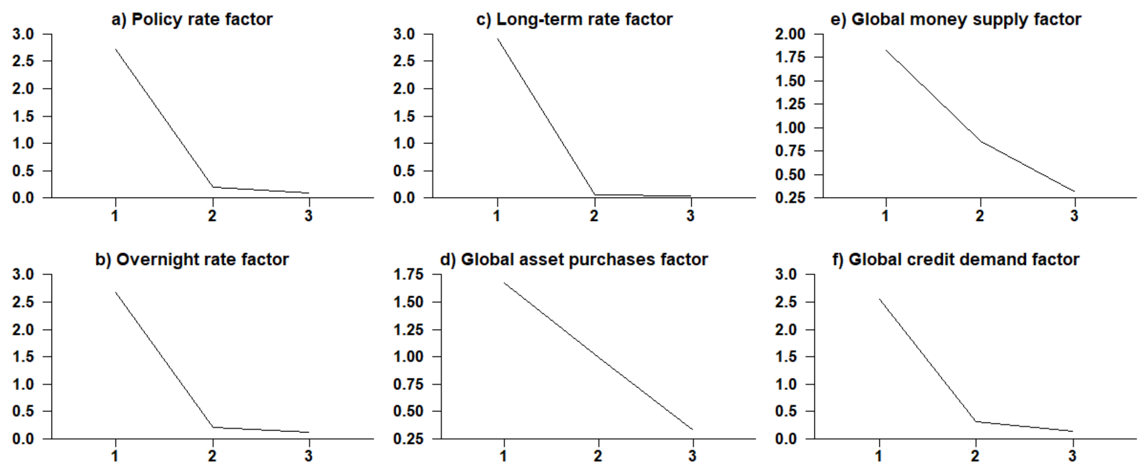
Source: Author's calculations

Figure A2.1 Construction of global liquidity indices from selected central bank policy rates and balances sheets



Source: Author's drawing

Figure A2.2 The scree plots of the ordered eigenvalues for various global liquidity factors



Note: The Scree plots show the common factors and the corresponding r largest eigenvalues. The cutoff point for the significance of the number of factors based on the Scree plot of the eigenvalues is one.

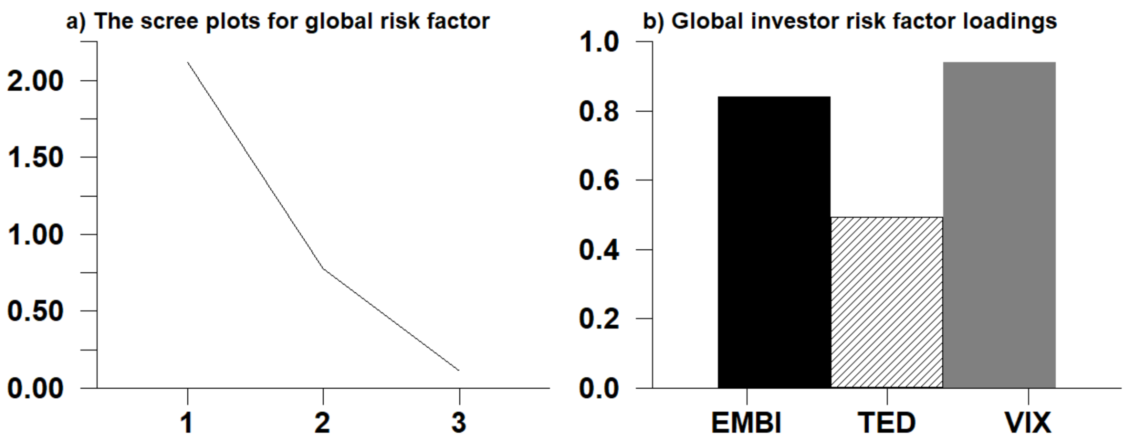
Source: Author's calculations

Table A2.2 The Bai and Ng (2002) criteria for the selection of the number of factors: Global risk factor

Number of factors	Eigenvalues	Proportion of variation explained
Global investor risk perception		
1	2.115	0.705
2	0.776	0.259
3	0.109	0.036

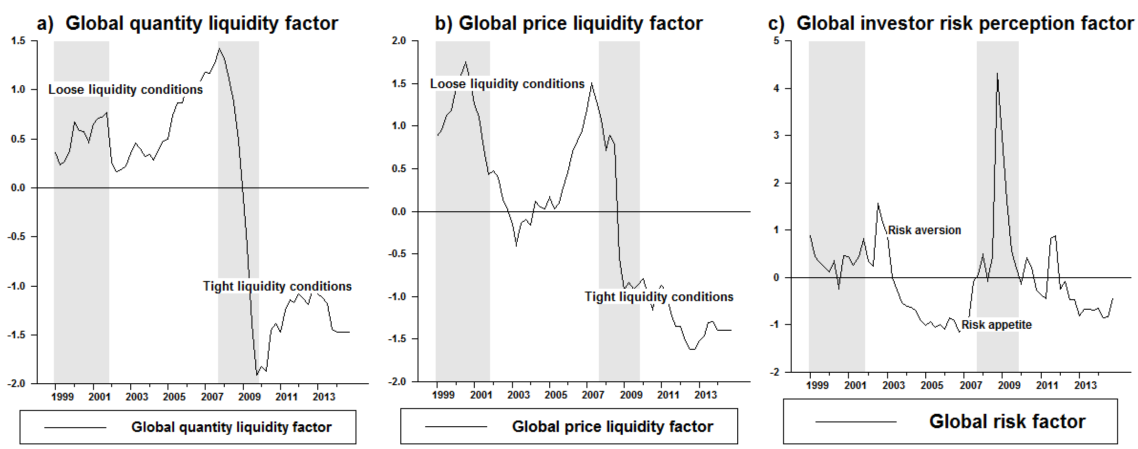
Source: Author's calculations

Figure A2.3 Factor loadings for global investor risk perception



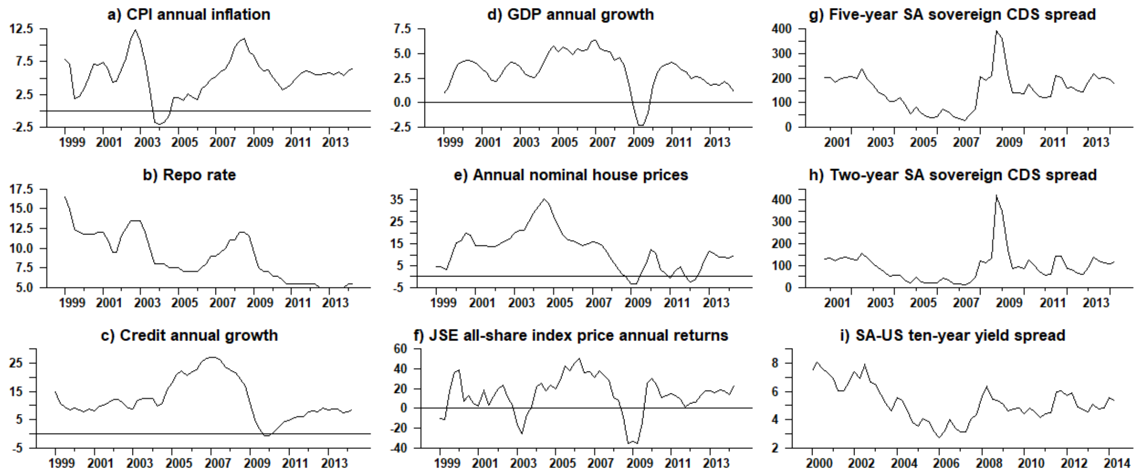
Source: Author's calculations

Figure A2.4 Aggregates estimated factors for global quantity and price liquidity and investor risk



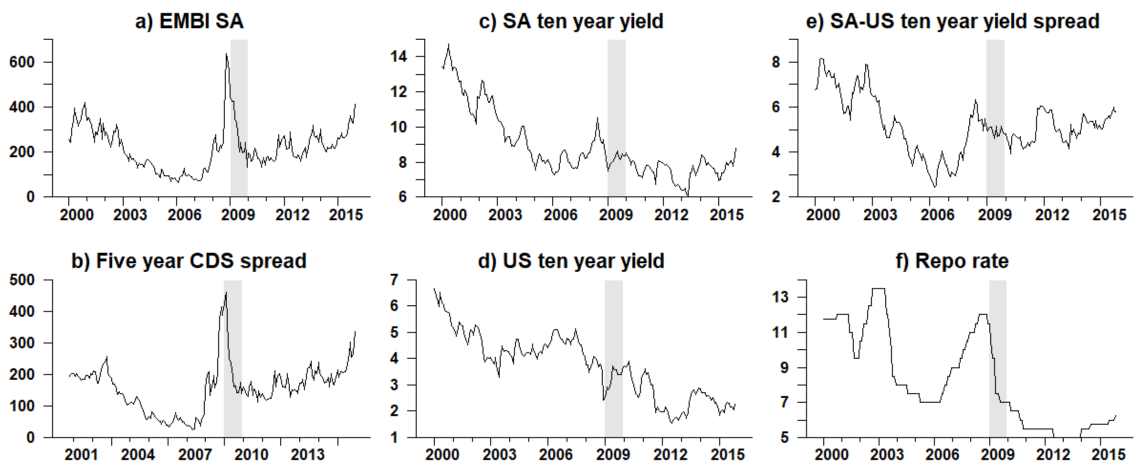
Source: Author's calculations

Figure A2.5 Plot of South African variables



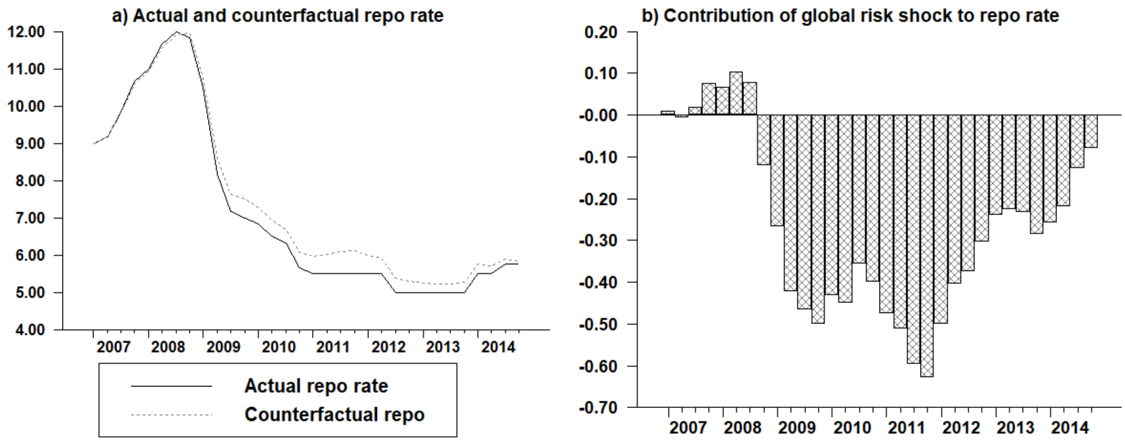
Source: South African Reserve Bank

Figure A2.6 Yield on ten-year US government bond and selected SA sovereign credit risk and interest rates



Source: South African Reserve Bank

Figure A2.7 Actual and counterfactual repo rate responses to positive global liquidity shocks



Source: Author's calculations

Chapter 3 The impact of capital inflows and domestic monetary policy on credit growth and housing markets and selected financial and macro-economic variables

3.1 Introduction

Do capital inflow shocks play a much larger role relative to monetary policy shocks in the transmission of positive global liquidity shocks? Moreover, how persistent are the effects of capital inflow and monetary policy shocks? The impact of positive global liquidity shocks and the associated capital flows to emerging market economies (EMEs) has pre-occupied policymakers and academics alike. For instance, Gouteron and Szpiro (2005) show that the investment strategies of global investors seeking higher yields in EMEs tend to be associated with strong capital flows to EMEs where interest rates are generally higher relative to advanced economies. Forbes and Warnock (2011), show that the channel of transmission is mainly through global risk. Other global factors, such as strong global growth increase the probability that countries will experience capital flow surges. Similarly, Fratzcher et al., (2013) establish evidence that changes in global investor risk perception, exchange rate and asset prices play a significant role as drivers of credit growth, financial market conditions, economic activity, and current account positions.

However, Forbes and Warnock (2011) show that the surge of capital inflows to EMEs can have some harmful consequences for price and financial stability. Of particular concern are changes in global investors' risk appetite and the high level of volatility that characterizes cross-border capital flows. Heightened global investor risk aversion increases the probability of sudden stops in capital inflows. For example, Artus and Virard (2010) show that events associated with increases in global investor risk aversion tend to lead to large withdrawals of capital and sudden stop episodes which can result in higher risks of economic growth contraction, inflationary consequences and financial crisis. Furthermore, recent literature shows that the composition of capital flows matters. Davis (2015) shows that debt and equity capital inflows have different effects on macroeconomic indicators. Debt capital inflows directly involve the balance sheets of financial intermediaries and therefore tend to lead to the domestic financial accelerator effects compared to equity-based capital inflows.

Empirically, this chapter contributes to limited research on the interaction of capital inflow shocks and monetary policy shocks on credit growth, asset prices, GDP growth and the current account in South Africa. In addition, the chapter fills the existing academic and policy research gaps related to the role of the composition of capital inflows such as debt and equity inflows. To this end, we disaggregate capital inflows and outflows into debt and equity capital flows and assess the degree to which they exert different effects on South African variables and derive policy implications for price and financial stability. Furthermore, we analyze the impact of large capital outflows or sudden stops of capital inflows on the South African economy.

Why is it important to assess the impact of capital inflows and domestic monetary policy on credit growth and housing markets and selected financial and macro-economic variables? The search for yield by international investors within the accommodative global monetary policy and financial conditions is one of the main drivers of global investor risk perception and the direction of capital flows. The direction and magnitudes of capital flows matter for policy makers because capital flow episode, namely, capital flow surges, capital flight, capital retrenchment and capital flow sudden stops have a significant influence on the developments and dynamics of domestic financial and macro-economic variables. In addition, the volatility associated with capital flows and changes in global investor risk perceptions render the country to be vulnerable to events such as sudden large withdrawals and sudden stop episodes. In turn, developments and dynamics of domestic financial and macro-economic variables have a large bearing on how policy makers respond to mitigate or propagate the shock effects of capital flow episodes. For instance, capital flow surges tend to lead to the exchange rate appreciation, commodity price increases and other asset price increases such as equity prices and house prices. The developments in the exchange rate, commodity prices and other asset prices tend to have a large influence on demand side pressures, trade growth, investment growth, revenue growth, output growth and employment growth. At any given point, these economic factors require policy makers to understand how respond and make sure that the policy settings are well aligned with the achievement of the price stability and financial stability mandates. On the other hand, policy makers also pay a lot of attention of capital flow sudden stops shocks because they have historically resulted in financial crisis in several countries that are characterized by wide current account deficits and fiscal deficits. Of particular concern to policymakers is the fact that a widening current account and budget deficits require financing and South Africa depends on capital flows to finance the bulk of the current account shortfall. A large capital flow sudden stop shock is a significant policy risk factor and policy makers need to understand how to neutralize its effects when it occurs.

Methodologically, the chapter contributes to existing literature by adopting the pure and penalty function approaches to sign restriction. Uhlig (2005) shows that the pure sign restriction approach does not produce sharp inferences compared to the penalty function approach. This is because in the pure sign restriction approach all impulse vectors satisfying the sign restrictions are considered equally in the determination of the impulse responses. In contrast, the penalty function approach by minimizing the information criterion choses the best of all impulse vectors and results in smaller standard errors. We use the two approaches to assess the impact and persistence of capital flow shocks and monetary policy shocks on the South African economy. In addition, we use the penalty function approach as a robustness test of our results.

Furthermore, our analysis of the impact of sudden stop episodes differs from the univariate approach that is normally used in literature. The sign restriction approach enables us to assess the impact of sudden stops without necessarily imposing any assumptions about the size of change in capital outflows (net capital inflows). We also complement the sign restriction approach by applying the Kilian and Vigfusson (2011) approach to test for the asymmetric transmission of capital outflows and the response of GDP growth. The Kilian and Vigfusson approach analyses non-linear impulse response functions calculated by simulating the effects of different magnitudes and signs of shocks using different scenarios of magnitudes of a decline in capital outflows. We are not aware of papers that use this approach in South Africa. In addition, the approaches used in this chapter complement the often-used definition that sudden stops are abrupt declines in net or gross capital inflows as done in Calvo et al., (2006b) and Forbes and Warnock (2011).

For further robustness tests we use the Uhlig (2005) approach to extract the capital inflow and monetary policy shocks and assess how reasonable and robust they are in explaining selected macroeconomic developments. To derive the policy implications of the impact of persistent capital inflow and monetary policy shocks, we use the counterfactual scenario and historical decomposition approaches.

The results show that across various specifications and capital inflow categories, capital inflow shocks are more persistent and induce more variability in credit, house prices, equity prices, investment, commodity prices and the current account. Essentially, the results confirm that capital inflows shocks have persistent effects compared to monetary policy shocks. The data confirms the *"savings glut"* hypothesis. For example, the results show that during the credit and housing boom in 2004Q1 to 2007Q4 monetary policy shocks made positive but very transitory contributions to credit and house price growth compared to capital inflow shocks. Furthermore, capital inflows have larger and more persistent shock effects on investment, commodity prices and the current account.

However, the results show that the composition of capital inflows matters. Credit growth and house prices are more responsive to equity inflows compared to debt inflows. Capital inflow shocks, in particular, equity inflows were the key contributors to increases in commodity prices during the commodity price boom. Furthermore, evidence suggests that post-financial crisis and recession in 2009Q4, despite historically low interest rates and liquidity injections by central banks monetary policy shocks have not exerted much stimulatory effects on credit growth. Similarly, the impact of capital inflow shocks is less potent and persistent compared to the period pre-financial crisis. The muted impact of monetary policy and capital inflow shocks may indicate that supply-side factors may be relevant in establishing the link from capital inflows to commodity prices, credit growth and housing market activity. House prices, equity prices and commodity prices present additional important channels through which accommodative monetary policy and positive capital inflow shocks are transmitted via different categories of capital inflows to domestic credit markets.

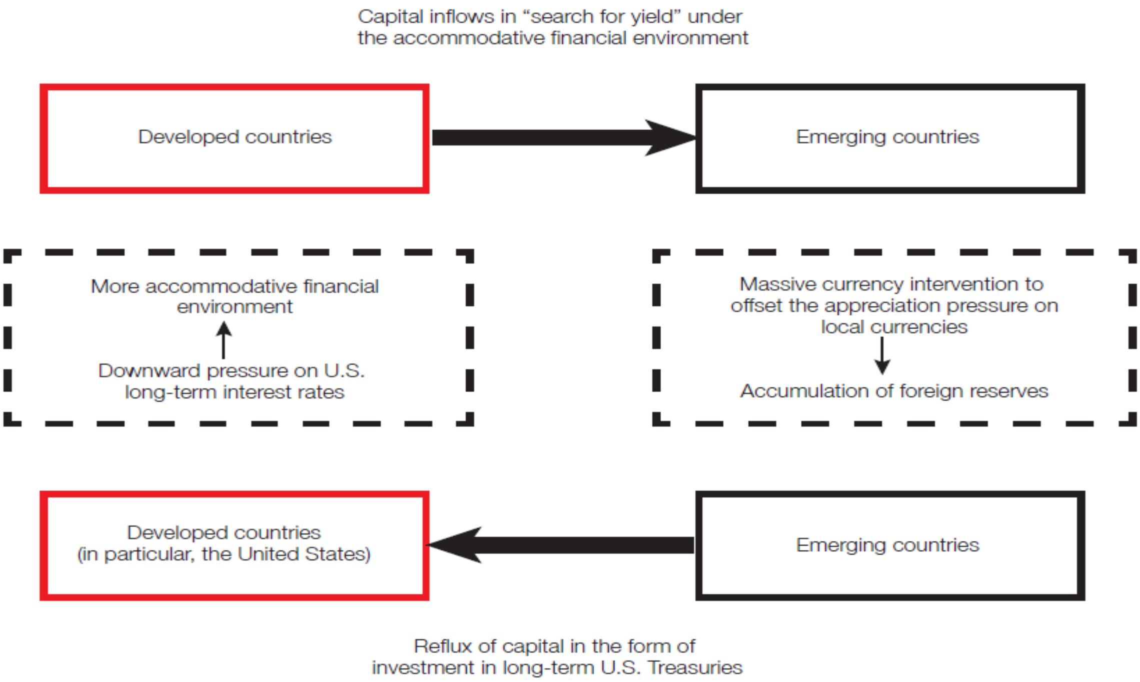
Therefore, capital inflow shocks are more persistent compared to monetary policy. Capital inflows, in particular equity inflows, induce more variability credit, housing prices, equity prices, investment, commodity prices and the current account. Although monetary policy shocks are transitory, by loosening the credit and financial constraints, they contribute to changes in sentiment and domestic supply and demand factors. The interaction of monetary and capital flow shocks affects asset prices and real economic activity with implications for the exchange rate, monetary and financial stability mandates

The rest of the chapter is structured as follows: section two and three present a brief literature review on the interaction of monetary policy and capital inflows. Section four discusses the econometric approaches used in the chapter. Section five presents the data used and stylized facts. Section six discusses the theoretical basis for the imposed sign restrictions followed by the discussion of the empirical results and the conclusion and policy implications.

3.2 Channels of transmission of capital inflow shocks

Figure 3.1 depicts the feedback loop of international capital flows. The feedback mechanism is largely driven by the search for yield within the accommodative global monetary policy and financial conditions. The transmission of accommodative global monetary and financial conditions across borders manifests through the decline of investor risk perceptions and risk premiums for debt securities. Joyce et al. (2010) establish a positive relationship between nominal interest rates and the risk premia characterizing the search or reaching for yield through the portfolio balance channel.

Figure 3.1 The feedback loop of international capital flows



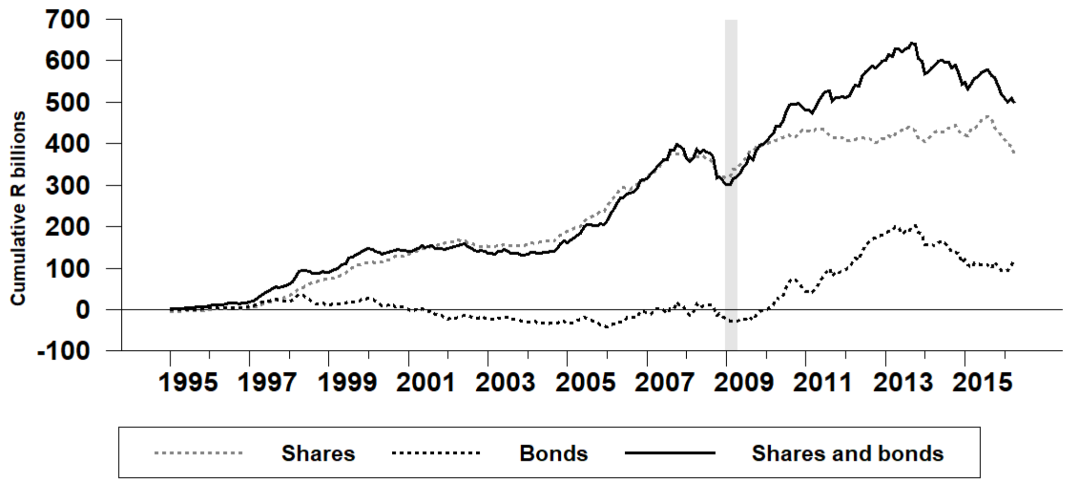
Source: Kobayashi and Yoshino, 2011.

The direction and magnitudes of capital flows matter for policy makers. This is because sudden stops in capital inflows were common and were a main characteristic of the emerging market crisis during the 1990's. Concerns about the re-occurrence of such episodes resurfaced in light of the end in the asset purchases (QE) by the United States Federal Reserve (US Fed) in October 2014 and the eminent policy rate normalization. This is especially the case for South Africa and other EMEs characterized by wide current account deficits and fiscal deficits. Of particular concern to policymakers is the fact that a widening current account and budget deficits, suggest that the country is borrowing more, and this debt needs to be repaid. Both the current account and fiscal deficits require financing. Even if the two deficits are deemed to sustainable, the fact is that South Africa depends on capital flows to finance the bulk of the current account shortfall is a policy risk factor. As a result, the volatility associated with capital flows and changes in global investor risk perceptions render the country to be vulnerable to events such as sudden large withdrawals and sudden stop episodes.

3.2.1 Foreign and domestic interest rates

To contextualize the schematic feedback loop shown in Figure 3.1 we start by showing the non-resident activity in the South African equity and debt (bond) markets in Figure 3.2. The trends shown by the cumulative net purchases of bonds and equities show that the participation of non-residents in the South African financial markets increased and almost doubled post the financial crisis and recession in 2009. The period post-2009 was characterized by large scale asset purchases (QE) by central banks in advanced economies (AEs). The injection of liquidity by the central banks and low interest rates in AEs via the search for yield and global investor risk appetite was channeled to South African markets.

Figure 3.2 Non-residents activity in the South African equity and debt (bond) markets



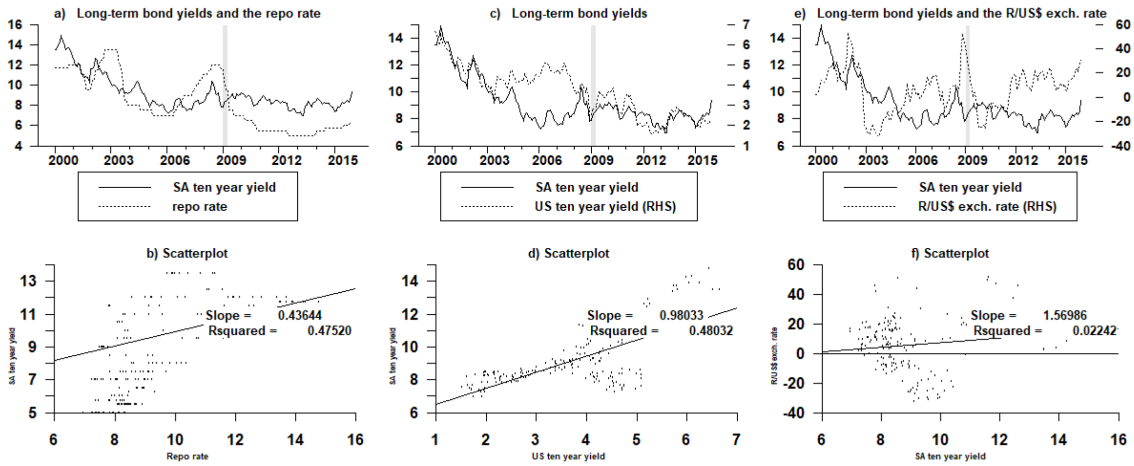
Source: South African Reserve Bank

In addition, the trends in Figure 3.2 show that on a net cumulative basis, non-residents have bought more South African bonds post-2009 compared to shares (equity). These trends can be partly explained by the increase in the budget deficit considering the conduct of counter-cyclical fiscal policy and the inclusion of South African government bonds in the World Global Bond Index (WGBI) in October 2012. South African government bonds constitute 0,32 per cent of the WGBI.

Figure 3.1 shows that AEs, in particular the U.S by lowering policy interest rates to almost zero and conducting various round of QE injected liquidity into global markets. The excess global liquidity was channeled to EMEs largely due the positive interest rate differentials. In the context of the question posed in this chapter, the repo rate represents a monetary policy shock whereas different categories of capital inflows represent capital inflow shocks. To contextualize the search for yield to the South African context Figure 3.3 shows the relationship between the domestic and US policy and long-term rates. First, Figure 3.3(a) shows that the South African repo rate positively related to long-term bond yields. Based on the R-square in Figure 3.3(b), a one percent changes in the repo rate results in a 47 basis points change in long-term yields.

In addition, South African and U.S long-term bond yields are positively related in Figure 3.3(c). A one percent change in U.S long-term rates results in a 48 basis points change in domestic long-term yields. In turn, changes in the Rand-US dollar exchange rate are positively related to changes in long-term bond yields as shown in Figure 3.3(e). However, the R-square in Figure 3.3(f) suggests that the strength of the relationship is not that strong and other factors explain the changes in the Rand-US dollar exchange rate.

Figure 3.3 South African and U.S. bond yields



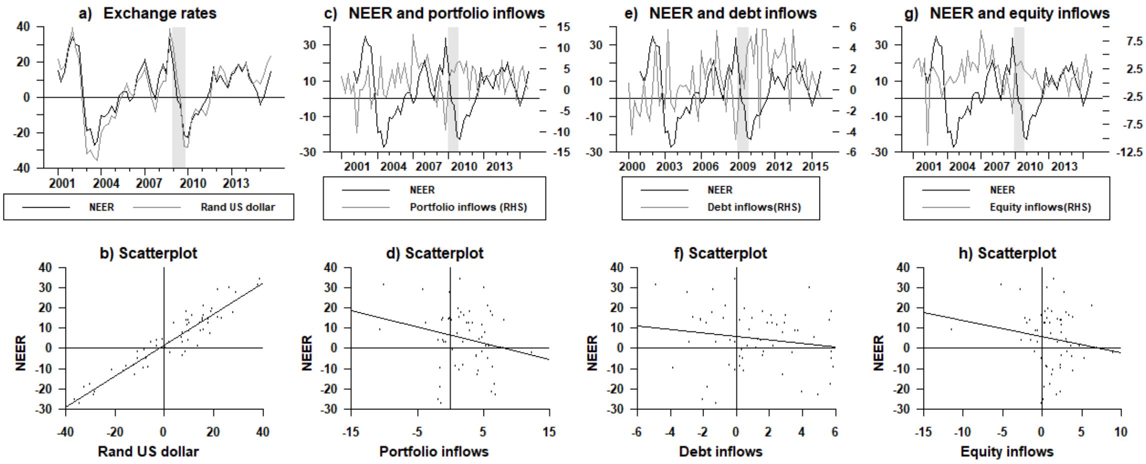
Source: South African Reserve Bank and author's calculations

3.2.2 What is the relationship between different categories of capital inflows and the nominal exchange rates?

Figure 3.1 showed that the transmission of global liquidity also occurs via the exchange rate channel. As capital inflows surge into EMEs, the exchange rates tend to appreciate resulting in the loss of competitiveness. Figure 3.4 shows the relationship between different categories of portfolio inflows, the Rand-US dollar exchange rate and the nominal effective exchange rate (NEER). First, we show the relationship between the Rand-US dollar exchange rate and the NEER in Figure 3.4(a). The NEER and the Rand-US dollar exchange rate are positively related in Figure 3.4(b). We show this stylized relationship because in the empirical estimations section we estimate different models that either use the NEER and the Rand-US dollar exchange rate as the exchange rate measure to compare the impact of monetary and capital inflow shocks.

Figure 3.4 (c) to (f) shows that there is a negative relationship between capital inflows and the Rand-US dollar exchange rate. The bilateral relationships between the NEER and the different categories of capital flows (debt and equity) show a negative relationship between.[16]

Figure 3.4 NEER, Rand US dollar and portfolio, equity, and debt inflows



Source: South African Reserve Bank and author's calculations

The implication is that an increase (decrease) results in an appreciation (depreciation) in the exchange rate. However, the negative relationship is much stronger in relation to debt inflows and bond yields compared to other categories.

So far, the stylized relationships that contextualize the channels of transmission shown in Figure 3.1 indicate that both monetary policy and capital inflow shocks have an impact on long-term interest rates and the exchange rate. However, the impact and the degree of the persistence of these different shocks will be determined empirically in the next sections.

3.2.3 Domestic imbalances and capital flows

The sizes of the current account, budget deficits and the reliance of the bulk of the required financing on capital flows is usually used as a benchmark to assess the degree of vulnerability of countries to sudden large capital outflows and sudden stops. This means that a greater reliance on foreign financing makes the country more vulnerable. Largely due to globalization, financial flows play a much more important role in explaining movements in the current account, the exchange rates and other asset prices. As a result, changes in investor risk perceptions and large and sudden

[16] The relationships are not presented in the chapter but can be availed to the reader upon request. See Figure A3.1 in the appendix for the evolution of portfolio, debt, and equity flows. Figure A3.2 shows the relationship between capital inflows and ten-year bond yields. On the other hand, Figure A3.4 shows the relationship between capital inflows and the NEER.

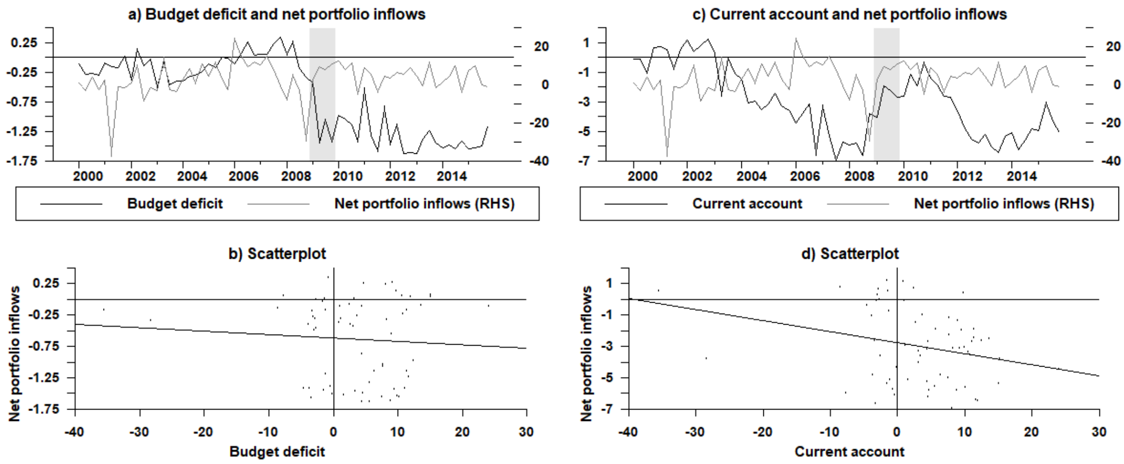
capital outflows can result in challenges in financing the current account deficit.

Furthermore, the associated exchange rate effects imply the valuation of any foreign exchange borrowing and investments (Forbes, 2016). After the financial global crisis concerns surrounding the current account balance emphasize its role as a potential conduit for the transmission of external shocks or as a carrier of financial vulnerability. Belkar et al. (2007) and Obstfeld (2012) state that the thrust of the argument is that large current account and fiscal deficits can be a symptom that deeper financial threats are gathering.[17] Figure 3.5 shows that the relationship between the budget deficit, current account and net capital flows is negative.

This implies that as the two deficits widen, the larger the need for foreign capital to finance the shortfall. The presentation of the bilateral relationships in Figure 3.5 is by no means a test for the twin-deficits hypothesis i.e. that government budget deficits cause current account deficits. However, we note that the trends displayed in Figure 3.5 indeed show that the budget deficit and the current account more than often move in different directions. This implies that not all the movements in the current account and the direction of capital flows are explained by the budget deficit as shown in Figure A3.3 in the appendix. However, the stylized facts presented in Figure 3.5 are simple bilateral linear relationships and convey extremely limited information about the risks, vulnerability and macro-economic adjustments posed by high reliance on funding via foreign capital inflows. Hence, we empirically explore the impact large and sudden capital outflow on the macro-economy.

[17] Literature shows that large external imbalances can also signal elevated macroeconomic and financial stresses, for example, credit and asset price booms; and risk-taking.

Figure 3.5 Fiscal and current account deficits



Source: South African Reserve Bank and author's calculations

3.3 Literature review

The debate on the impact of global liquidity and capital flows on exchange rates, asset prices and external imbalances are basically rooted on several views and hypothesis. Firstly, low private and public savings in several countries (i.e. the so-called deficit countries) is seen as the main driver of capital flows and external imbalances (Bems et al., (2013). This view asserts that central banks, in particular the US Fed kept interest rates exceptionally low in the first half of the 2000s. In turn, this resulted in lower borrowing costs, encouraged a credit boom characterized by excessive risk-taking behavior and asset prices growth, in particular house prices, Sa and Wieladek, (2010).

The second view raises the role of surplus countries. This argument emphasizes the contribution of the *"saving glut"* in Asia and oil-exporting countries, (Bernanke, 2005). The thrust of the argument is that the lack of financial assets and incomplete asset markets in surplus EMEs is a key determinant of the direction of capital flows. This view asserts that global imbalances resulted in increased liquidity and exerted downward pressure on long-term real interest rates. For example, Gourinchas and Rey (2007) show that in such cases, capital flows are therefore an outcome of excess of saving over investment in surplus EMEs. The current account surpluses in EMEs contributed to the flow of capital and eased financial conditions in deficit countries. This means that current global liquidity, capital flows and current account deficits reflect underlying macroeconomic imbalances, such as monetary policy, low productivity growth, excessive consumption or investment, miss-priced asset prices and unsustainable fiscal deficits (Forbes, 2016).

3.3.1 Monetary policy, capital flows and the macro-economy

The relative importance of the impact of monetary policy and capital flows on asset prices, rapid credit growth and the macro-economy has been extensively explored, with studies arriving at different conclusion on the persistence of these shocks. The distinction of the relative contributions of monetary and capital inflow shocks is particularly important given their impact on the global financial cycle (i.e. the booms and busts in equity prices, commodity prices and house prices) on the current account and economic activity.

Sa and Wieladek (2010 and 2011) use a sign restriction approach to empirically separate the relative contributions of these two factors to the US housing market. They find that the effects of a capital inflows shock on US house prices and residential investment is about twice as large and substantially more persistent relative to that of a monetary policy shock. They conclude that capital inflows to the US largely driven by an increase in foreign savings played a much bigger and persistent role in generating the increase in house prices than monetary policy loosening.

Fratzscher et al. (2013), find that equity and house price shocks are a major determinant of the US current account. This contrasts with the insignificant role played by the real exchange rate. They conclude that this evidence suggests that the exchange rate adjustments may not be sufficient in correcting the large external imbalances given the significant role of global asset prices. Bruno and Shin (2014) show that asset price growth also plays an important role in easing financial and credit conditions for firms and allows them to finance investment opportunities. Kollmann et al (2014) show that asset bubbles and the loosening of credit constraints for households and firms had a more pronounced role in Spain pre-global financial crisis. However, post financial crisis, a fall in real houses and residential investment facilitated the deleveraging by the household sector. On the other hand, the tightening of firm credit constraints during the Spanish sovereign debt crisis was offset by QE policy interventions by the ECB. As a result, lending via QE policy interventions by the ECB substituted foreign private lending.

Justiniano et al (2015) find that the housing boom that preceded the global financial crisis was the result of an increase in credit supply driven by looser lending constraints in the mortgage market. The loosening in the credit constraints was transmitted via the unprecedented increase in house prices and a decline in mortgage rates that supported the increase in household debt and the housing boom. Bruno and Shin (2014) show that the leverage cycle of global banks is a key driver of international banking-sector flows and domestic private credit. Jorda et al. (2011) show that the relationship between credit and the current account has become more significant in recent years. Mendoza and Terrones (2008) find that credit booms are typically associated with net capital inflows. Similarly, Calderon and Kubota (2012) show that surges in gross debt inflows are a good predictor of credit booms.

Kobayashi and Yoshino (2011) establish that the prolonged low level of interest rates in advanced economies played a meaningful role in the direction of capital flows to emerging market economies in search for higher yield. Whereas Ju and Wei (2006) find that the limited universe of financial assets in which EMEs can invest in was a significant factor contributing to the global imbalances in the lead up to the 2007 global financial crisis. Kim (2001) finds that, a contractionary (tight) monetary policy shock increases capital inflow into the South Korean bond market and this is the key channel through which the domestic exchange rate appreciates. However, the effects of the contractionary monetary policy are neutralized by the withdrawal of domestic investors in the equities market resulting in a decline in capital inflows.

Habib and Stracca (2013) emphasize the role of shocks to global risk and idiosyncratic shocks on the direction of cross boarder capital flows. They find evidence of systemic portfolio outflows associated with shocks to global and idiosyncratic risks. Similarly, Forbes and Warnock (2011) show that global factors, in particular global risk is the most important determinant of capital flow surges, sudden stops, capital flight and capital flow retrenchments. Cowan et al. (2007) show that contagion through trade and bilateral banking systems exposures also play a key role in determining sudden stops and capital flow retrenchments.

Recent literature also shows that the impact of capital inflow shocks also depends on the composition (category) of the inflows. For instance, Igan and Zhibo (2015) establish that non-FDI capital inflows tend to result in an increase in credit growth and the likelihood of credit booms in both household and corporate sectors. In addition, both demand and supply side factors play a role. Davis (2015) finds that debt inflows which consists of either bank loans or portfolio debt results in some increases in output, inflation, asset prices, credit growth and exchange rate appreciation. These effects contrast with those exerted by shocks to equity inflows.

Lane and McQuade (2013) show that current account balance is a misleading indicator in understanding the relation between international capital flows and domestic credit growth. Domestic credit growth is strongly related to net debt inflows as opposed to net equity inflows in European countries. Pre-financial crisis, there was the divergence between domestic deposit growth and credit growth. Meaning that, credit growth was financed by short-term international borrowing as opposed to domestic deposit growth. They conclude that this implies that there is a strong international dimension to the determination of national credit growth rates.

3.3.2 What about capital outflows, sudden stops, and their impact on the macro-economy?

Sudden stops in capital inflows have been a common occurrence in many EMEs and are often associated with not only exchange rate and financial crisis but severe declines in output, consumption growth and investment. The decline in output tends to be accompanied by an increase in inflation and a decline in real wages. Calvo et al (2003) find that the severity of the impact of sudden stop episodes often makes sustainable fiscal and other external positions unsustainable. Hence, the occurrence of sudden stop episodes is an ever-present risk in policy evaluations, particularly in countries with large and persistent current account deficits. During sudden stop episodes, net capital flows are drastically curtailed resulting in the depreciation in the real exchange rate and a decline in output. The domestic economy adjusts through a combination of expenditure reduction and expenditure switching.

However, empirical findings differ on the impact of sudden stops. For instance, Mendoza (2006) finds that output growth, consumption growth and investment growth decline due to a sudden stop. But Kehoe and Ruhl (2009) find that the decline in output is not necessarily on account of sudden stops per se. They argue that the presence of financial frictions via collateral constraints and working capital loans exert far more negative effects and thus result in a decline in output. Similarly, Calvo et al (2006a) show that liability dollarization, in particular large financial currency mismatches and the fact that Argentina was a relatively closed economy played a crucial role in magnifying the effect of the sudden stop in capital flows thus creating the fiscal and financial crisis. This strand of literature emphasizes the role of sudden stops as the tightening of financial constraints when debt-deflation lowers the value of the marginal product of factors of production.

Mendoza (2006) shows that the debt-deflation mechanism not only amplifies the impact of sudden stop episodes by lead to asymmetry and persistence of the responses of macroeconomic aggregates to shocks. When credit constraints are binding, they set in motion Irving Fisher's (1933) debt-deflation mechanism which induces nonlinear feedback between access to credit, prices and the allocation of goods and assets on which debt is leveraged. Akinci and Chahrour (2014) find key in the feedback loop is leverage. This is because sudden stops are almost always preceded by a substantial build-up of leverage during the period of optimism causes. As a result, the leverage constraint tends to bind more strongly, leading to a debt-deflation spiral that is strongly non-linear.

In addition, Bachmann and Leist (2013) using the Markov switching VAR approach find that the impact of sudden stops exerts asymmetric effects. When the economy switches from the normal to the sudden stop regime, the effects result in a significant decline in output.

For polices to mitigate the impact of a potential tightening of financial constraint due to capital inflow reversals and sudden stops, Cabellero and Panageas (2007) show that a combination of reserves accumulation and hedging strategies can offer insurance and welfare gains to EMEs. This implies that precautionary saving can limit the impact of sudden-stops but they remain a positive-probability event in the long-run (Mendoza, 2006).

3.4 Methodology: sign restriction approach

In this chapter we use the pure and penalty function approaches to sign restriction. The sign restriction approach requires imposing a set of economically plausible restrictions and the leaves the question of interest unrestricted. The penalty function heavily penalizes choices that violate the imposed signs and constraints (Uhlig, 2005). The approach minimizes a criterion function which penalizes impulse responses violating the sign restrictions, with respect to the identifying weights. This contrasts with the pure sign restriction approach where all the impulse responses that obey the imposed signs are considered equally likely. This means that the penalty function approach uses an additional criterion to select the best of all impulse vectors. In addition, the penalty function approach can be used to sharpen the impulse responses in cases where the error bands are relatively wide for some variables (Rafiq and Mallick, 2008).

The sign restriction approach starts with a reduced form VAR in Equation 3.1

$$Y_t = B_{(1)}\, Y_{t-1} + B_{(2)} Y_{t-2} + \cdots + B_{(l)} Y_{t-i} + u_t, t = 1, \ldots T \quad (3.1)$$

Where, Y_t is a $m \times 1$ vector of data at time $t = 1 - l, \ldots., T, B_{(i)}$ are coefficient matrices of size $m \times m$ and u_t is a $(k\ x\ 1)$ vector of the one-step ahead prediction errors with $E\ [u_t\ ] = 0$ and $(k\ x\ k)$ symmetric covariance matrix $E[u_t u_t'] = \Sigma_u = [\sigma_{i\,j}]$. If there are m fundamental innovations which are mutually independent and normalized to be of variance 1 and written as a vector v of size $m \times$ 1with $E[vv'] = I_m$. We need a matrix A such that $u_t = Av_{t.}$ The $j-th$ column of A represents the immediate impact on all variables of the $j-th$ fundamental innovation, one standard error size. The identification problem translates the correlated prediction errors u_t into orthogonal structural shocks e_t. The assumption is that the structural shocks are zero-mean random variables with the covariance matrix $E\ [e_t e_t'] = I_k$. The relationship between prediction errors and structural shocks is given by $u_t\ Ae_t$, where the $(k\ x\ k)$ matrix A provides the factorization of the error covariance matrix $AA' = \Sigma_u$. The restrictions on A emerges from the covariance structure in Equation 3.2

$$\Sigma = E[u_t\ u_t']\ A'\ AA' \qquad (3.2)$$

There are $m\ (m-1)/2$ degrees of freedom in specifying A and restrictions are needed to achieve identification. In the case of identifying a single shock, this means that we need to find a single column $a \in \mathbb{R}^m$ of the matric A in Equation (3.2) which satisfies some restrictions that identify that particular shock. The vector $a\ \in \mathbb{R}^m$ is an impulse vector if there is some matrix A, so that $AA' = \Sigma$ and a is a column of A. If $x_i, i = 1, \ldots., m$ be the eigenvectors of $\sum$ normalized to form an orthonomal basis of $\mathbb{R}^m$. Let $\lambda_i, i = 1, \ldots., m$ be the corresponding eigenvalues. Then a is an impulse vector if and only if there are coefficients $\alpha_i, i = 1, \ldots, m$ with $\sum_{i=1}^m \alpha_i^2 = 1$ so that

$$a = \sum_{i=0}^{n} \left(\alpha_i \sqrt{\lambda_i}\right)\ x_1 \qquad (3.3)$$

Where the $v_t^{(a)} = b'u_t$ is the scale of the shock at time t in the direction of the impulse vector $a$and $v_t^{(a)}a$ is the part of u_t which is attributable to that impulse vector. These tools can perform variance decompositions or counterfactual scenarios. The identification of the impulse vector corresponding to shocks of interest can be done via the pure sign restriction approach and the penalty function approach.

3.4.1 Pure sign restriction approach

The pure sign restriction approach imposes the sign restrictions on the impulse responses. Unlike the recursive identification approach, the sign-restrictions approach does not require the number of shocks to be equal to the number of variables. Furthermore, the sign restriction approach does not impose any linear restrictions on the contemporaneous relation between reduced-form and structural disturbances (Caldara and Kamps, 2010). Rather, Mountford and Uhlig (2009) impose signs directly on the impulse responses.

The pure sign restriction approach chooses a horizon $K\ \geq 0$, takes a joint draw from both the posterior for the VAR parameters as well as a uniform distribution over the $(m-1)$ dimensional sphere $(\alpha_1, \ldots., \alpha_{m-1}), \sum\alpha_i^2 = 1$. The impulse vector in Equation (3.3) is constructed and the impulse responses $r_{k,j}$ at horizon $k = 0, \ldots, K$ for the variables j in the VAR. If the all the impulse responses satisfy the sign restrictions, all the draws are kept. If not, they are discarded. This process is repeated sufficiently often based on the draws kept. The error bands are then calculated based on the draws that are kept. The orderings of the variables do not alter the results as the results are independent of the chosen decomposition of $\sum$, Fratzcher et al. (2013).

3.4.2 The penalty function approach to sign-restriction

The penalty function approach is an alternative to the pure sign restriction approach used to select one particular solution out of the set of pure sign restriction solutions. The penalty function approach is used in literature to numerically solve constrained nonlinear optimization problems for which closed form analytical solutions may be hard to obtain or may not exist at all (Caldara and Kamps, 2010). The difference is that the penalty function approach replaces the sign restrictions with a continuous penalty function that permits but (heavily) penalizes choices that violate the imposed signs. This means that the constrained problem is replaced with an unconstrained one.

Caldara and Kamps (2010) show that in essence, the penalty function criterion solves a constrained optimization problem. The penalty function procedure finds the impulse vector that maximizes the forecast error variance of some variables in the VAR, subject to the imposed sign restrictions. In addition, Mountford and Uhlig (2009) indicate that that imposing sign restriction on the impulse responses does not produce sharp inference. Hence, it may be necessary to use the penalty function approach to sharpen the impulse responses.

The penalty function approach chooses a horizon $K \geq 0$ and the penalty function is defined as in Equation 3.4

$$f(x) = \begin{cases} x & if\ x \leq 0 \\ 100 * x & if\ x \geq 0 \end{cases}, \qquad (3.4)$$

The penalty function penalizes positive responses in linear proportion and rewards negative responses in linear proportion but at a slope 100 times smaller than the slope for penalties on the positive. This means that the penalty on the coefficients of the wrong sign is 100 times larger than that on the correct sign. Furthermore, Uhlig (2005) states that the penalty function approach leaves the reduced form VAR untouched and prefers large responses that are far away from the imposed sign restrictions. As a result, it will identify a unique impulse vector conforming to the imposed sign restrictions for any given VAR.

3.4.3 The Kilian and Vigfusson approach for asymmetric transmissions of shocks

We use the Kilian and Vigfusson (2011) approach to test for the asymmetric transmission of capital outflow shocks. The Kilian and Vigfusson (2011) approach use an impulse-response technique based on the Wald test to differentiate between shocks of different magnitudes. The central point of the Kilian and Vigfusson approach is that the slope-based test focuses on the wrong null hypothesis. The authors argue that testing the null hypothesis of symmetric response functions requires a test based on impulse responses rather than slopes. Hence, the impulse-response based test proposed in Kilian and Vigfusson (2011) is superior to traditional tests as it tests the null hypothesis of interest to economists.

In addition, Kilian and Vigfusson (2011) demonstrate that the degree of asymmetry of the response functions is in general highly dependent on the magnitude of the unexpected change in the variable of interest. Slope-based tests do not distinguish between shocks of different magnitude hence they are inherently unsuitable for evaluating the degree of asymmetry of the response functions. The Kilian and Vigfusson (2011) approach analyses non-linear impulse response functions which are calculated by simulating the effects of different magnitudes of shocks at time t. The Kilian and Vigfusson (2009) approach tests the null hypothesis (H_0) that assumes a symmetric response functions to a positive shock should be equal to the vector of impulse responses to a negative shock. In addition, the Kilian and Vigfusson (2009) approach algorithm computes the various impulse response functions by Monte Carlo integration.

We use a simplified version of the Kilian and Vigfusson (2011) methodology to compute non-linear impulse response functions due to a sudden large outflow of sudden stop of capital. Computing non-linear impulse responses based on the Kilian and Vigfusson (2011) involves two steps.

The first step estimates the shocks and the second step utilizes these estimated shocks to compute non-linear impulse responses. The first step estimates capital outflow shock and the second step that uses these shocks to estimate the non-linear responses based on Equation 3.5

$$\Delta Y_t = \alpha + \sum_{p=0}^{M} \beta_i^{+} \tau_{t-p}^{+} + \sum_{p=0}^{M} \beta_n^{-} \tau_{t-n}^{-} + \sum_{l=0}^{L} \beta_l \, \Delta Y_{t-l} + \varepsilon_t \quad (3.5)$$

The history of the coefficients Ω_{t-1}^{i} and residuals ε_t from Equation 3.5 consists of Mconsecutive values of τ_t^{+} and τ_t^{-} from the actual data of the variables of interest. The values are drawn from a sequence of H negative and positive shocks and the residuals ε_t. Using the history of the coefficients Ω_{t-1}^{i} and the sequence of shocks to simulate Hvalues of Y_t shocks for the time path $y_{t+j}^{ns}, j = 1, 2, , \ldots\ldots, H$. This step is repeated by choosing the shock of interest, so that for example, if the shock is to be given a negative capital outflow shock, then τ_t^{-} will be set to equal δ. The values of all τ_{t+j}^{-} for $j = 2, 3, \ldots., H$ present a new sequence of shocks for time path for Y_t represented by $y_{t+j}^{s}, j = 2,3, \ldots\ldots, H$. The difference of the two-time paths is then generated, and these steps are repeated Ntimes to collect N such series. Then the average resulting series to obtain the impulse response of y_t to a shock size δ conditional on history Ω_{t-1}^{i} will be represented as in Equation 3.6

$$IRF(h, \delta, \Omega_{t-1}^{i}) = \frac{\sum_{k=1}^{N} Y_t^{s}(h,\delta,\Omega_{t-1}^{i},k) - y_t^{ns}(h,\delta,\Omega_{t-1}^{i},k)}{N} \quad (3.6)$$

Where, $y_t^{ns}(h, \delta, \Omega_{t-1}^{i}, k)$ represents the computed value of y_t at the h^{th} horizon and $y_s^{t}(h, \delta, \Omega_{t-1}^{i}, k)$ is the estimated value of $y_t$at $h^{th}, h = 1,2, \ldots., H$ horizon after a shock size δ for history Ω_{t-1}^{i}. The final average $IRF(h, \delta, \Omega_{t-1}^{i})$ over all histories to obtain the non-linear impulse response of $y_t$to a shock of δ is represented by Equation 3.6

$$IRF(h, \delta) = \int IRF\left(h, \delta, \Omega^{i}\right) \mathrm{d}\Omega^{i} \quad (3.7)$$

3.5 Data

The data used in the study spans the period 2000Q1 to 2015Q4 sourced from the South African Reserve Bank database. We use the sample period that starts in 2000Q1 as it coincides with the implementation of the inflation targeting monetary policy framework. We use portfolio (portfolio), debt and equity inflows and portfolio outflows as ratios of GDP, credit growth, GDP growth, repo rate (short rate), ten-year government bond yield (long rate), R/US dollar exchange rate annual changes (R/US$), Alsi share price index (Jse), Absa house price (HP) annual growth rate, Rand commodity prices including gold (Comm), real investment and the current account as a ratio of GDP (CA). All growth rates are at an annual rate.

3.5.1 The difference between using gross capital flows versus net capital flows in defining capital flow episodes

Literature shows that there is a difference between using gross capital flows versus net capital flows in defining capital flow episodes in conducting empirical estimations. Forbes and Warnock (2011) show that the definition of the data used matters. For instance, there is a short coming of using net capital flows to define capital flow episodes as the size and volatility of gross flows can increase while net capital flows have become more stable. In addition, capital flow waves can be classified according to sudden stops, capital inflow surges, retrenchment, and capital flight. Forbes and Warnock (2011) define (i) the sudden stops as those that occur when foreign capital inflows suddenly slow or stop, (ii) capital inflow surges are episodes during which foreign capital inflows increase rapidly, (iii) capital inflow retrenchment episodes occur when domestic investors liquidate their foreign investment positions and (iv) whereas, capital flight episodes occur when domestic investors send large amounts of capital abroad. As a result, in this chapter we do not use net capital inflow and outflow categories. We use gross capital flow data as ratios of GDP.

3.5.2 Unit root tests

Rafiq and Mallick (2008) show that the sign restriction approach is robust to the presence of non-stationarity in the data. However, we conduct the Augmented Dickey–Fuller (ADF) test and Kwiatkowski, Phillips-Perron (PP), and Phillips, Schmidt and Shin (KPSS, 1992) test. The ADF and the PP tests the null hypothesis that variables have unit roots. The KPSS tests the null hypothesis that variables are stationary. Table 3.1 shows the unit root test results. The tests suggest that the variables are stationary.

Table 3. 1 Unit root tests for global risk measures of global liquidity

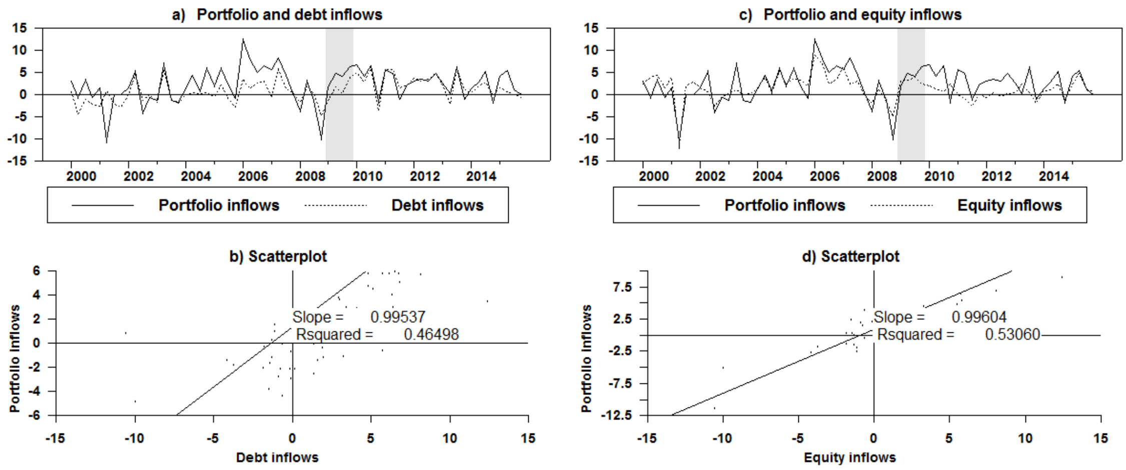
Variable	KPPS	ADF	PP
Portfolio	-6.95797**	-5.653*	0.196366*
Equity	-6.55163**	-4.684*	0.123815*
Debt	-8.16711**	-7.556*	0.434767*
R/US$	-3.72285*	-3.502*	0.104608*
Short rate	-2.38146*	-3.389*	0.535019*
Long rate	-4.10590*	-3.602*	0.560504*
CA	-4.10590*	-3.263*	0.739000*
Comm.	-3.05133*	-5.217*	0.112599*
GDP	-2.50446*	-3.676*	0.168146*
HP	-2.74125*	-3.536*	0.432985*
JSE	-5.88232**	-4.998*	0.171202*
Investment	-2.21206*	-3.877*	0.687300*
Credit	-2.79813*	-3.460*	0.162480*

Note: Significance at 5 per cent **, at 10 per cent*. Source: Author's calculations

3.5.3 Stylized relationships

In the empirical estimations we use three measures of capital flows variables namely, portfolio, debt, and equity flows. Debt and equity flows are separate categories of the portfolio flows and are driven by different motives hence they are expected to exert different effects on macroeconomic variables. Forbes and Warnock (2011) show that debt inflows are more responsive to external factors compared to equity flows which tend to place greater emphasis on idiosyncratic (country specific). Lane et al (2013) shows that large companies and banks can raise international funding through bond issuance and intra bank lending/borrowing. Figure 3.6 shows that debt and equity flows are positively related to portfolio inflows, but equity inflows are more responsive to portfolio inflows as indicated by the R-squares in (b) and (d).

Figure 3.6 Relationships between capital flow categories

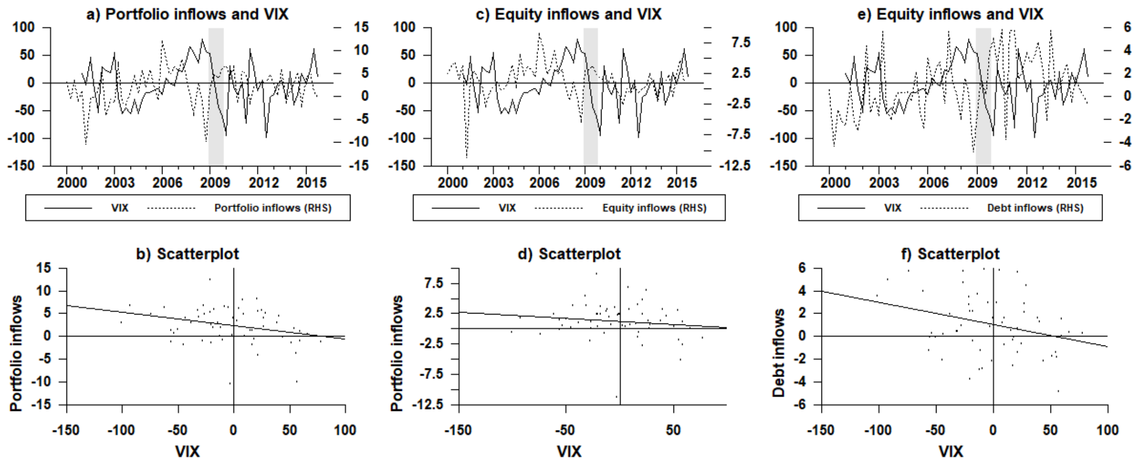


Source: South African Reserve Bank and author's calculations

In addition, Figure 3.7 shows that all the categories of portfolio flows are sensitive and negatively related to global investor risk perceptions as measured by VIX. The implication is that low (high) levels of global investor risk perceptions are associated with high (low) levels of capital inflows into South Africa. However, equity inflows are much more sensitive to VIX compared to debt inflows.

Favilukis et al (2012) established inter-linkages between house prices and capital flows and the current account. The study establishes domestic credit growth as a key mechanism that links capital flows and house prices. This implies the existence of direct and indirect channels through which capital flows affect credit supply factors to influence house prices. Figure 3.8 shows that credit and house prices are positively related. In addition, equity inflows are positively related to credit growth as opposed to debt inflows which are negative. The implication is that equity flows are channelled to the domestic banking sector and the funds are used to support credit growth.

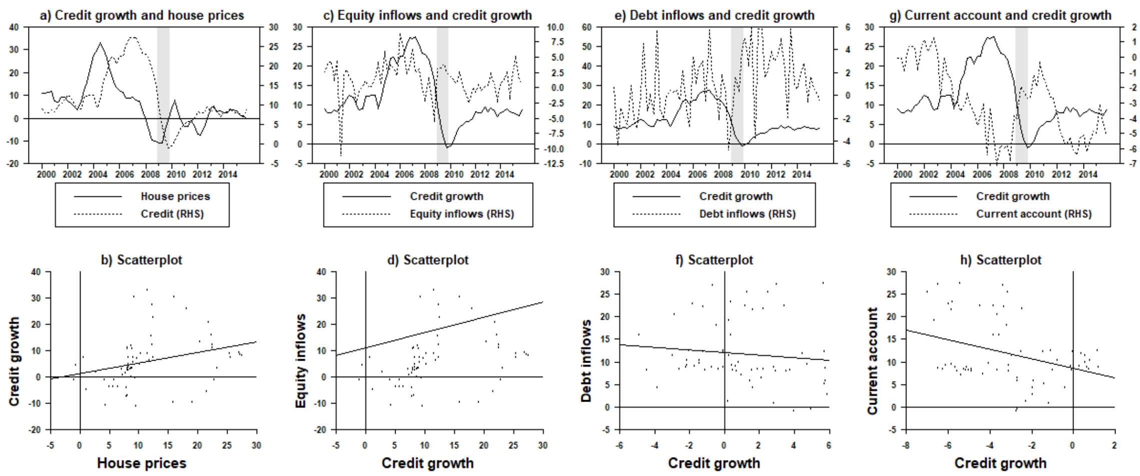
Figure 3.7 Relationship between global risk (VIX) and capital flows



Source: South African Reserve Bank and author's calculations

On the other hand, Figure 3.9 shows that there is a negative relationship between the current account and credit growth. Meaning that as credit growth increases, the current account worsens. What about the preliminary evidence on the relationship between capital flows and house prices and in turn the current account? Literature shows that house price increases result in a decline in private savings but supports consumption expenditure and residential and non-residential investment. Caballero and Panageas (2007) suggest that this theoretical mechanism emphasizes the role of monetary policy, capital flows and asset prices in driving the current account.

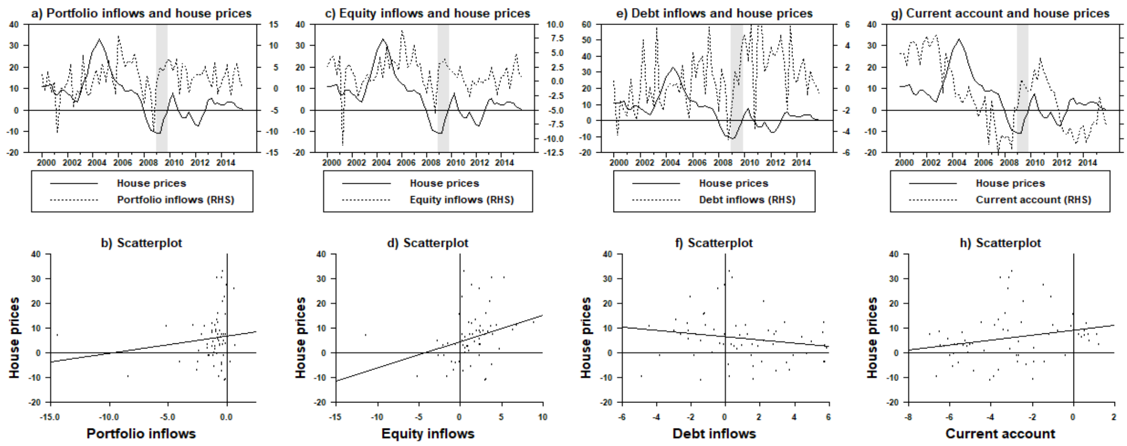
Figure 3.8 Credit, current account, and capital inflows



Source: South African Reserve Bank and author's calculations

Figure 3.9 shows that portfolio and equity inflows are positively related with house prices but negatively so with debt inflows. This is consistent with the relationships established for credit growth. However, contrary to credit growth we find that the relationship between house prices and the current is positive implying that there are idiosyncratic factors within the nexus between capital flows-house prices-credit and the current account that explain the positive association of credit growth and the current account.

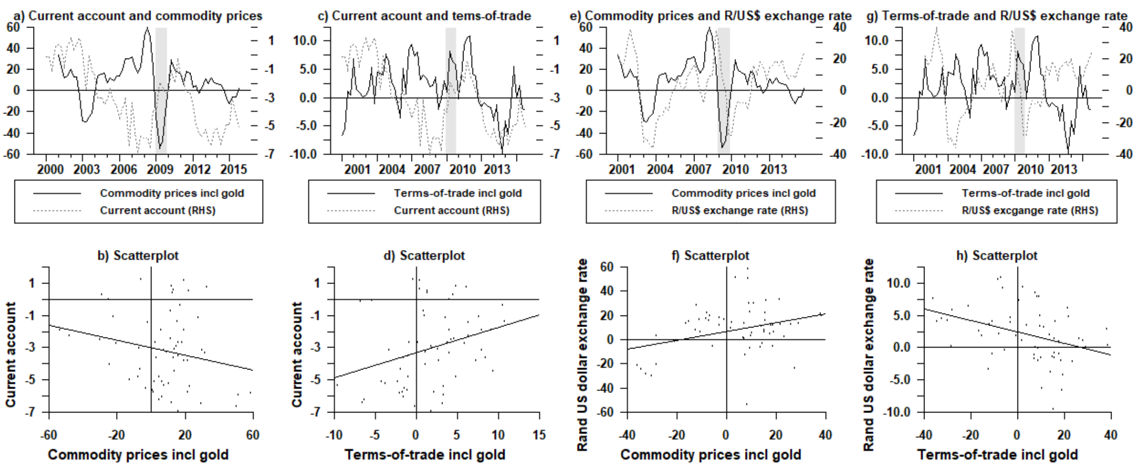
Figure 3.9 House prices, current account, and capital inflows



Source: South African Reserve Bank and author's calculations

The relationship between capital flows and current account would be inadequate if it does not assess the impact on terms-of-trade and commodity prices. Figure 3.10 show that the commodity prices and the terms-of-trade have different relationships with the current account.

Figure 3.10 Current account, commodity prices and terms-of-trade



Source: South African Reserve Bank and author's calculations

Terms-of-trade are defined as the ratio of export prices to import prices. Hence, they represent more than commodity price movements. In addition, Calvo et al. (2004) shows that a drop in net capital inflows can also be due to a positive terms-of-trade shock or a commodity price shocks. The idiosyncratic effects of both factors need to be adequately identified. In turn, terms-of-trade and commodity prices have an impact on asset prices, the exchange rate, and the current account.

3.6 The theoretical validity of the identification scheme

We estimate five models in this chapter and this section discusses the theoretical foundations of the sign restrictions used in each model. In all models, we identify an expansionary (decline in the policy rate) monetary policy shock and a positive capital inflow shock. The capital inflow shock is further identified via positive shocks to portfolio, equity, and debt inflows. However, the impact of a positive capital inflow shock captured by the individual capital inflow categories is estimated in separate models. This means that we estimate three different models where portfolio inflows are replaced with equity inflows and debt inflows to compare the impact of the components of capital inflows on the variables of interest. The short rate represents the policy rate and the long rate is the yield on the long-term.

3.6.1 Identification in the benchmark model

The benchmark model or model one starts with six variables specified as shown in Equation (3.8)

$$Y_t = \{CI, GDP, Credit, ER, SR, LR\} \dots \dots \dots \dots \dots (3.8)$$

Where, CI is either portfolio inflows or equity inflows or debt inflows; GDP is GDP growth, Credit is total credit extended to the private sector; ER is the exchange rate of the Rand to the US dollar; SR is the short-term interest rate proxied by the repo rate and LR is the long-term interest proxied by the ten-year government bond yield. The identifying signs for model one is shown in Table 3.2. An expansionary monetary policy shock is expected to result in a decrease in short-term rates and lead to an increase in GDP growth. In contrast, an expansionary monetary policy shock is expected to have a negative impact on capital inflows largely through the decline in the interest rate differential and the search for yield. The lower interest rate differential is expected to change the direction of foreign capital.

In addition, accommodative monetary policy is expected to have a negative (decline) impact on the capital inflows and result in the depreciation of the exchange rate. In turn, consistent with a simple Mundell-Fleming model with free capital mobility, the inter-temporal optimization and sticky prices in open economy model, the exchange rate is expected to capture the traditional interest rate channel, where monetary policy has an immediate effect on changing the return on assets denominated in different currencies. In a nutshell, a reduction in the policy is expected to lead to capital outflows, a depreciation in the exchange rate and an improvement in the current account balance.[18]

Table 3.2 Identifying sign restrictions: Model one

	Monetary policy shock			Capital flow shock		
	VAR with PI	**VAR with EI**	**VAR with DI**	**VAR with PI**	**VAR with EI**	**VAR with DI**
Capital inflows	-	-	-	+	+	+
GDP	+	+	+	+	+	+
Credit	?	?	?	?	?	?
Exchange rate	?	?	?	-	-	-
Short rate	-	-	-	?	?	?
Long rate	?	?	?	-	-	-

Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

However, changes in the policy rate are expected to impact the entire yield curve via the traditional interest rate channel of monetary policy. We established earlier that the relationship between the repo rate and the ten-year yield on government bonds is positive. Furthermore, the response of the exchange rate and long-term interest rates are left unrestricted under the identification of a monetary policy shock.

On the other hand, a positive capital inflow shock is defined as an unexpected increase in foreigners' demand for South African assets. We showed earlier that the widening of current account deficit and the budget balance were accompanied by an increase in capital inflows. We assume that an increase in capital inflows lowers long-term interest rates and has a positive effect on GDP growth and appreciation in the exchange rate. Sa and Wieladek (2010) indicate that the signs imposed on long-term interest rates and the exchange rate enable the distinction of the monetary policy shock and the capital inflow shock. The short-term rate is left unrestricted under the identification of a capital inflows shock as it is under the control of monetary policy makers. Furthermore, in the identification scheme, the response of credit growth to monetary and capital flow shocks is unrestricted as it is the key variable of interest.

[18] Sa and Wieladek (2010) adopt the same identification scheme of an expansionary monetary policy shock.

3.6.2 The role of monetary policy and capital inflow shocks on asset prices and the housing market

We stated that one of the objectives of this chapter is to quantify the impact and compare the relative importance of monetary policy and capital inflow shocks on the housing market and asset prices. Essentially, the specification of the second model in Equation 3.9 assesses whether the capital inflows shock or the "savings glut" hypothesis has a significant impact on asset prices and the housing market relative to the monetary policy shock.

$$Y_t = \{CI, GDP, Credit, ER, SR, LR, HP, EP\} \ldots \ldots \ldots \ldots \ldots (3.9)$$

Where, CI is either portfolio inflows or equity inflows or debt inflows; GDP is GDP growth, Credit is total credit extended to the private sector; ER is the exchange rate of the Rand to the US dollar; SR is the short-term interest rate proxied by the repo rate; LR is the long-term interest proxied by the ten year government bond yield; HP is real house prices deflated by headline CPI and EP is are real equity prices also deflated by the headline CPI.

The identification of the monetary policy and capital inflow shocks in Equation 3.9 are shown in Table 3.3. The imposed signs for the identification of each shock are like those imposed in model one. The responses of equity prices and house prices are unrestricted as they are the variables of interest in this section. However, the assessment of the impact of monetary policy and capital inflow shocks shown by the specification in Equation 3.2 would be incomplete if we only assessed house prices.

Table 3.3 Identifying sign restrictions: House prices and equity prices

	Monetary policy shock			Capital flow shock		
	VAR with PI	VAR with EI	VAR with DI	VAR with PI	VAR with EI	VAR with DI
Capital inflows	-	-	-	+	+	+
GDP	+	+	+	+	+	+
Credit	?	?	?	?	?	?
Exchange rate	?	?	?	-	-	-
Short rate	-	-	-	?	?	?
Long rate	?	?	?	-	-	-
House prices	?	?	?	?	?	?
Equity prices	?	?	?	?	?	?

Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Studies that analyze the differential roles of monetary policy and capital inflow shock on the housing market include variables that proxy for activity over and above prices. For instance, Taylor (2007) shows that there were signs of a remarkable secular change in the housing cycle, in particular the decline in the volatility of the average size of the fluctuations in residential construction. He attributes the decline in volatility to improved and systematic monetary policy responses to deviations in inflation and GDP growth as captured in the Taylor rule.

Sa and Wieladek (2010) find that that capital flows shocks played a much larger and persistent in increasing house prices and residential investment compared to monetary policy shocks. In addition, they show that variance decompositions due to capital inflows shocks explain 15 per cent of the variation in real house prices compared to 5 per cent by monetary policy shocks. In turn, the counterfactual scenarios suggest that if the U.S Fed had kept policy rates constant or followed the Taylor rule since the end of 1998, house prices might have been 8 per cent and 5.5 per cent lower, respectively by the end of 2007.

To capture activity in the housing market, we adjust the specification in Equation 3.9 and replace equity prices with residential investment as shown in Equation 3.10.

$$Y_t = \{CI, GDP, Credit, ER, SR, LR, HP, Inv\} \ldots \ldots \ldots \ldots \ldots (3.10)$$

Where, Inv residential investment used to proxy housing market activity. The responses of residential investment are left unrestricted in the model in Table 3.4. We rely on other variables to reasonably identify the two shocks on housing market activity.

Table 3.4 Identifying sign restrictions: House prices and residential investment

	Monetary policy shock			Capital flow shock		
	VAR with PI	VAR with EI	VAR with DI	VAR with PI	VAR with EI	VAR with DI
Capital inflows	-	-	-	+	+	+
GDP	+	+	+	+	+	+
Credit	?	?	?	?	?	?
Exchange rate	?	?	?	-	-	-
Short rate	-	-	-	?	?	?
Long rate	?	?	?	-	-	-
House prices	?	?	?	?	?	?
Investment	?	?	?	?	?	?

Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

3.6.3 The role of commodity prices and the current account

To assess for the role of monetary policy and capital inflow shocks on commodity prices and the current account we adjust the specifications in the earlier sections. We replace the housing market variables with commodity prices including gold and the current account as shown in Equation 3.11.

$$Y_t = \{CI, GDP, Credit, ER, SR, LR, CP, CA\} \dots\dots\dots\dots\dots (3.11)$$

After the financial global crisis concerns surrounding the current account balance emphasize its role as a potential conduit for the transmission of external shocks or as a carrier of financial vulnerability. The commodity price changes, and the current account are included to capture the effects of the external balance. Furthermore, commodity prices are expected provide a more accurate price response of the exchange rate pass-through channel as a component of the cost of imported intermediate goods. Sa and Wieladek (2010) indicate that commodity prices serve as a non-policy variable that captures additional information about the future course of inflation.

The identification scheme used in the estimation of this model is shown in Table 3.5. Literature shows that the impact of expansionary monetary policy shock on the current account depends on the parameters of the model.

Table 3.5 Identifying sign restrictions: Commodity prices and the current account

	Monetary policy shock			Capital flow shock		
	VAR with PI	VAR with EI	VAR with DI	VAR with PI	VAR with EI	VAR with DI
Capital inflows	-	-	-	+	+	+
GDP	+	+	+	+	+	+
Credit	?	?	?	?	?	?
Exchange rate	?	?	?	-	-	-
Short rate	-	-	-	?	?	?
Long rate	?	?	?	-	-	-
Comm. prices	?	?	?	?	?	?
CA	?	?	?	?	?	?

Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Comm price is commodity prices and CA is the current account as a ratio of GDP. Source: Author's calculations

In a simple Mundell-Fleming model, the depreciation due to accommodative monetary policy shock is expected to lead to an improvement in the current account if the Marshall-Lerner condition holds, if

(i) if the elasticity of substitution between home and foreign goods is greater than one. Then, the depreciation in the exchange rate shifts world spending towards home goods and improves the current account. However, if the elasticity of substitution between home and foreign goods is smaller than one, the current account does not improve.

(ii) Alternatively, when the effects of pricing to market[19] dominate, depreciation does not change the prices paid by consumers. The elasticity of substitution between home and foreign goods has little effect on the current account. Lane (1999) suggests that the elasticity of inter-temporal substitution plays a bigger role in the adjustment of the current account.

Theoretical and empirical research is mixed as to the response of the current account to monetary and capital inflow shocks. Betts and Devereux (1996) and Lane (1999) show that expansionary monetary shocks generate exchange rate depreciation, the current account initially deteriorates but quickly starts to improve and moves into surplus after about a year. On the other hand, Bems et al (2010), Barnett and Straub (2008) find that the depreciation due to expansionary monetary policy shock results in the deterioration in the current account.

Due to theoretical and empirical uncertainty on the response of the current account, we do not impose any sign restrictions as shown in Table 3.5. The responses of the current account to monetary policy and capital flow shocks are left unrestricted in the estimations. This means that we allow the data and the identification of other variables in the model to determine the response of the current account. The responses can adhere to either the dominance of the elasticity substitution or the pricing to market hypothesis. The responses of commodity prices are also left unrestricted.

3.6.4 Sudden stop shocks

To complete the analysis of the impact of monetary policy and capital inflow shock we consider the effects of the sudden stop of capital inflows or large capital outflows on domestic variables. We assess the impact of sudden stop episodes considering the concerns about such an occurrence and the economic costs associated with it. Sudden stops are usually accompanied by among other events, severe depreciations in exchange rates, drops in asset price growth, output growth, consumption growth and investment growth.

We use sign restrictions to define and identify a sudden stop in Eq. 3.12 as shown in Table 3.6. This approach differs to Calvo et al., (2006b) who defines as sudden stop as a decline in the change of net capital inflows exceeding minus one standard deviation below the prevailing mean. Similarly, we differ with most empirical studies which define a capital flow sudden stop as an episode during

[19] This scenario applies in cases where all prices are set in the currency of the buyer.

which gross capital outflows increase more than gross capital inflows decrease. Alternatively, episodes during which gross capital inflows decrease more than gross capital outflows increase.

$$Y_t = \{CI, GDP, Credit, ER, SR, LR, HP, Inv, CP, CA\} \dots\dots\dots\dots\dots (3.12)$$

Table 3.6 Identifying sign restrictions: Sudden stops

	Capital outflow shock		
	VAR with PI	**VAR with EI**	**VAR with DI**
Capital outflows	-	-	-
GDP	-	-	-
Credit	?	?	?
Exchange rate	+	+	+
Short rate	?	?	?
Long rate	+	+	+
House prices	?	?	?
Investment	?	?	?
Commodity prices	?	?	?
Current account	?	?	?

Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows.

However, Calvo et al. (2004) show that a decline in capital inflows can be due to a positive terms-of-trade or commodity price shock. There is therefore a need to control for terms-of-trade or commodity prices in the VAR estimation. The identification scheme must distinguish between sudden stops and terms-of-trade shocks. Hence, we only include commodity prices in our specification and leave them unconstrained in Table 3.6.

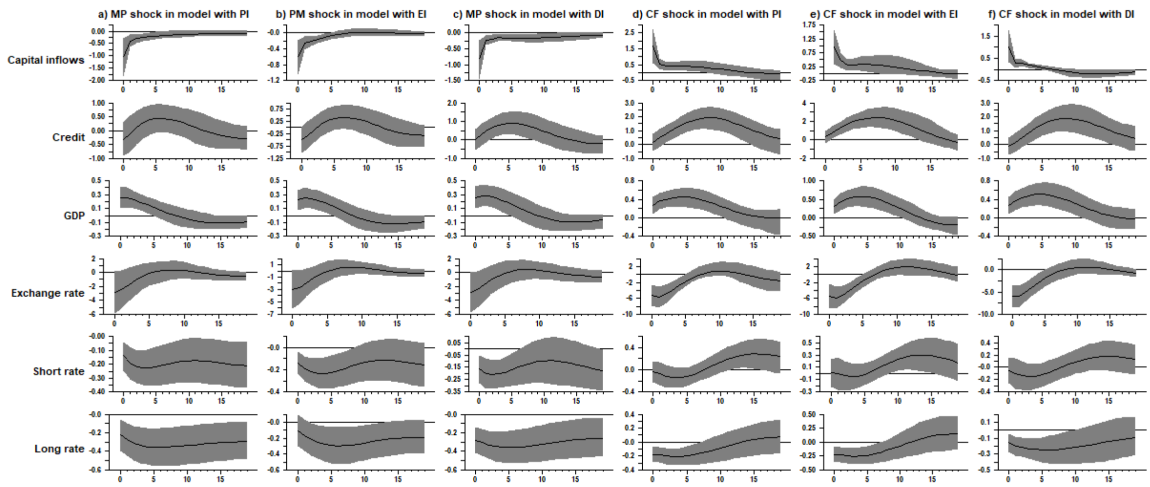
The short and long interest rates and the exchange rate are included to capture aspects related to risk premiums. Mendoza (2008) shows that the risk premium is a potentially important variable to capture the impact of sudden stop shocks on GDP. In all models estimated, we impose that the sign restrictions last for one quarter $(K = 1)$ after the shock. The confidence bands are drawn by taking draws from the posterior distribution and identifying the shocks for each variable. The bands are 16^{th} and 84^{th} percentile for the dynamic responses, which correspond to a one-standard deviation band under normal distribution. All the estimated VAR models have 2 lags chosen by AIC and SBC. The models have no constant or a time trend. In generating these responses 10 000 Monte Carlo draws were produced in which the sign restrictions imposed have been satisfied.

In all the sections discussing the empirical findings we present the impulse responses based on the pure sign restriction approach followed by the penalty function approach. All variables of interest i.e. credit growth, GDP growth, house prices, equity prices, residential investment and commodity prices enter the VAR in growth rates. Portfolio flows (outflows), equity inflows (outflows), debt inflows (outflows) and the current account enter the VAR as ratios to GDP. Short-term and long-term interest rates are in levels.

3.7 Estimation Results for the pure sign restriction approach: model one

The results of the impulse responses to monetary policy and capital flow shocks for the pure sign restriction approach are shown in Figure 3.11. The restricted variables respond according to the signs imposed. Under the expansionary monetary policy shock in columns (a), (b) and (c), the short-term rate declines resulting in a similar decline in capital inflows and long-term rates. This is in line with the assumptions of the portfolio rebalancing approach as the interest rate differentials results in capital outflows or a lower level of capital inflows.

Figure 3.11 Responses to monetary policy and capital-inflows shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

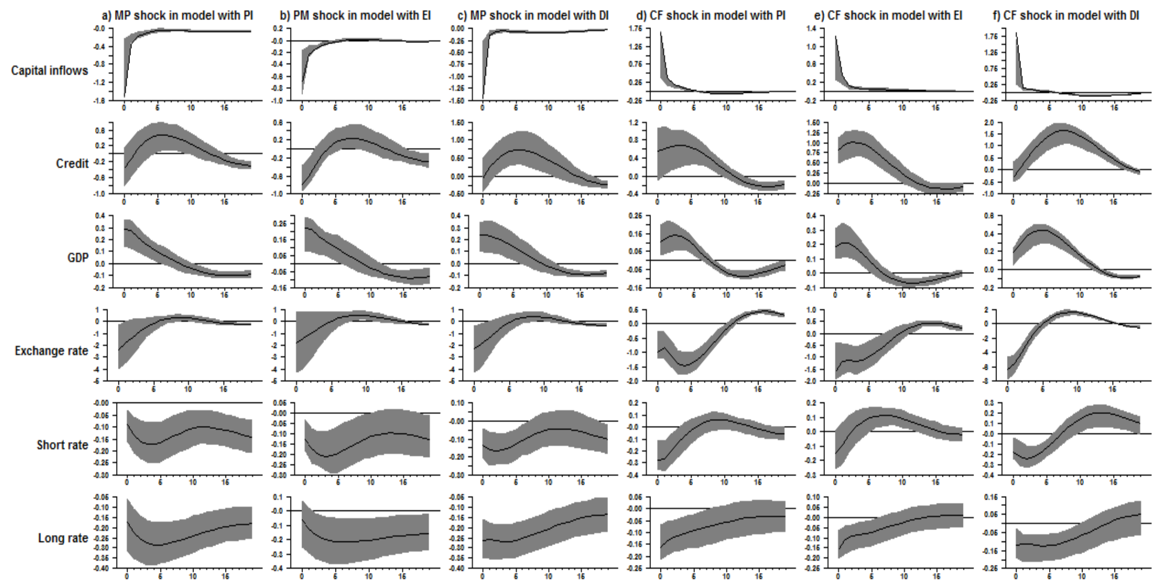
Similarly, GDP growth responds as expected due to accommodative monetary policy. Of interest is the response of credit growth. The responses are positive in line with theoretical prescriptions but the responses on impact and the peak magnitudes differ depending on the capital flow category. It is evident that credit is more responsive to expansionary monetary policy shock in the model with debt inflows compared to portfolio and equity inflows.

In contrast to a positive monetary policy shock, the impact of a positive capital inflows shock in columns (d), (e) and (f) shows that capital inflow increases as expected, long-term interest rates decline, the exchange rate appreciates and GDP growth increases. However, short-term interest rates also decline but by a lesser magnitude and duration compared to that under the monetary policy shock. Short-term interest rates decline in response to all capital flow shocks on impact, but the decline is insignificant compared to that induced by the monetary policy shock. Short-term interest rates decline and reach the peak decline after four quarters and then increase significantly, in the model with portfolio inflows (PI) and equity inflows (EI). Similarly, credit responds much more to a positive capital inflows shock. The magnitudes and duration of the responses are quite different to those under the monetary policy shock. For instance, all credit growth responses are twice in peak magnitude compared to responses under the monetary policy shock. The responses of credit are particularly responsive to portfolio inflows compared to monetary policy shocks. Credit growth increases in response to a monetary policy but the increase is statistically insignificant in a model with portfolio inflows and equity inflows compared to that with debt inflows.

3.7.1 Impulse responses based on the penalty function approach

Figure 3.12 shows the responses of the variables in the model estimated with the penalty function approach to sign restriction.

Figure 3. 12 Responses to capital-inflows shock and monetary policy shock



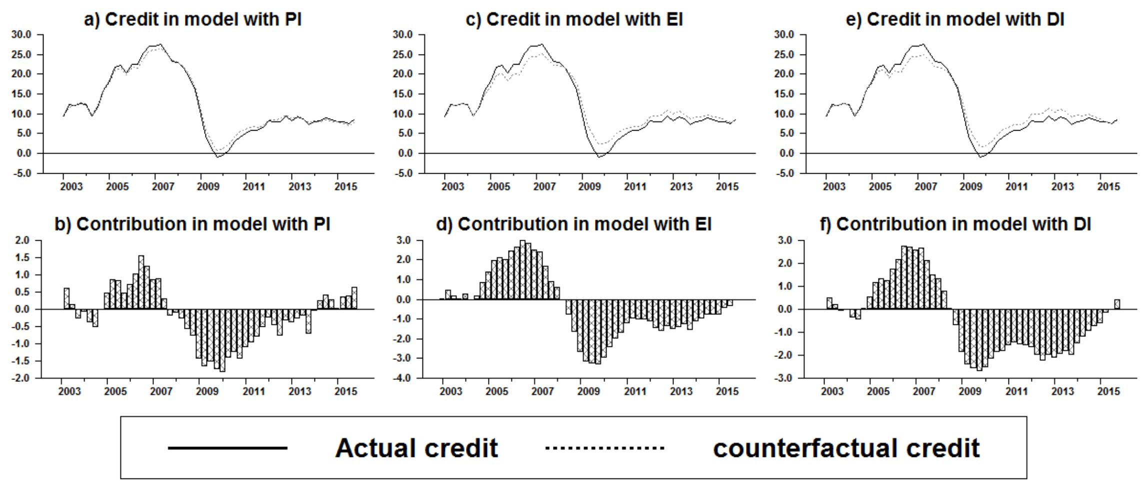
Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The intention of estimating the penalty function alongside the pure sign restriction approach is sharpen the responses of the variables the imposed constraints whilst conducting robustness analysis. The responses of the variables with imposed sign restrictions are as expected although the error bands are clearly narrow compared to those under the pure sign restriction approach. This indicates the sharper responses. The unrestricted variables respond as expected in line with theoretical predictions. The trajectories and magnitudes of credit growth responses to monetary policy and capital inflow shocks are comparable to those under the pure sign restriction approach. This indicates that the model is robust to changes in technique used.

3.7.2 Counterfactual scenarios and contributions of monetary policy and capital inflow shocks between 2003Q1 and 2015Q4

To derive policy implications for the different impact of monetary policy and capital inflow shocks on the unrestricted variables in model one, we show the comparison of the historical contributions of the shocks to credit growth in Figures 3.13 and 3.14, respectively. We show the comparison for the period 2003Q1 to 2015Q4 which encompasses (i) the credit boom during 2005Q1 to 2007Q4 (ii) the recession in 2009Q1 to 2009Q4 and (iii) post financial crisis period characterized by global unconventional monetary policy and historically low domestic interest rates. The intention is to have a long enough sample periods in which we can compare the impact of monetary policy shocks and capital flow shocks.

Figure 3.13 Counterfactuals credit responses and contributions of monetary policy shock

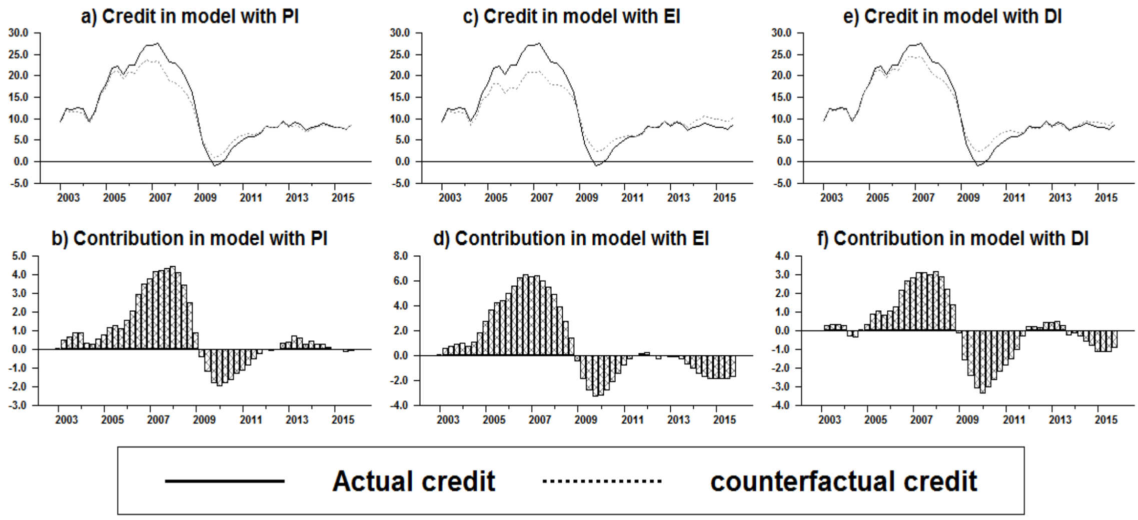


Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

First, Figure 3.13 shows the contributions of monetary policy shocks in the three models with different components of capital flows. It is evident that between 2005Q1 and 2007Q3, monetary policy shocks in models with all the capital inflows categories made positive contributions to credit growth. In addition, the analysis of the contributions of the monetary policy shock differs depending on the capital inflow category used in the estimations. The assessment on portfolio inflows alone in (a) and (b) presents muted contributions of monetary policy shocks during these periods compared to models with equity inflows in (c) and (d) and debt inflows in (e) and (f) in which the contributions are almost double.

However, during the recession and financial crisis monetary policy shocks did make positive contributions to credit growth despite low domestic and global policy rates and massive liquidity injections via QE. On the other hand, the contributions of capital inflow shocks shown in Figure 3.14 are distinctly different to those of monetary policy shocks. Throughout 2003Q1 to 2009Q1, all capital inflow shocks made persistent positive contributions to credit growth that were more than double those of monetary policy shocks. In Figure 3.14 (a) and (b) portfolio inflows shocks contributed more than four per cent to credit growth at peak during 2007 compared to 1.5 per cent due to the monetary policy shock in Figure 3.13 (a) and (b).

Figure 3.14 Counterfactuals credit responses and contributions of capital flow shock



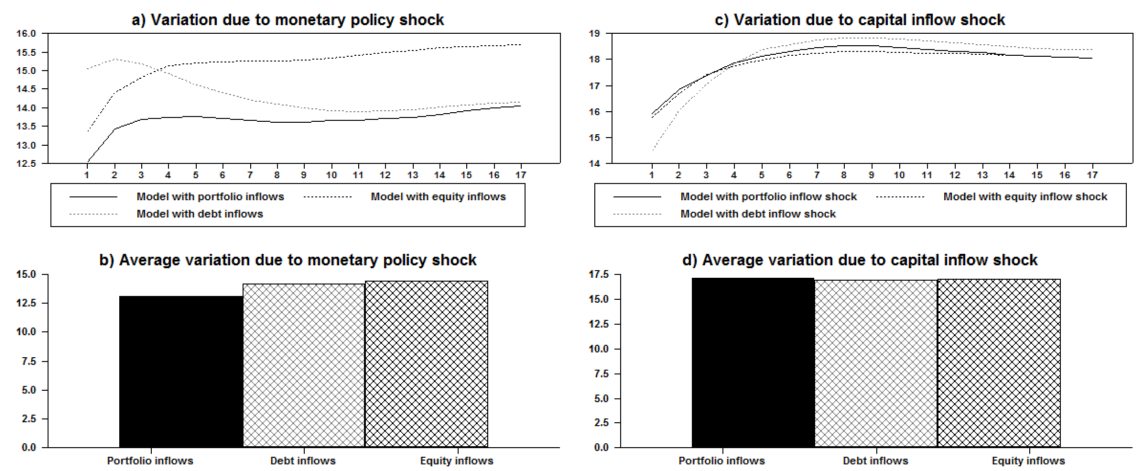
Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Similarly, in a model with equity inflow shocks in Figure 3.14 (c) and (d) the capital inflow shock made persistent positive contributions and peaked at slightly more than six per cent at peak during 2007 compared to just below 3 per cent in Figure 3.13 (c) and (d) due to a monetary policy shock. On the other, the contributions of capital inflows in the model with debt inflows in Figure 3.13 (e) and (f) are comparable to those due to a monetary policy shock in Figure 3.14 (e) and (f). However, post 2007 capital inflows across model specifications made negative contributions to credit growth. The biggest negative capital inflows contributions are in a model with equity inflows. In the models with portfolio inflows, the capital inflows shocks made marginal positive contributions to credit growth post 2011. It seems that this was due to debt inflows.

3.7.3 Policy inferences based on variance decomposition

What fraction of variance of k-step ahead forecast error in credit growth is attributed to monetary policy and capital flow shocks? Figure 3.15 shows a graphical representation that compares the variation in credit growth explained by both shocks.[20] The capital flows shock explains more variation in credit growth on impact and across the forecast horizon compared to the monetary policy shock. In addition, the variations are more persistent due to capital inflow shocks compared to the monetary policy shock. The exception is the variation due to a monetary policy shock in the model with equity inflows which persists at 15.5 per cent variation in credit growth.

Figure 3.15 Variance decomposition in credit growth due to a monetary policy and capital inflow shocks



Source: Author's calculations

Figures 3.15(b) and (d) show the average variation explained by each shock over the forecast horizon. Overall, the results suggest that the capital inflows shocks explain more variability in growth credit growth and relative to expansionary monetary policy shock.

[20] The tables presenting the variance decompositions of the shocks for all the variables are shown in Tables A3.1, A3.2 and A3.3 in the appendix.

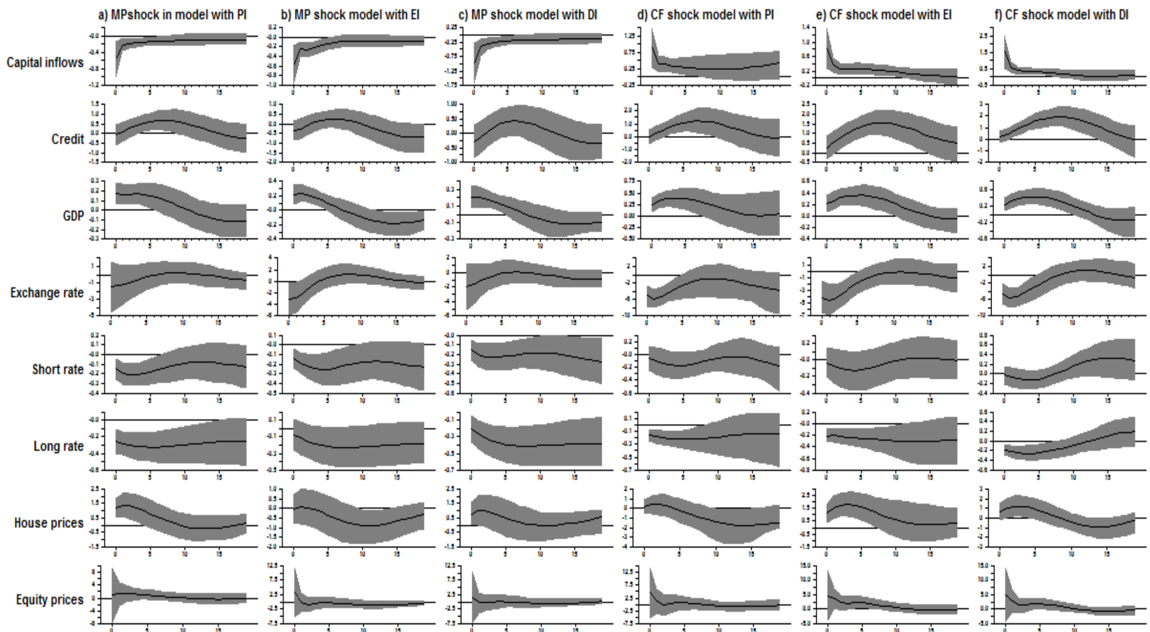
3.8 Model with house and equity prices

This section extends model one by adding two asset price variables, namely real house process and real equity prices. Nominal house prices and equity prices are deflated with headline CPI inflation.

3.8.1 Impulse responses based on the pure sign restriction approach

First, Figure 3.16 shows that the responses of the variables adhere to the imposed signs. Second, the responses credit growth conform to theoretical predictions, are significant and are comparable to those obtained in model one. This means that the variables are not sensitive to the extension and change in the specification of the model.

Figure 3. 16 Responses to monetary policy and capital inflows shocks



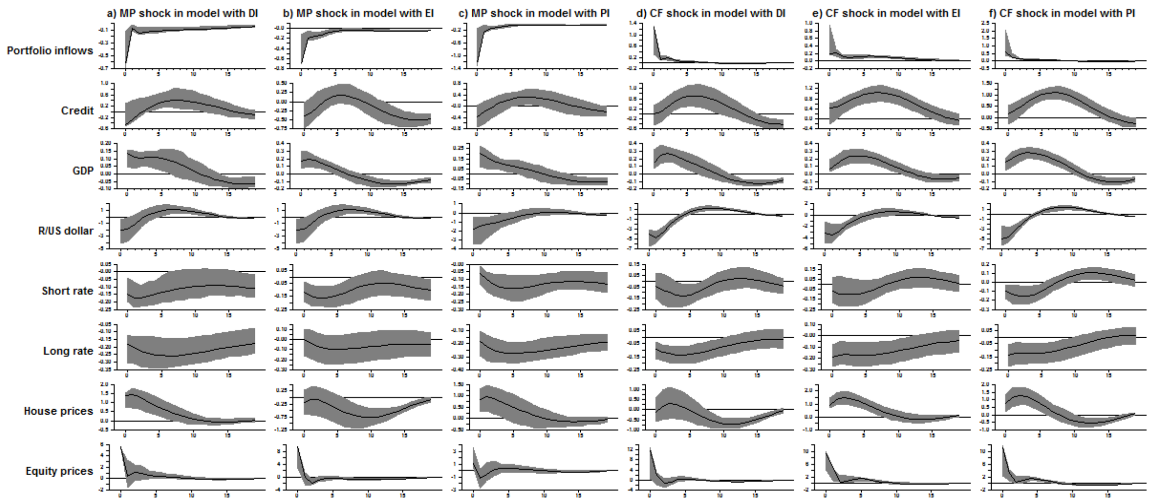
Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

However, the results show that real house prices respond positively to accommodative monetary policy shock and the capital inflow shocks although the magnitudes of response differ. Real house prices are more responsive to a monetary policy shock in the model with portfolio inflows and a capital inflow shock in a model with equity inflows. The responses to monetary policy shocks in models with equity inflows and debt inflows show that house prices increase but the increases are statistically insignificant. Similarly, the responses of real house prices to capital flow shocks in the model with portfolio inflows and debt inflows increase but the increase is insignificant. On the other hand, equity prices respond more to capital inflow shocks. Both equity and debt inflows result in comparable increase in equity price increase, although the increases are statistically insignificant.

3.8.2 Impulse responses based on the penalty function approach

The results of the impulse responses using the penalty function approach are shown in Figure 3.17 and show that the model is not sensitive to change in technique. House prices are more responsive to capital inflow shocks, in particular portfolio and equity inflows compared to monetary policy shocks. On the other hand, equity prices are still more responsive to a capital inflow shock compared to a monetary policy shock.

Figure 3.17 Responses to monetary policy shocks and capital inflows shocks



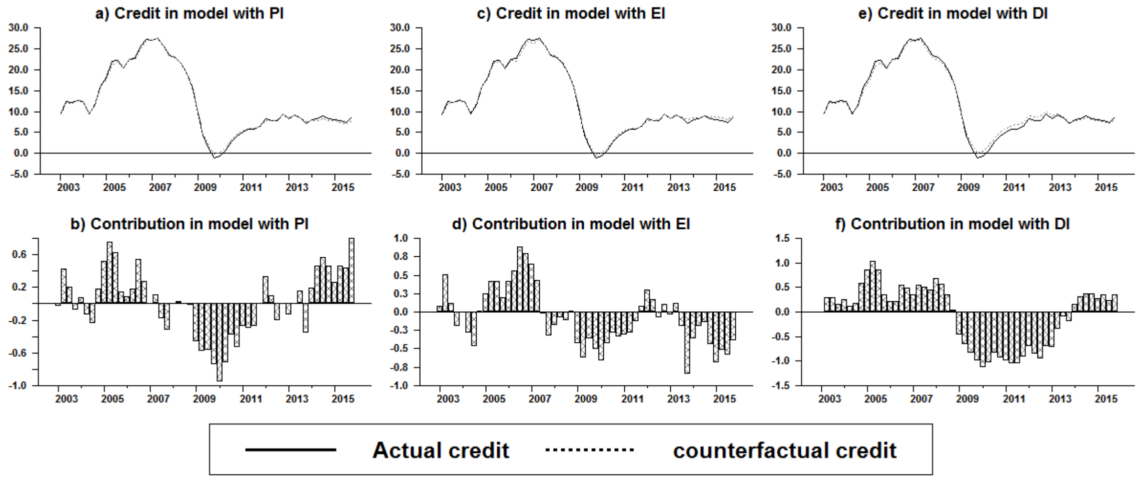
Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

3.8.3 Counterfactual scenarios and contributions of monetary policy and capital inflow shocks to credit growth

We start by showing the counterfactual scenarios for the monetary policy shock in Figure 3.18. The results show that the inclusion of house and equity prices does not alter the response of credit growth, the relative importance and persistence of shocks. However, the extended specification presents different counterfactual scenarios for the historical contributions of monetary policy and capital inflow shocks for the period 2003Q1 to 2015Q4. For instance, a monetary policy shock still contributes less to credit growth during the period of the credit and housing boom in 2004Q1 and 2007Q4, but the persistence of the shock becomes more apparent in the model including debt inflows compared to equity inflows.

Similarly, post the financial crisis and domestic recession in 2009, a monetary policy shock in the specification including debt inflows contributed to a persistent decline in credit growth. However, since 2014Q1 it has contributed to positive growth in credit coma pared to contributions in the model with equity inflows. This was not the case under the specification of model one in Figure 3.13. This means that the inclusion of house and equity prices present additional important channels through which an accommodative monetary policy shock is transmitted via capital inflows categories to domestic credit markets.

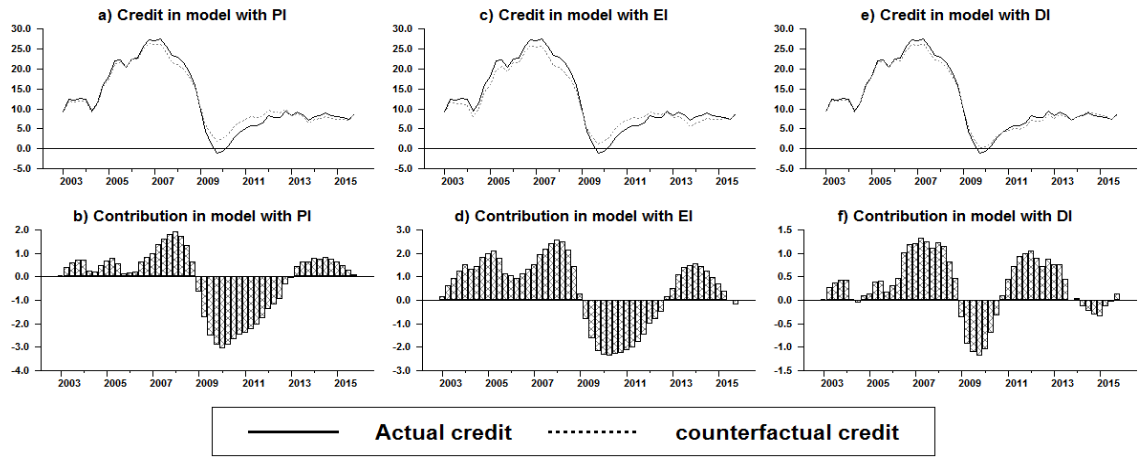
Figure 3.18 Counterfactuals for credit growth monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

A similar picture emerges in Figure 3.19 in the contributions of capital inflow shocks to credit growth. Compared to the results in model one in Figure 3.14 it is evident that shocks although capital inflow shocks in particular equity inflows contributed more to credit growth during the boom years, the magnitudes are much lower.

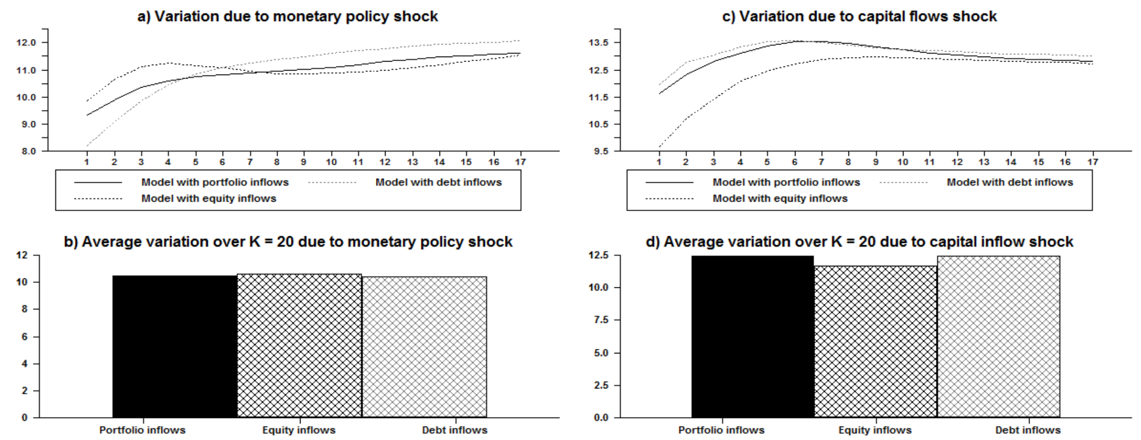
Figure 3.19 Counterfactuals for credit growth portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The magnitudes of the contributions of the different capital inflow categories are more than half what they were in model one when house and equity prices were not included in the specification. In addition, the counterfactual scenarios show that debt inflows had the least persistent effects on credit growth during the 2009 recession compared to equity inflows. The negative contributions due to debt inflows shocks died out quickly and contributed positively to credit growth between 2011Q1 and 2014Q2 compared to negative contributions due to equity inflows that lasted for the period 2009Q1 to 2013Q1. The variance decompositions of the variation induced by monetary and capital inflow shocks on credit growth in Figure 3.20 corroborate the observations based on the counterfactual scenarios.

Figure 3.20 Variance decomposition in credit growth due to a monetary policy and capital inflow shocks



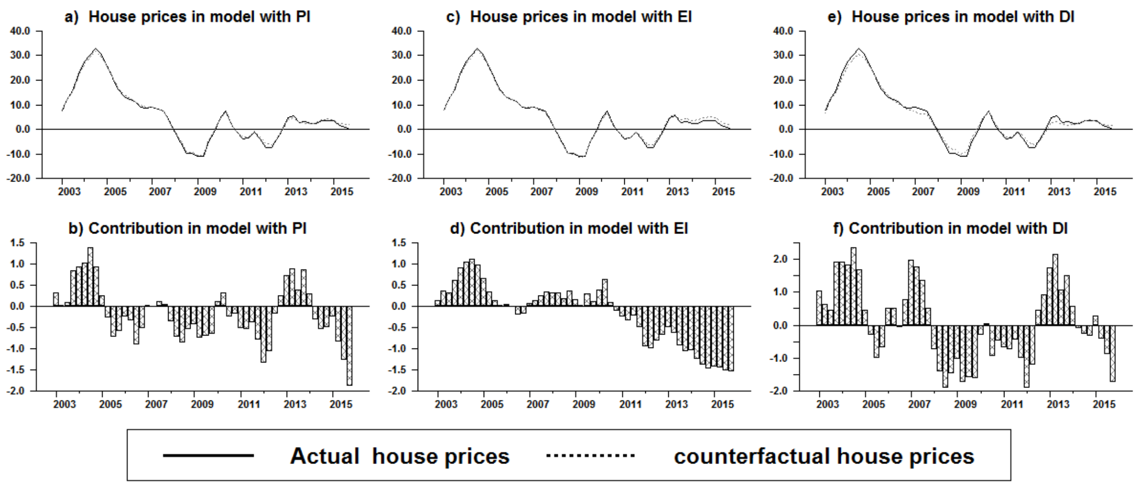
Source: Author's calculations

The variation in credit growth due to capital inflow shocks under different model specifications is not only higher on impact but it peaks at 13.5 per cent after six quarters and remains persistent around 13 per cent for the remainder of the forecast horizon. On the other hand, monetary policy shocks across the different model specifications explain around 10 per cent of the variation in credit growth across the forecast horizon.

3.8.4 What do the counterfactual scenarios suggest the persistence of monetary policy shocks and capital inflow shocks on house and equity prices are?

One of the key questions of interest of the chapter is which shock made persistent contributions house prices during the credit boom. Equally important is what explains the developments during the period low policy rates and excessive liquidity injections post the global financial crisis. Figures 3.21 and 3.22 show the contributions of monetary policy and capital inflow shocks to house prices between 2003Q1 and 2015Q4. Figure 3.21 suggests that at the height of the house price boom in 2004, monetary policy shocks contributed slightly more to house price growth compared to capital inflow shocks. This is particularly the case in the model including debt inflows. However, the contributions of the monetary policy shock were very transitory compared to those of the capital inflow shocks.

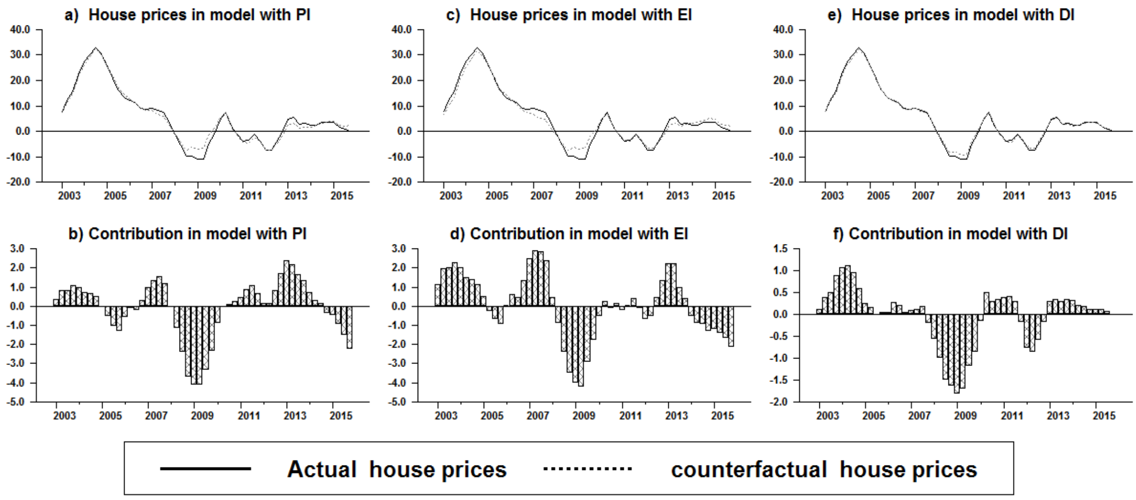
Figure 3.21 Counterfactuals for house price growth monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The capital inflow shock, particularly in the model with equity inflows continued to make larger contributions in 2007. However, during the recession in 2009 both monetary policy and capital inflow shocks made negative contributions to house price growth with the exception for the equity inflows in Figure 3.22. The contribution of monetary policy in the model with equity flows to house price growth was positive during 2009 compared to the negative contribution in the models with portfolio inflows and debt inflows. This contrasts with the contributions of the capital inflow shocks which made negative contributions to house prices in 2009 across all model specifications, i.e. a model with portfolio inflows, equity inflows and debt inflows. The negative contributions due to capital inflow shocks across model specifications are twice more than those due monetary policy shocks.

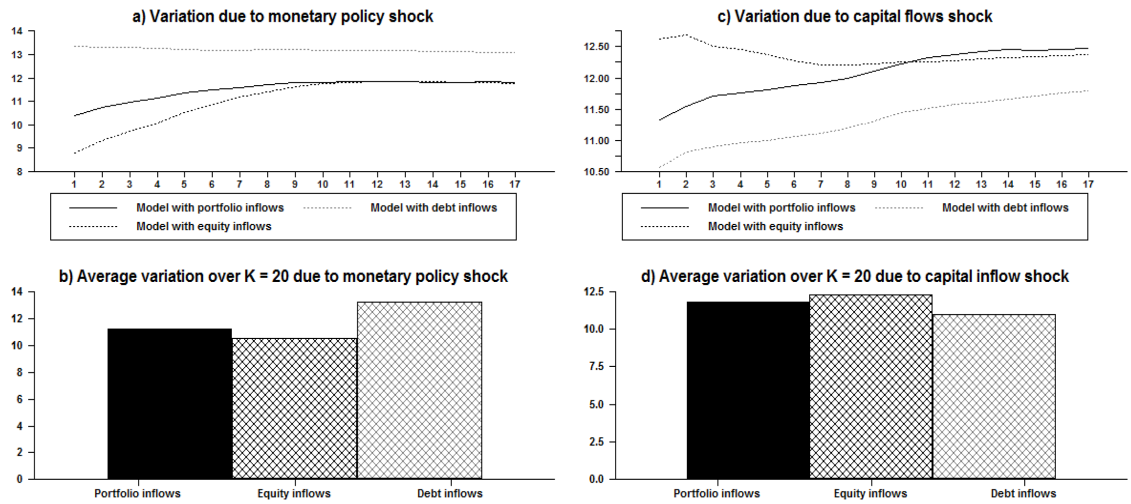
Figure 3. 22 Counterfactuals for house price growth portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Overall, the results from the counterfactual scenarios and the variance decompositions suggest that the assessment of the relative importance of accommodative monetary policy and positive capital inflow shocks is more informative when the different categories of capital inflows are considered.

Figure 3.23 Variance decomposition in house price growth due to a monetary policy and capital inflow shocks

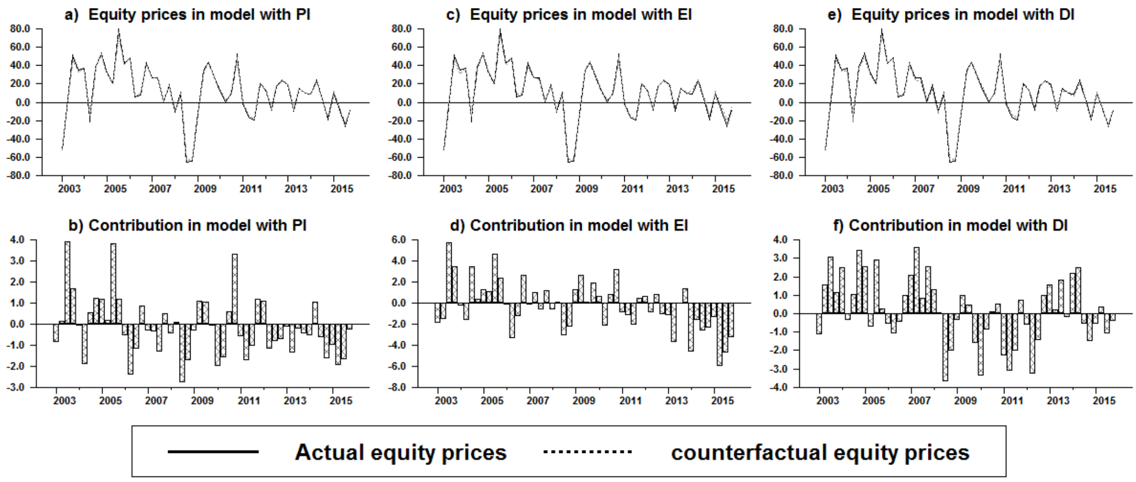


Source: Author's calculations

The analysis of aggregate portfolio inflows masks the heterogeneity inherent in the different capital inflow categories. The inclusion of debt inflows in the specification that identifies a negative monetary policy shock indicates that monetary policy shocks made larger albeit transitory contributions to house prices, compared to equity inflows. Similarly, the monetary policy shock explains more variation house price growth under the model with debt inflows compared to equity inflows and the aggregated portfolio inflows.

On the other hand, equity inflows make larger and more persistent contributions in the specification that identifies a positive capital inflows shock. The capital inflows shock explains a larger proportion of variation in house prices across the entire forecast horizon compared to the monetary policy shock. Furthermore, a comparison of the contributions of monetary policy and capital inflow shocks in Figures 3.24 and 3.25 indicates that despite the volatility of equity prices, monetary policy shocks tend to make not only smaller contributions, but they are very transitory.

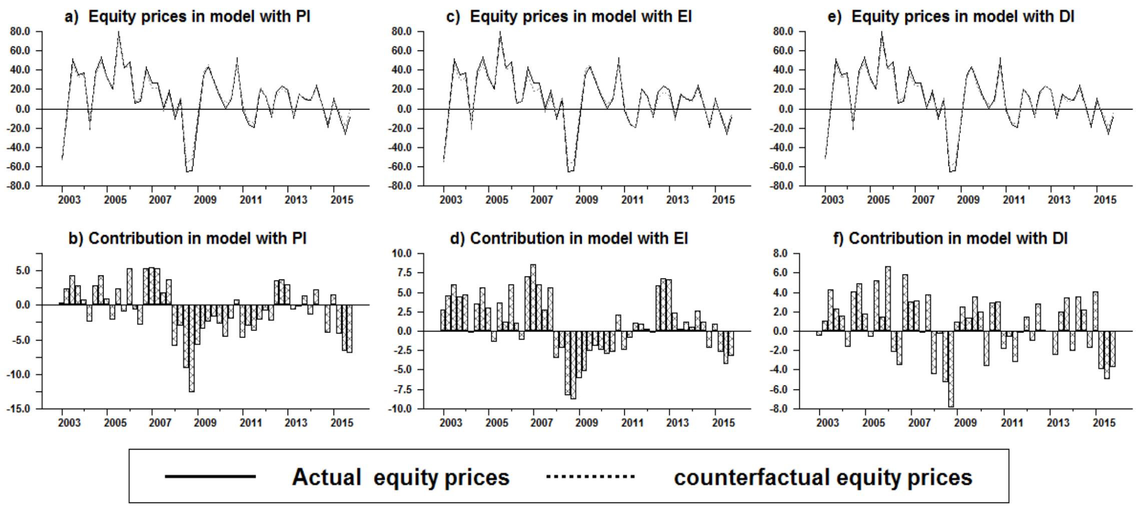
Figure 3.24 Counterfactuals for equity price growth monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Capital inflow shocks across different specifications make persistent contributions that are more than double those of the monetary policy shock. Furthermore, the capital inflow shock in the model with equity prices tends to make persistent contributions compared to debt inflows. The capital inflows shock in the model with equity inflows contributed more to the decline in equity prices during the recession in 2009 compared to debt inflows.

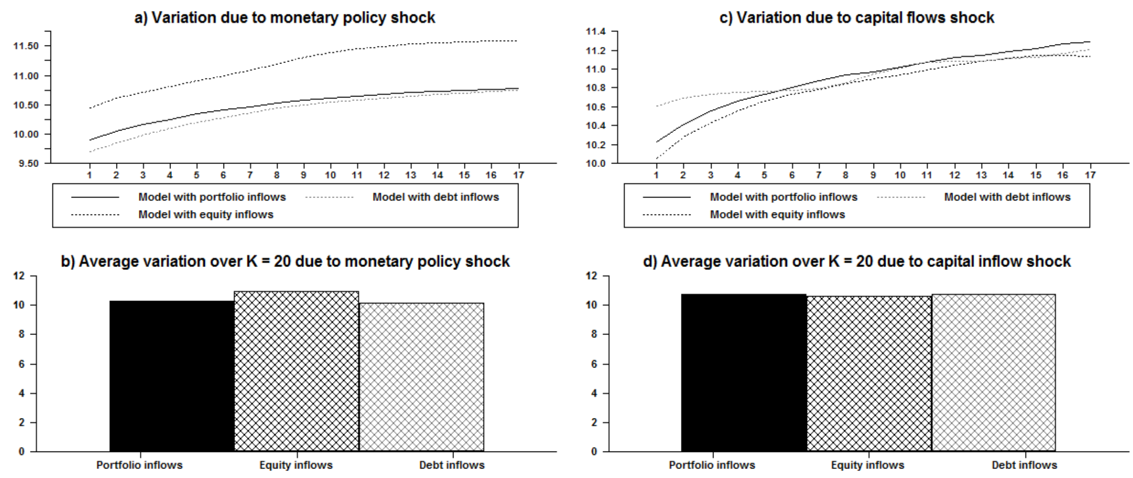
Figure 3.25 Counterfactuals for equity price growth capital flow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The variance decompositions in Figure 3.26 corroborate these findings monetary policy shocks explain a lower variation in equity prices compared to capital inflow shocks.

Figure 3.26 Variance decomposition in equity price growth due to a monetary policy and capital inflow shocks

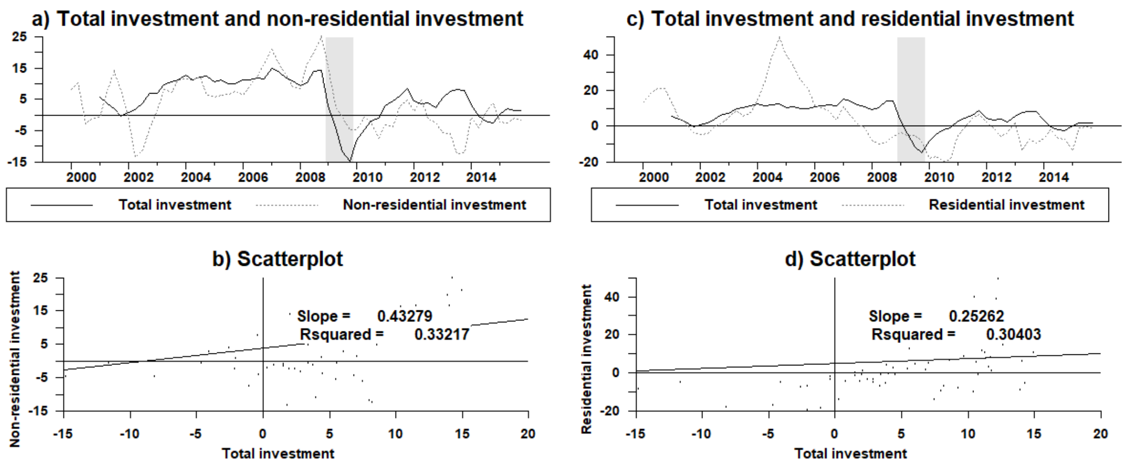


Source: Author's calculations

3.8.5 Does the inclusion of investment growth together with house prices alter the relative importance of monetary policy and capital inflow shocks?

First, we show bilateral relationships between total investment, residential and non-residential investment in Figure 3.27. The trends show that both components of investment are positively related with total investment. But total investment is more sensitive to changes in non-residential investment in Figure 3.27(b) compared to residential investment in (d).

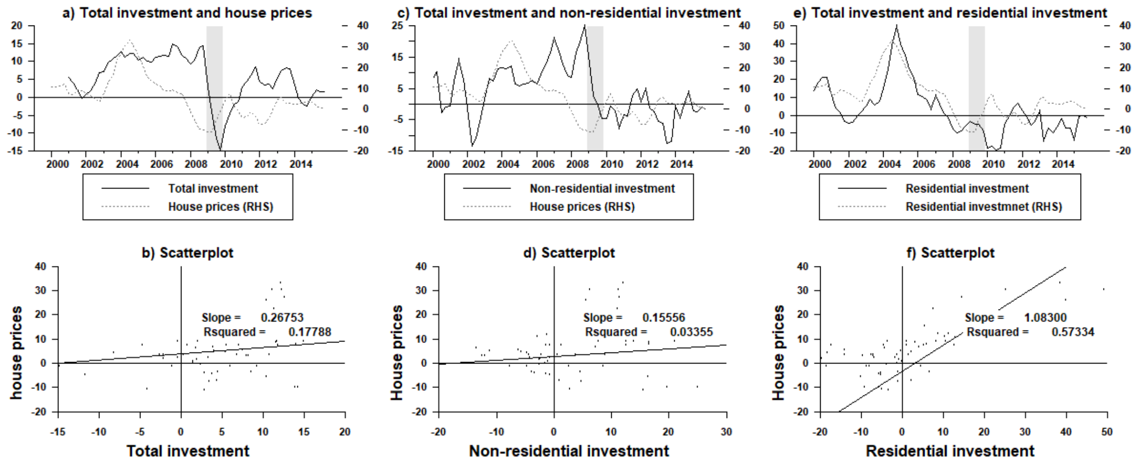
Figure 3.27 Total investments, residential and non-residential investment



Source: South African Reserve Bank and author's calculations

But residential investment is more sensitive to changes in house prices in Figure 3.28 compared to total and non-residential investment. Even though non-residential investment is less sensitive to house price changes, it dominates the changes in total investment.

Figure 3.28 House prices, total investment, residential and non-residential investment



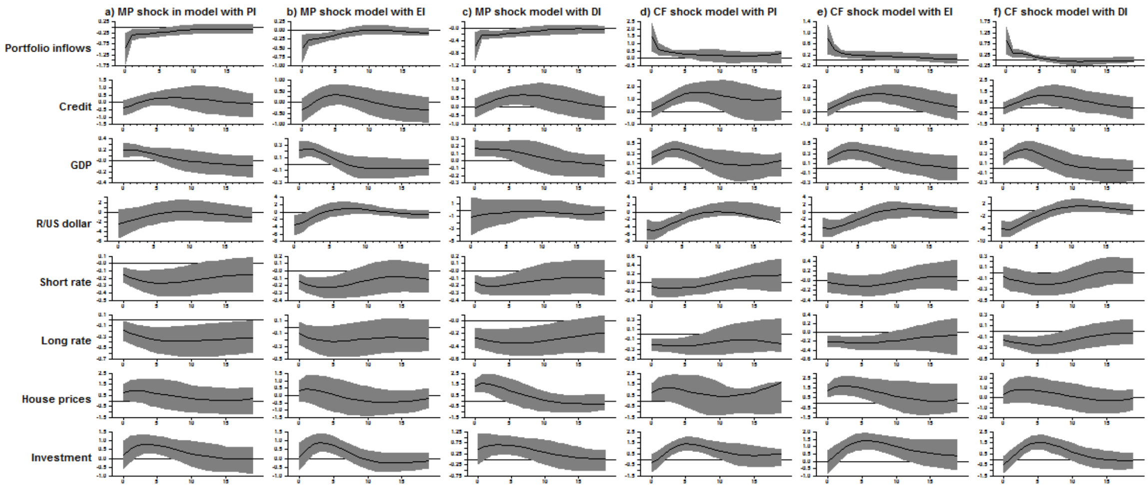
Source: South African Reserve Bank and author's calculations

For instance, as the housing boom faded in after 2004 total investment continued to grow at a robust pace due to non-residential investment. As a result, in the empirical analysis we consider both total investment and residential growth.

3.8.6 Impulse responses for housing and investment based on the pure sign restriction approach

Figure 3.29 shows the responses for credit growth are as expected and does not change with the different specification in model three. Of importance to the analysis in this section are the responses of house prices and investment growth to get a more comprehensive analysis of the housing market. The results show that house prices still respond positively to accommodative monetary policy shocks and positive capital inflow shocks as was the case in the specification in model two. However, the magnitudes of response are much higher in the specification that includes investment growth. This means that the inclusion of investment can capture some channels through which monetary policy and capital inflow shocks affect house prices and credit extension. The responses of investment growth are positive across the different specifications in Figure 3.29 due to both monetary policy and capital inflow shocks as expected. However, investment responds more to positive capital inflow shocks compared to monetary policy shocks.

Figure 3.29 Responses to monetary policy and capital inflows shocks

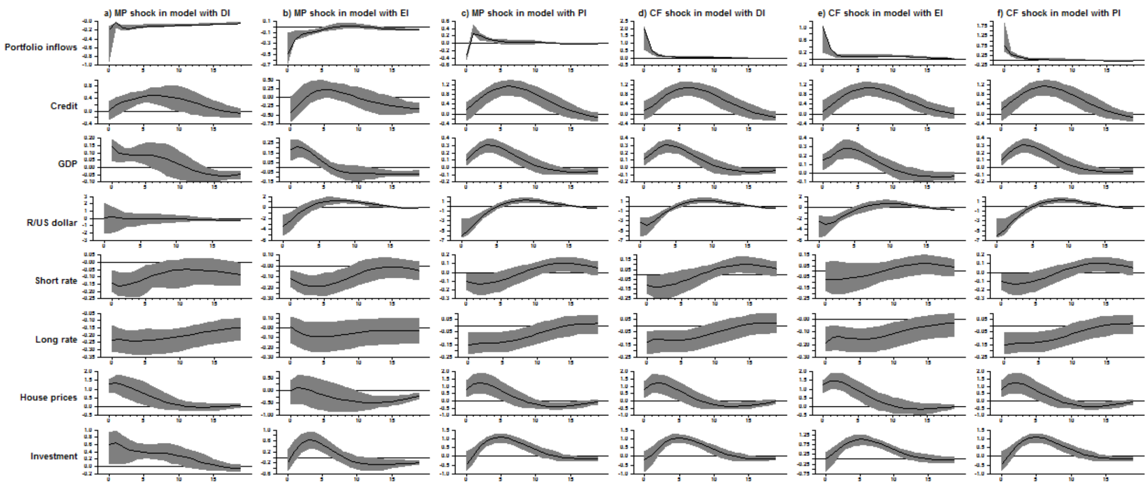


Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

3.8.7 Impulse responses based on the penalty function approach

A similar pattern of impulses responses is evident in Figure 3.30 meaning that the results are robust to changes in the technique used.

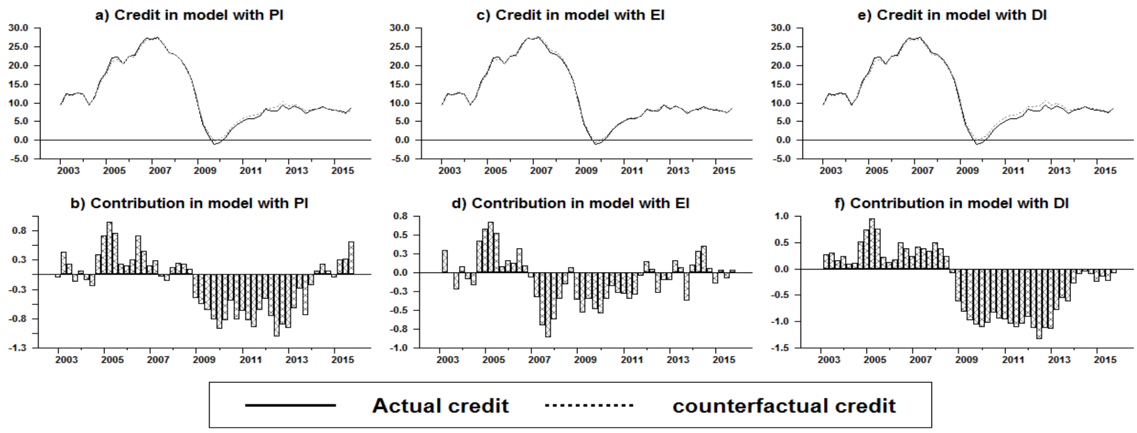
Figure 3.30 Responses to monetary policy and capital inflows shocks



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Credit growth, house prices and investment growth are more responsive to capital inflow shocks compared to monetary policy shocks. Furthermore, similar to the results for the specifications in model two, the inclusion of investment growth results in much lower contributions of the monetary policy shock to credit growth during the housing and credit boom pre-the global financial crisis in Figure 3.31.

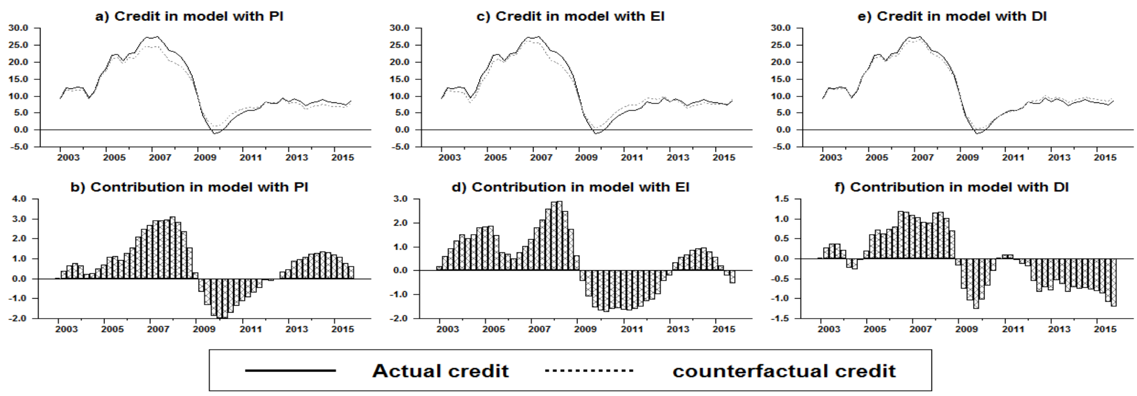
Figure 3.31 Counterfactuals for credit growth and contributions of the monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Across specifications, monetary policy shocks contributed less than one per cent in credit growth pre-2009. The positive contributions were more persistent in the model including debt inflows compared to equity inflows. On the other hand, capital inflow shocks in Figure 3.32 persistently contributed more to credit growth pre-2009, particularly equity inflows.

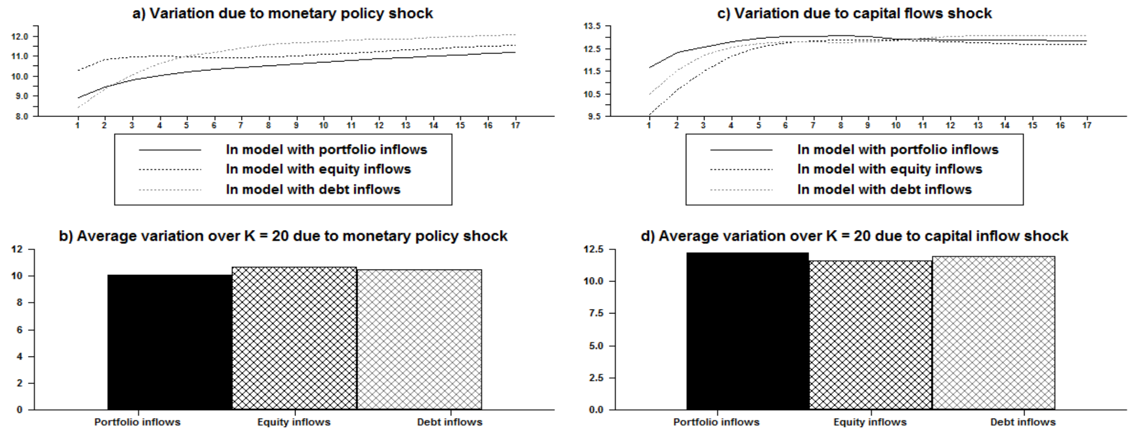
Figure 3.32 Counterfactuals for credit growth and contributions of portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The variance decompositions in Figure 3.33 confirm the evidence in the impulse responses and counterfactual scenarios. Across all horizons, capital inflow shocks explain a higher variation in credit growth compared to monetary policy shocks.

Figure 3.33 Variance decomposition in credit growth due to a monetary policy and capital inflow shocks

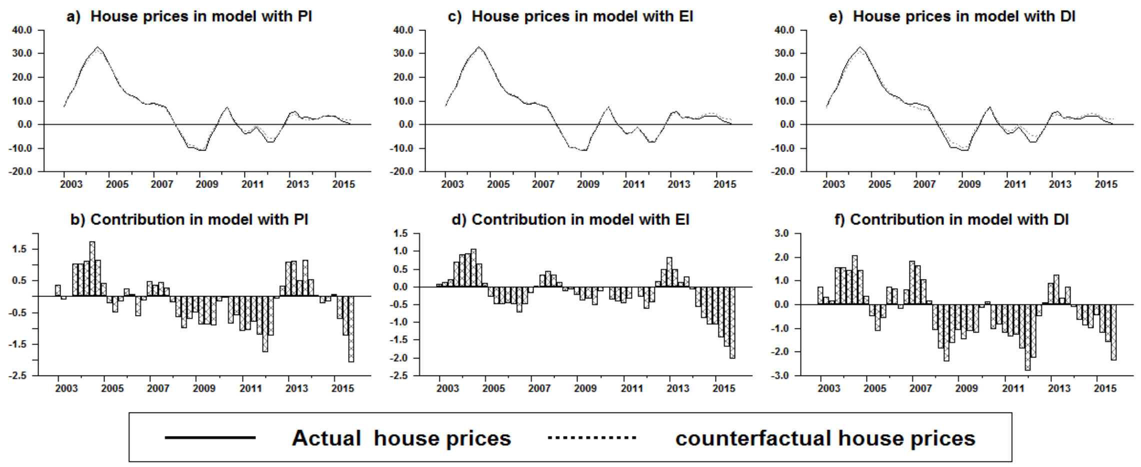


Source: Author's calculations

3.8.8 Does the inclusion of investment growth alter the persistence of monetary policy shocks and capital inflow shocks on house price growth?

The results in Figure 3.34 show that the earlier findings in the specification of model 2 with equity prices are robust to changes in the specification. Monetary policy shocks contributed more to house prices during the boom in 2004 compared to capital inflow shocks. However, as in the earlier findings the contributions were much more temporary compared to those due to capital inflow shocks in Figure 3.35.

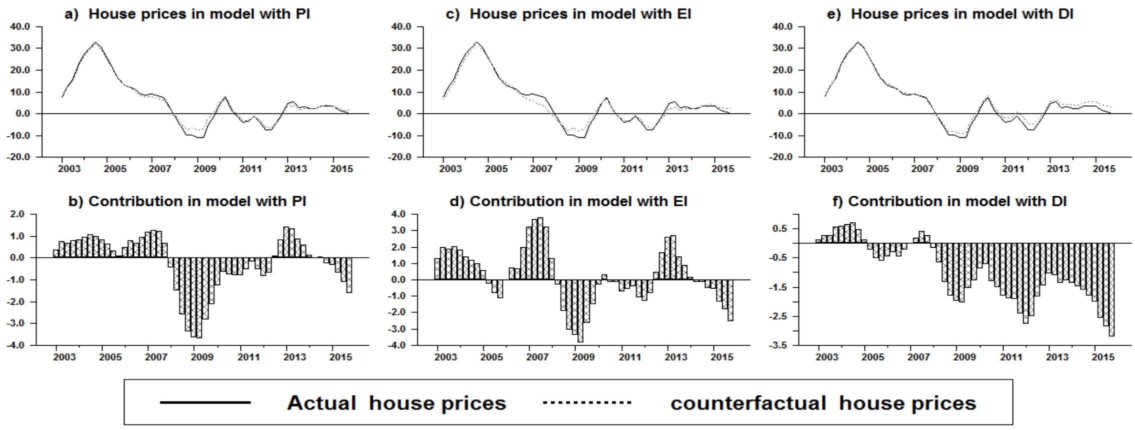
Figure 3.34 Counterfactuals for house price growth and contributions of monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

In addition, equity inflow shocks contributed more to house prices during the boom in 2004 and just before the recession in 2007. However, they contributed more to the decline during the recession.

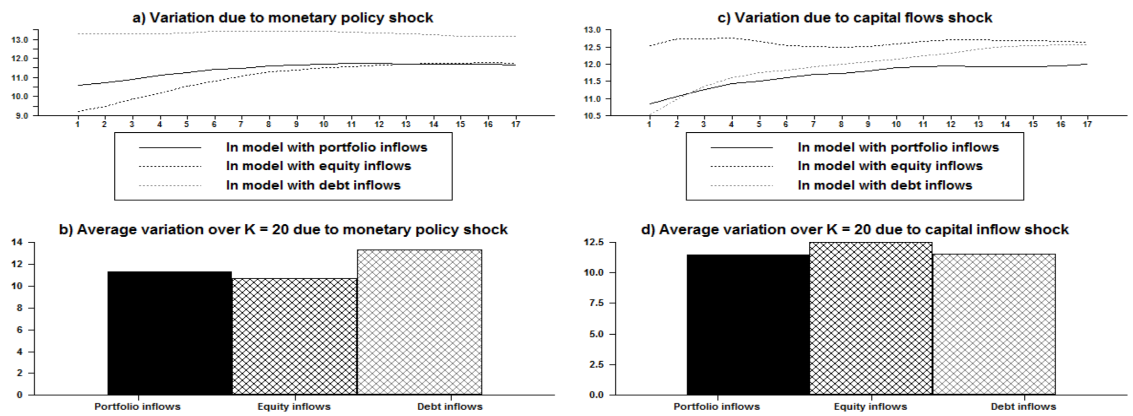
Figure 3.35 Counterfactuals for house price growth and contributions of portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

On the other hand, debt inflows have persistently contributed negatively to house prices since 2007Q2. In addition, the variance decompositions in Figure 3.36 corroborate earlier findings that monetary policy shocks, particularly under the model specification with debt inflows explain higher variation in house prices. The variation explained by capital inflow shocks, in particular equity inflows is persistent and higher on average across the entire forecast horizon.

Figure 3.36 Variance decomposition in house prices growth due to a monetary policy and capital inflow shocks

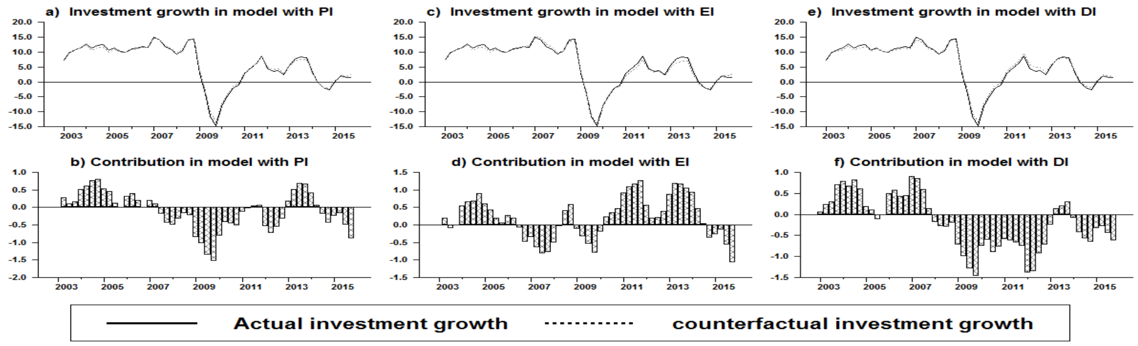


Source: Author's calculations

3.8.9 What is the relative importance of monetary policy shocks and capital inflow shocks on investment growth?

The counterfactual scenarios in Figure 3.37 and 3.38 suggest that monetary policy shocks made positive contributions to investment growth between 2003Q1 and 2006Q4, but these were far less compared to those due to capital inflow shocks.

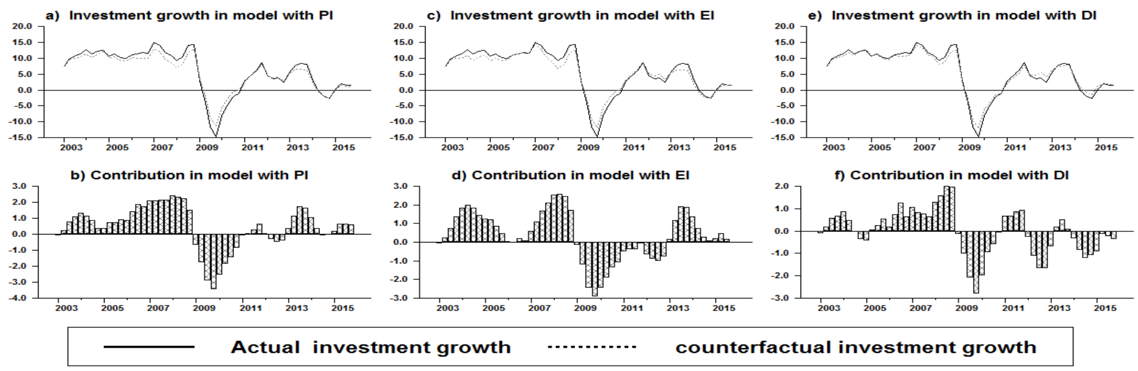
Figure 3.37 Counterfactuals for investment growth and contributions of monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Capital inflow shocks made persistent positive shocks that were more than double those due to monetary policy shocks between 2003Q1 and 2008Q4. The heterogeneity introduced by different categories of capital inflows is also evident in Figure 3.38(d) indicating that monetary policy shocks in the model with equity inflows made positive contributions to investment post 2009 compared to debt inflows.

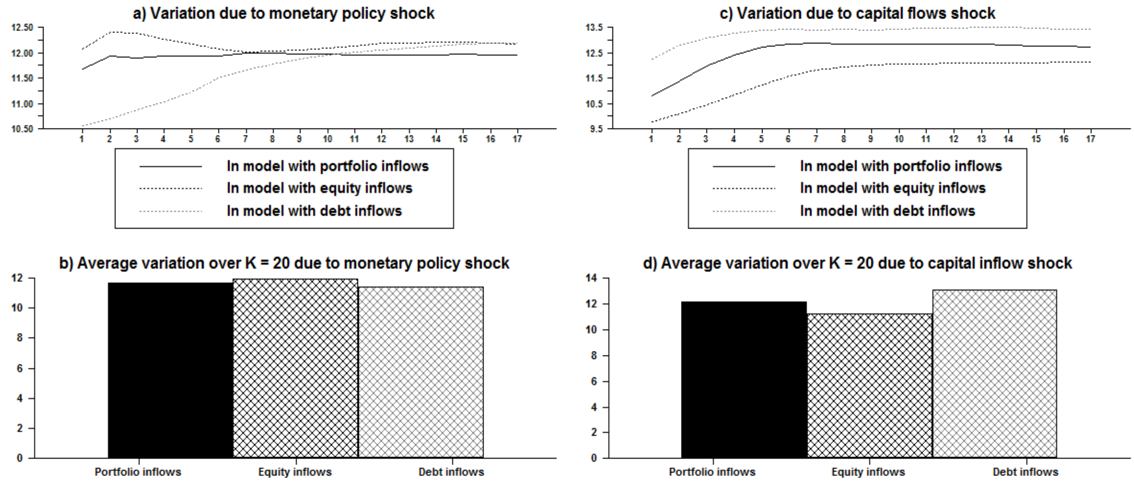
Figure 3.38 Counterfactuals for investment growth and contributions of capital flow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

The variance decompositions in Figure 3.39 confirm that capital inflow shocks persistently explain a larger proportion of the variation in investment growth compared to monetary policy shocks.

Figure 3.39 Variance decomposition in investment growth due to a monetary policy and capital inflow shocks

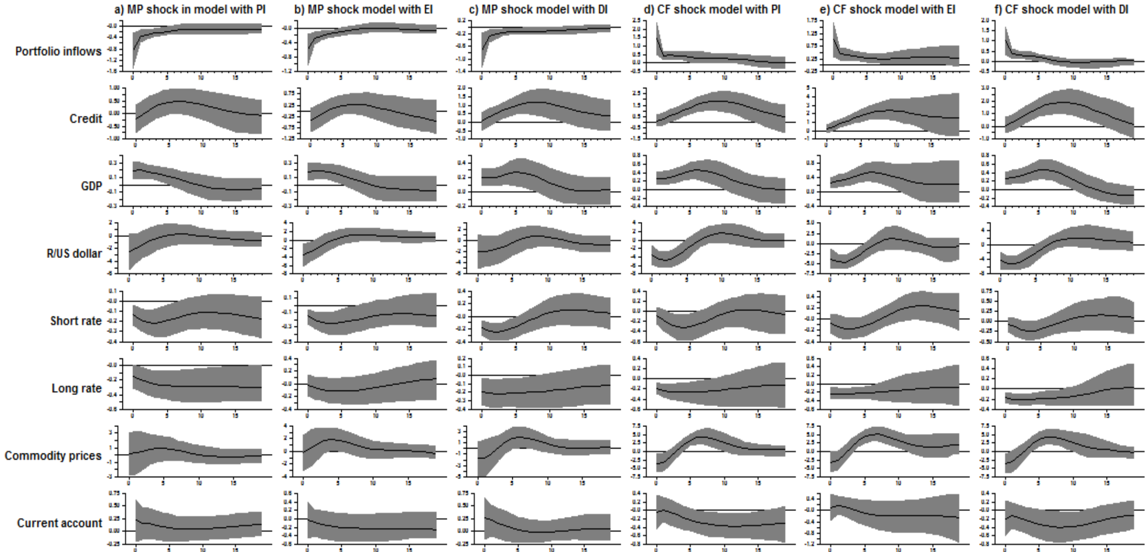


Source: Author's calculations

3.9 The role of commodity prices and the current account

The final section of the empirical analysis considers the role of commodity prices and the current account. We change the specification of the previous models and include commodity prices and the current account as a ratio of GDP. We stated earlier that the literature is uncertain about the impact of monetary policy and capital inflow shocks on the current. What do the results in the model five suggest the impact monetary policy and capital inflows are on the current account in South Africa?

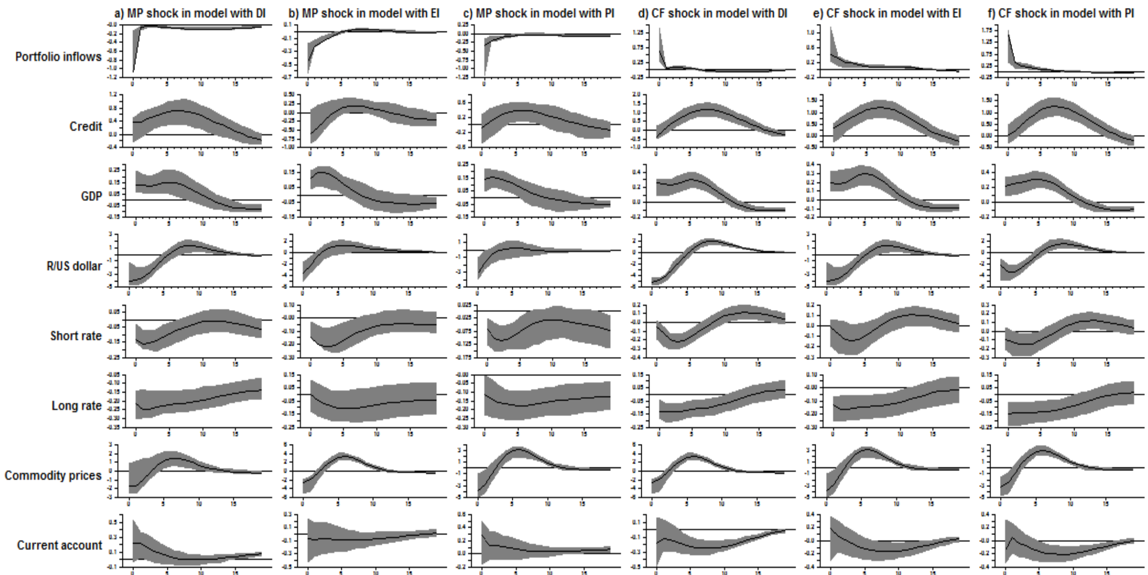
Figure 3.40 Responses to monetary policy and capital inflows shocks: pure sign restriction approach



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

First, Figure 3.40 indicates that the responses of credit growth are consistent with theoretical predictions and are not different to the previous specification. This implies robustness to changes in the specification of the model.

Figure 3.41 Responses to capital-inflows and monetary policy shocks: penalty function approach



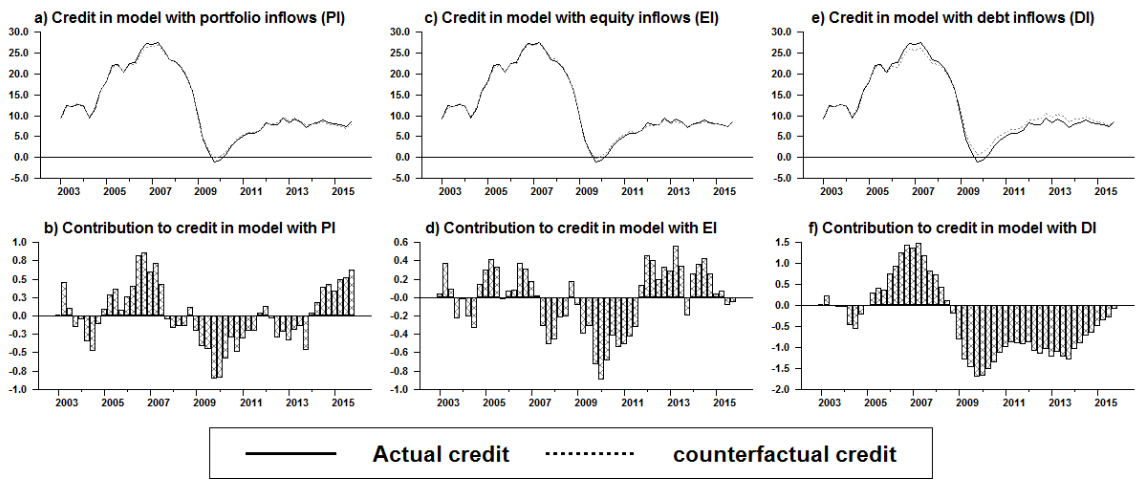
Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Second, commodity prices generally decline in response to both monetary policy and capital inflow shocks in the first four quarters of the shock and increase thereafter. This is consistent with the appreciation in the exchange rate. This results in a very temporary improvement in the current account. The results from the penalty function approach corroborate the responses from the pure sign restriction approach in Figure 3.40.

3.9.1 What do the counterfactual scenarios say about the persistence of monetary policy shocks and capital inflow shocks?

The counterfactual scenarios from the model including commodity prices and current account in Figure 3.42 and 3.43 concur with earlier findings that monetary policy shocks contributed less than capital flow shocks during the housing boom.

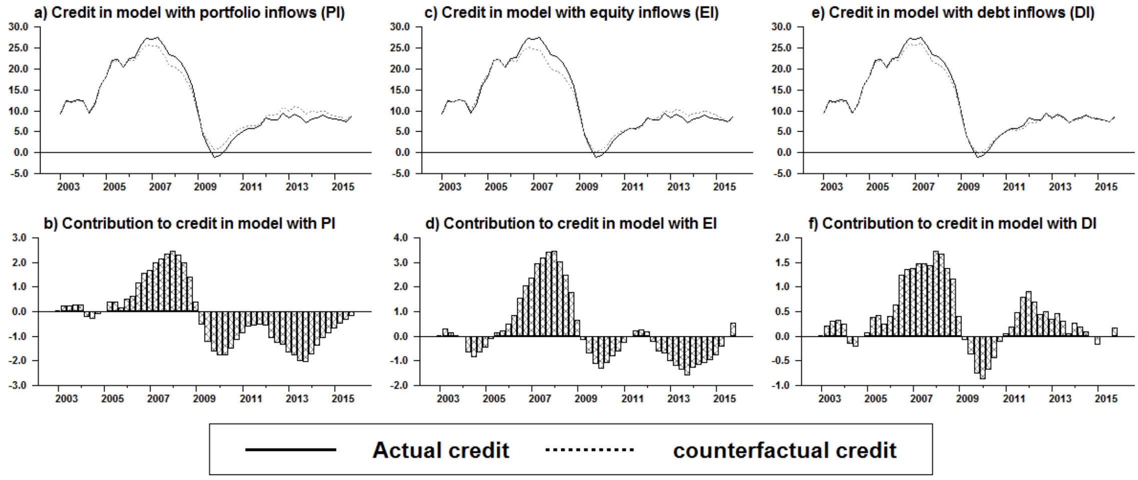
Figure 3.42 Counterfactuals for credit growth monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

Capital inflow shocks made more persistent positive contributions compared to monetary policy shocks. However, as in earlier sections the monetary policy shocks made positive contributions post the recession.

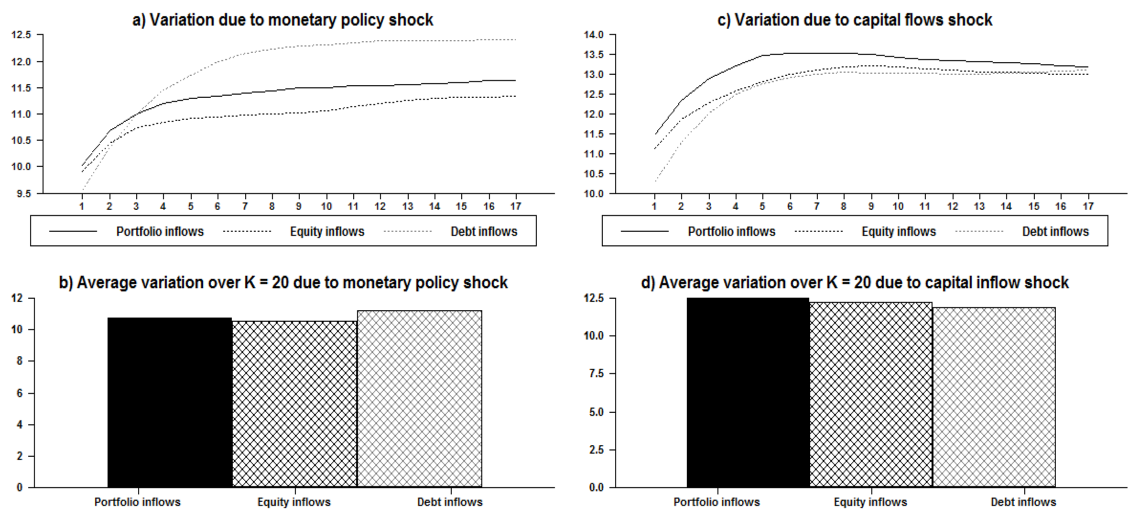
Figure 3.43 Counterfactuals for credit growth portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows. Source: Author's calculations

There are evident heterogeneities due to different components of capital flows. Monetary policy shocks in the model including equity inflows contributed more to credit growth since 2012Q1. On the other hand, capital inflows in the model with debt inflows contributed more to credit since 2011Q1. The variance decompositions in Figure 3.44 concur with earlier findings that capital inflows induce more fluctuations in credit growth compared to monetary policy shocks.

Figure 3.44 Variance decomposition in credit growth due to a monetary policy and capital inflow shocks

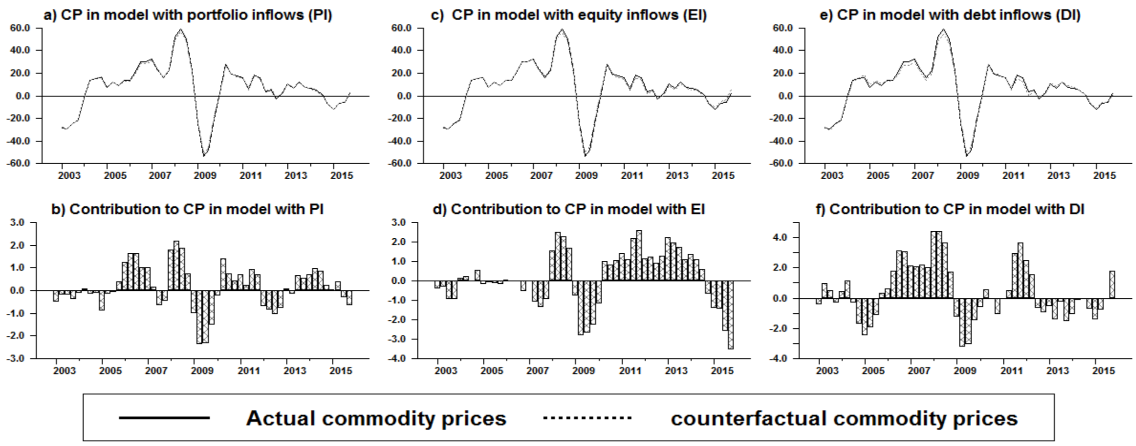


Source: Author's calculations

3.9.2 Are monetary policy shocks contributions to commodity prices more persistent compared to capital inflow shocks?

The South African economy and the exchange rate are heavily influenced by commodity price developments. What can the counterfactual scenarios tell us about the different impact of monetary policy and capital inflow shocks during the commodity price super cycle during 2005Q1 and 2007Q4? Figure 3.45 and 3.46 show that monetary policy shocks contributed far less than capital inflow shocks to commodity prices during the commodity prices boom.

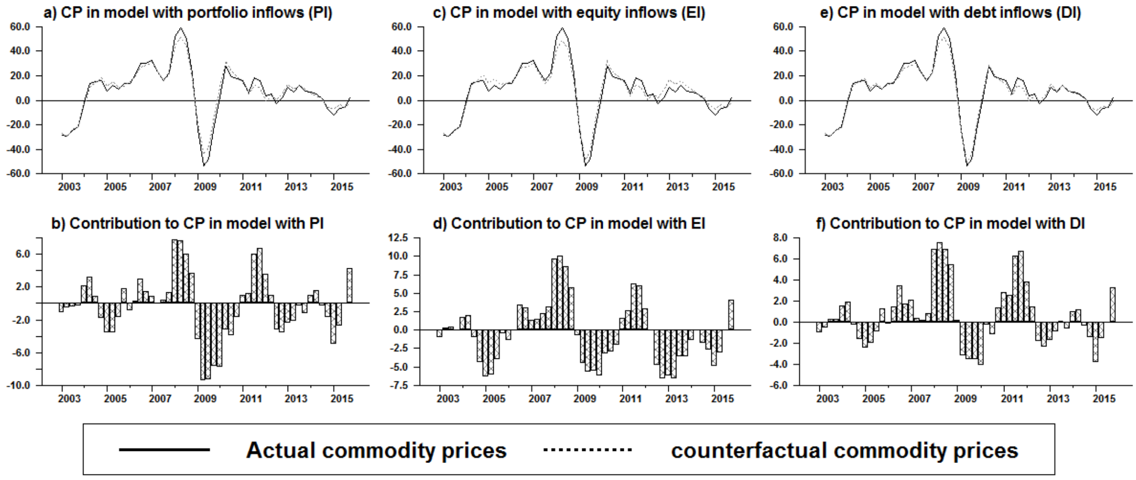
Figure 3.45 Counterfactuals for commodity price growth monetary policy shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows, CP = commodity prices. Source: Author's calculations

Capital inflow shocks, in particular equity inflows were the key contributors to increases in commodity prices. Similarly, during the recession in 2009 capital inflows made more negative contributions to commodity prices.

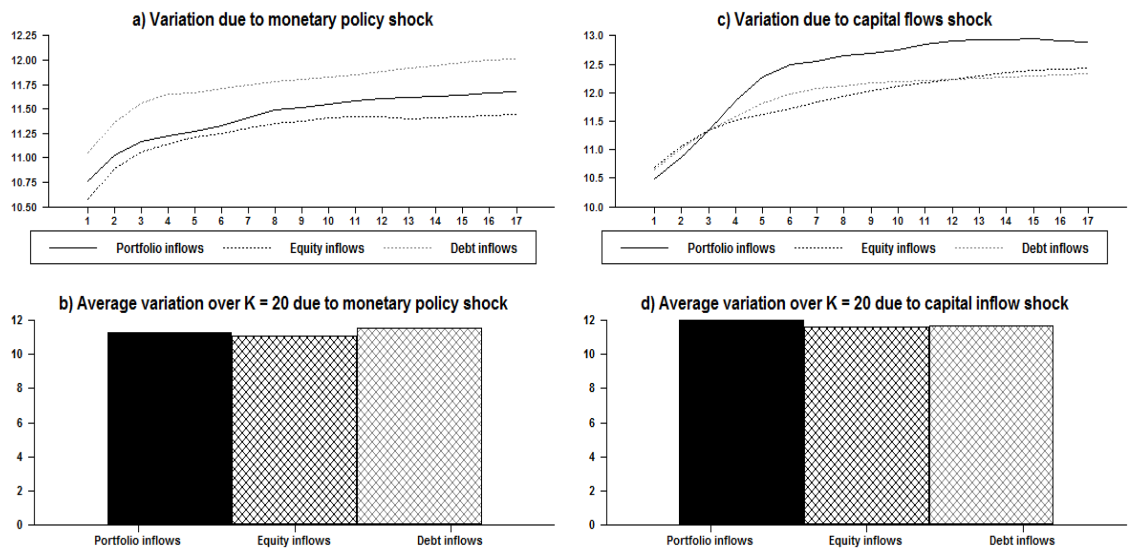
Figure 3.46 Counterfactuals for commodity price growth portfolio inflow shock



Note: PI = Portfolio inflows; EI= Equity Inflows and DI= debt inflows, CP = commodity prices. Source: Author's calculations

The variance decompositions in Figure 3.47 corroborate these findings and show that capital inflow shocks explain a larger proportion of the variation in commodity prices over the entire forecast horizon. Overall, the results imply that monetary policy shocks have an extremely limited impact on commodity prices compared to capital inflow shocks.

Figure 3.47 Variance decomposition in commodity price growth due to a monetary policy and capital inflow shocks

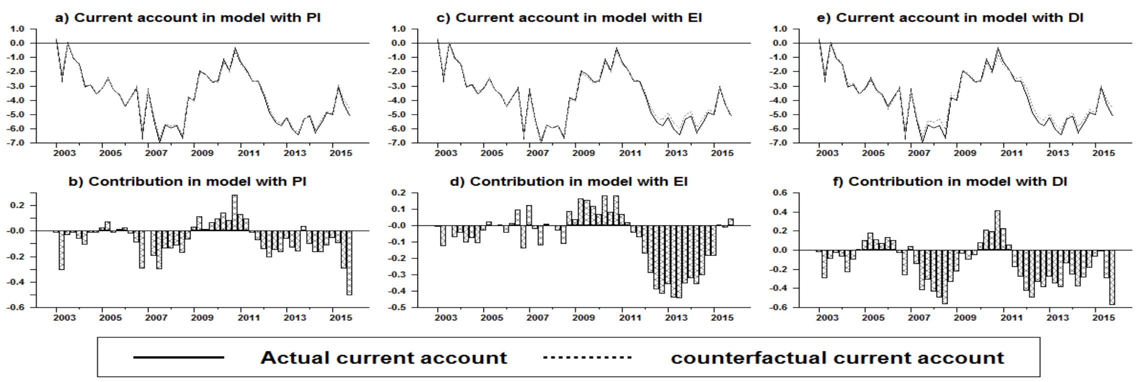


Source: Author's calculations

3.9.3 Which shock between monetary policy and capital inflow contributes to the improvement in the current account?

We showed earlier that the current account deficit is a constant source of vulnerability to the degree that it needs to be financed via foreign capital inflows. The results in Figures 3.48 and 3.49 indicate that monetary policy shocks made negligible contributions to the current account position for the entire period of 2003Q1 to 2015Q4.

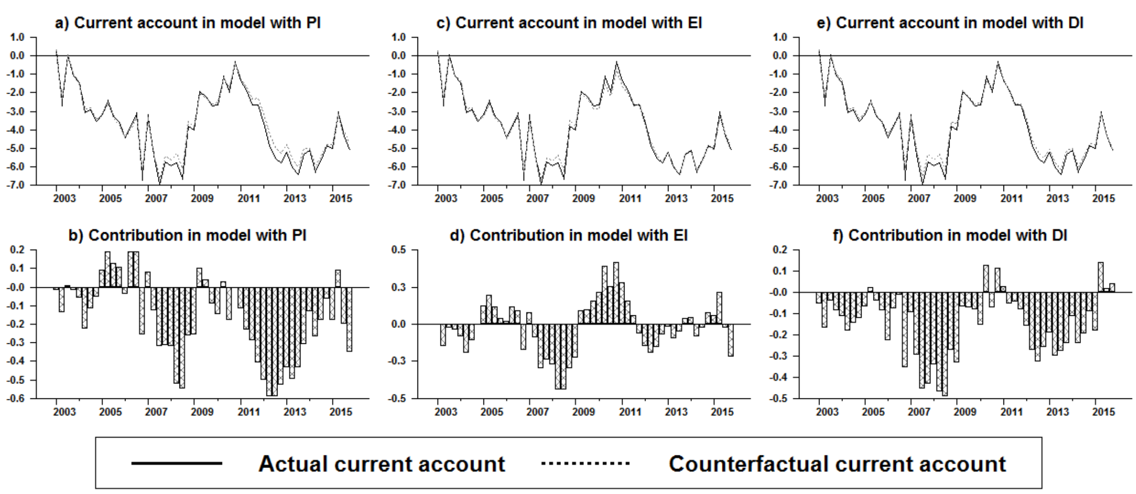
Figure 3.48 Counterfactuals for current account monetary policy shock



Note: PI = portfolio inflows, EI = equity inflows, DI = debt inflows. Source: Author's calculations

Despite capital flow shocks explaining a large share of the contributions to commodity prices during 2005Q1 and 2007Q4, this did not translate to persistent and higher improvement in the current account.

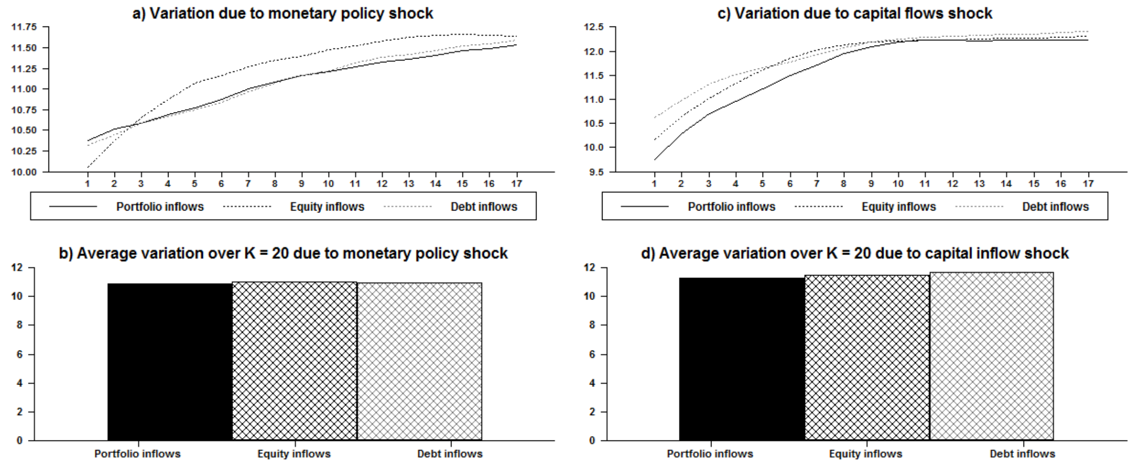
Figure 3.49 Counterfactuals for current account capital flow shock



Note: PI = portfolio inflows, EI = equity inflows, DI = debt inflows. Source: Author's calculations

The variance decompositions in Figure 3.50 show that capital inflow shocks explain more variations in the current account than monetary policy shocks.

Figure 3.50 Variance decomposition in current account due to a monetary policy and capital inflow shocks



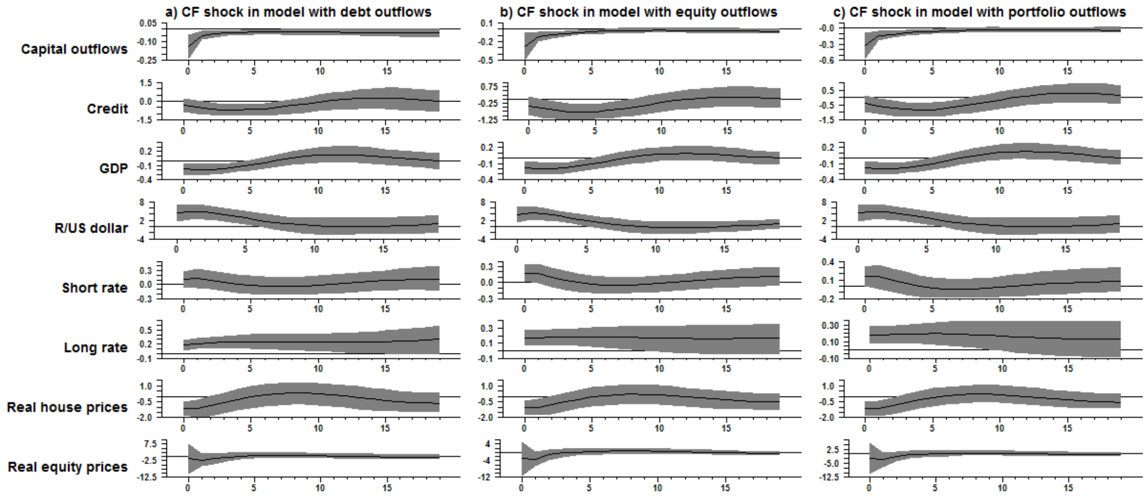
Source: Author's calculations

3.10 Capital outflows sudden stop shocks

The final analysis in the chapter considers the sudden stops of capital inflows on the variables included in all models estimated in the chapter. We assess the impact of sudden stop episodes considering the concerns about such an occurrence and the economic costs associated with it. Sudden stops are usually accompanied by among other events, severe depreciations in exchange rates, drops in asset price growth, output growth, consumption growth and investment growth. The global financial crisis and the ensuing period have been characterized by episodes of marked volatility in global risk and volatility in capital flows. Rey (2013) finds that various types of capital flows appear to be influenced by a global financial cycle, which can be proxied by the VIX index.

First, we consider evidence from the impulse responses. We define and identify a sudden stop as shown in shown in Tables 3.5. In addition, we consider the impact of the categories of capital flows during sudden stop episodes. Second, we show a comparison of the impact of scenarios of different magnitudes, namely a one standard deviation, four standard deviations and ten standard deviations shocks to portfolio outflows on financial and real economic variables. Figures 3.51 and 3.32 show that a capital outflow shock results in a decline in an increase in long-term rates, a decline in credit and GDP growth and asset prices. The exchange depreciates and because of the inflationary pressures, the short-term interest rates increase.

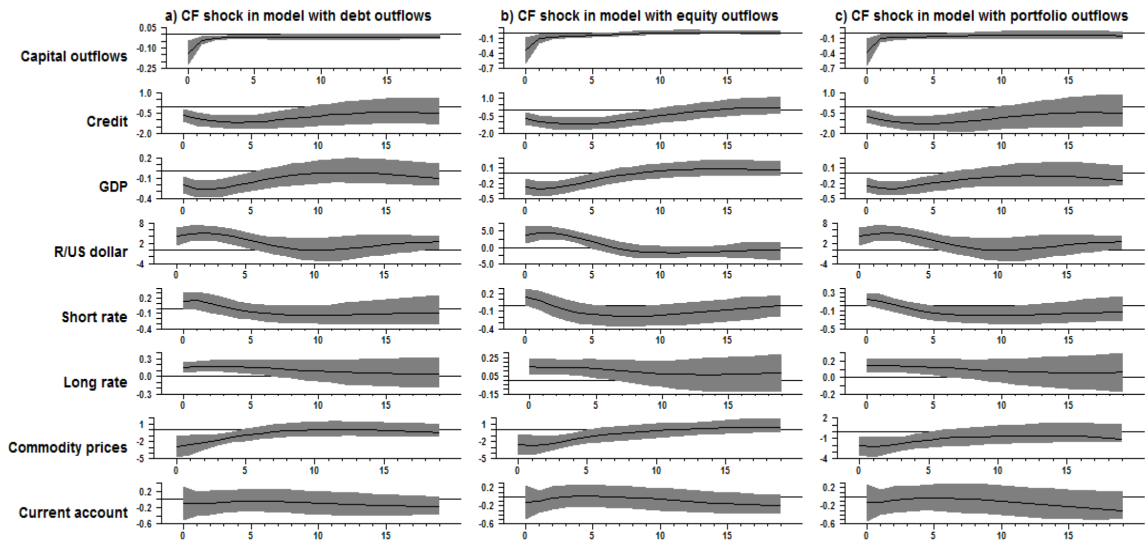
Figure 3.51 Comparison of the responses to sudden stops



Source: Author's calculations

However, the depreciation in the exchange rate assists in the narrowing of the current account. But the narrowing of the current account is short lived and insignificant suggesting that the effects of the depreciation in exchange rate and the decline in commodity prices probably neutralize the beneficial effects.

Figure 3.52 Comparison of the responses to capital outflows



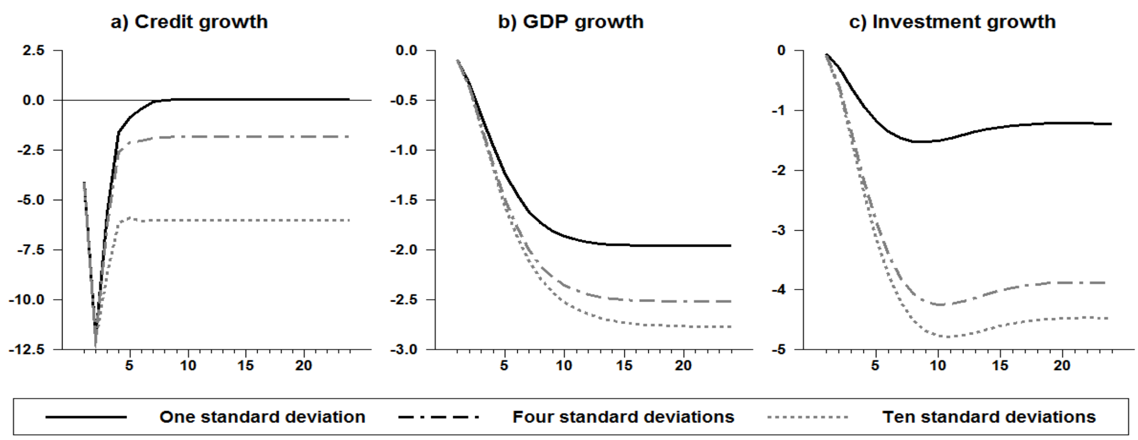
Source: Author's calculations

3.10.1 Responses of selected variables to different magnitudes of capital outflow shocks

The previous section showed the responses of financial and real economy variables to a one standard deviation shock in capital outflows. However, in reality it is possible that in extreme cases of sudden stop episodes capital outflows can be more than a one standard deviation shock. Calvo (1998) and Calvo et al. (2004) identify sudden stops as a decline in the change of net capital inflows exceeding minus two standard deviations below the prevailing mean. Hence in this section we estimate the impact of various sizes of capital outflow magnitudes. We adopt the Kilian and Vigfusson approach for asymmetric transmissions of shocks. The approach uses a scenario approach in the analysis of asymmetric responses to different sizes of capital outflows on selected macroeconomic variables.

Figure 3.53 shows that credit growth declines sharply in response to all magnitudes of capital outflow shocks. However, it recovers much quicker in response to the one standard deviation shock compared to the four and ten standard deviation shocks where credit growth remains depressed for the entire forecast horizon. Similarly, the contraction in GDP and investment growth is less severe due to a one standard deviation capital outflow shock compared to other scenarios.

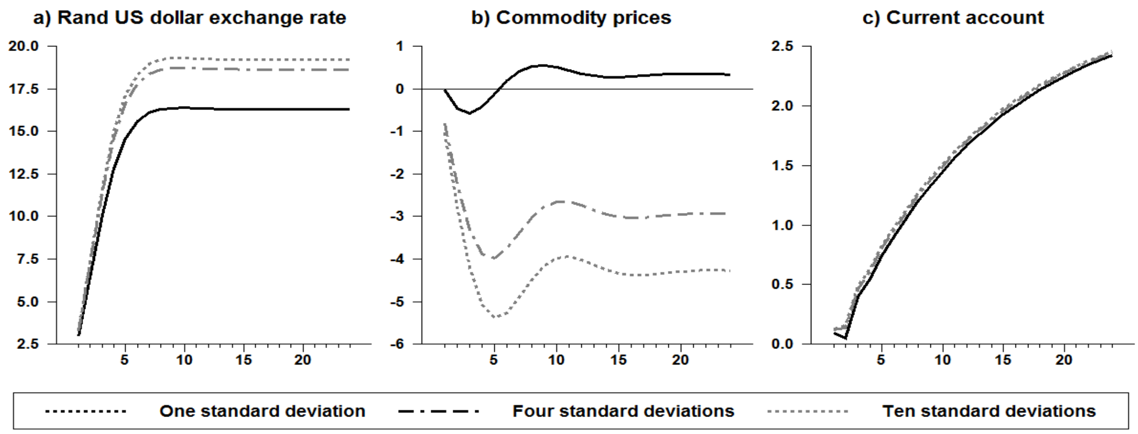
Figure 3. 53 Responses for credit, GDP and investment growth to different magnitudes of capital outflows



Source: Author's calculations

The exchange rate depreciates, commodity prices decline, and the current account improves in Figure 3.54. The severity of the depreciation in the exchange probably results in improved competitiveness of domestic exports whilst discouraging imports at the same time, hence the improvement in the current account.

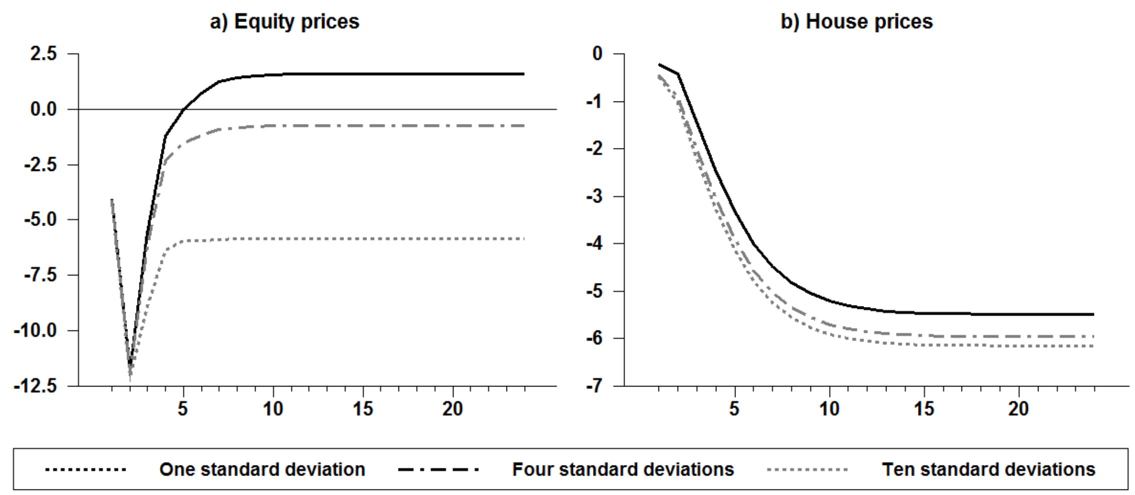
Figure 3.54 Responses for Rand US dollar exchange rate, commodity prices and the current account to different magnitudes of capital outflows



Source: Author's calculations

Finally, equity prices decline but recover much faster due to a one standard deviation shock compared to other scenarios. On the other hand, house prices remain depressed over the entire forecast horizon.

Figure 3.55 Responses for equity prices and house prices to different magnitudes of capital outflows



Source: Author's calculations

3.11 Conclusion and policy implications

Do capital inflow shocks play a much larger role relative to monetary policy shocks in the transmission of positive global liquidity shocks? Moreover, how persistent are the effects of capital inflow and monetary policy shocks? This chapter answered these questions via the pure and penalty function approaches to sign restriction. For policy analysis, we used the counterfactual scenarios and variance decompositions. We estimated various models based on the different components of portfolio inflows and outflows to test for the robustness of our results.

First, across various specifications and capital inflow categories we establish that capital inflow shocks are more persistent and induce more variability in credit, housing prices, equity prices, investment, commodity prices and the current account. Essentially, we confirm that capital inflows shocks have persistent effects compared to monetary policy shocks. The South African data confirms the "*savings glut*" hypothesis. For instance, during the credit and housing boom in 2004Q1 to 2007Q4 monetary policy shocks made positive but very transitory contributions to credit and house price growth compares to capital inflow shocks. Furthermore, capital inflows have larger and more persistent effects on investment, commodity prices and the current account.

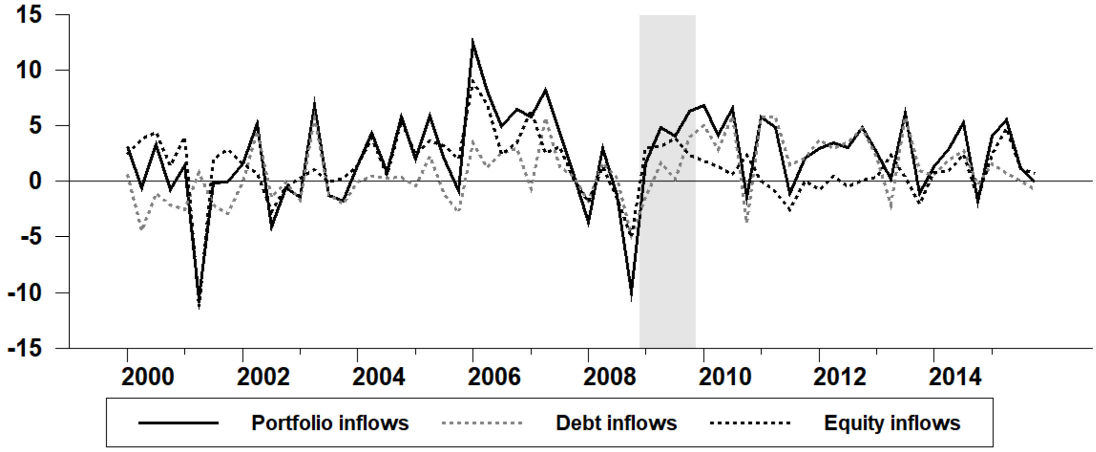
However, the results show that the composition of capital inflows matters. Credit growth and house prices are more responsive to equity inflows compared to debt inflows. Capital inflow shocks, in particular equity inflows were the key contributors to increases in commodity prices during the commodity price boom.

Second, evidence suggests that post the financial crisis and recession in 2009Q4 despite historically low interest rates and liquidity injections by central banks monetary policy shocks have not exerted much stimulatory effects on credit growth. Similarly, the impact of capital inflow shocks is less potent and persistent compared to the period pre-financial crisis. The muted impact of monetary policy and capital inflow shocks may indicate that supply-side factors may be relevant in establishing the link from capital inflows to commodity prices, credit growth and housing market activity. House price growth, equity price growth and commodity prices present additional important channels through which accommodative monetary policy and positive capital inflow shocks are transmitted via different categories of capital inflows to domestic credit markets.

The policy implications derived from the counterfactual scenarios and the comparison of the period pre and post 2009 suggest that it is possible that a domestic supply and demand shocks generate rapid credit growth. The positive but temporary contributions of monetary policy shocks suggest that, monetary policy by loosening the financial constraints, contributes to sentiment and domestic supply and demand. These factors attract capital inflows which support asset prices.

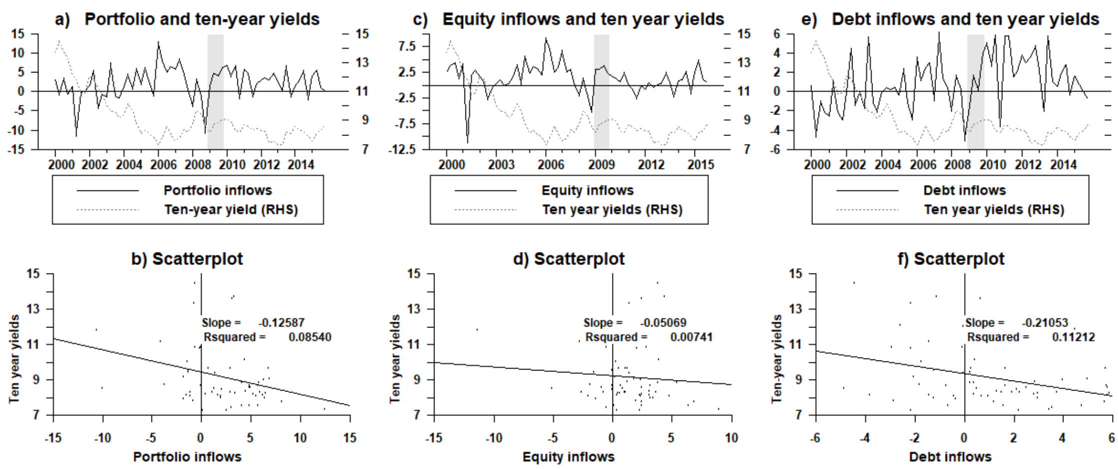
Appendix

Figure A3.1 Portfolio, debt, and equity inflows



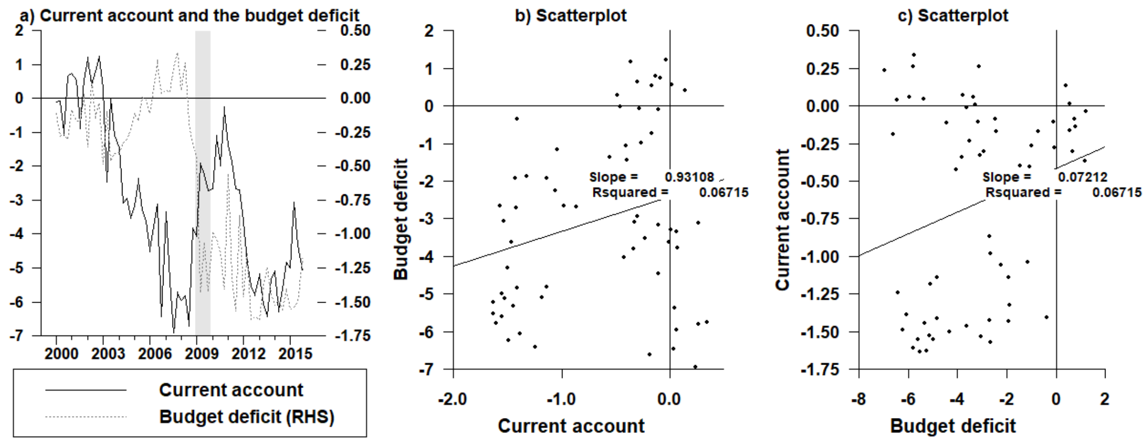
Source: South African Reserve Bank and author's calculations

Figure A3.2 Capital inflows and ten-year bond yields



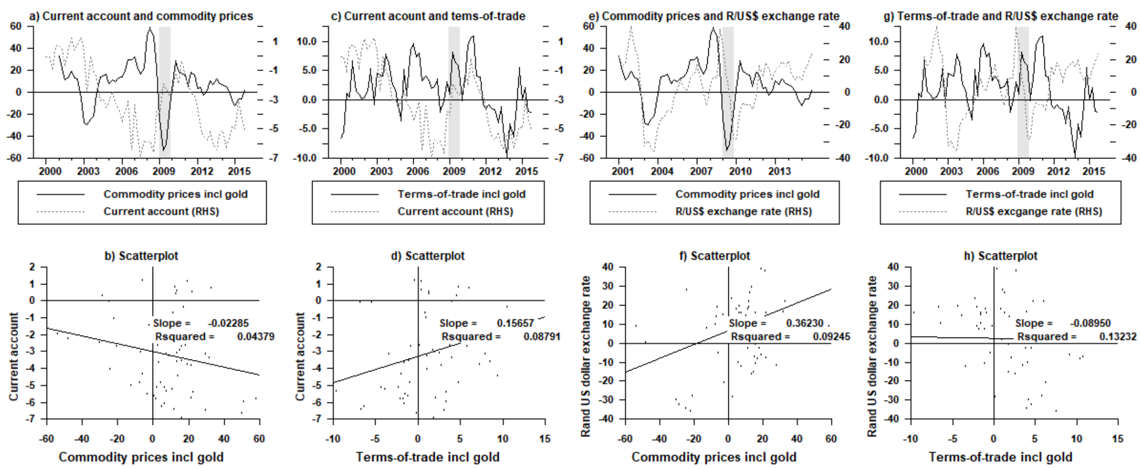
Source: South African Reserve Bank and author's calculations

Figure A3.3 Current account and the budget deficit



Source: South African Reserve Bank and author's calculations

Figure A3.4 Capital inflows and the NEER



Source: South African Reserve Bank and author's calculations

Table A3. 1 Variance decompositions due to a monetary policy shock in model with portfolio inflows

	Portfolio inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	4.5	8.8	19.8	12.3	16.7	10.6
K=4	6.0	12.5	17.0	13.9	16.6	12.5
K=8	6.9	13.8	16.1	15.3	16.2	14.0
K=12	7.4	13.6	16.0	15.7	15.4	14.5
K=16	7.8	13.7	16.1	15.9	15.0	14.5
K=20	8.0	14.0	16.2	15.9	14.5	14.3

Source: Author's calculations

Table A3.2 Variance decompositions due to a monetary policy shock in model with debt inflows

	Debt inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	6.3	8.5	15.8	11.0	15.6	14.5
K=4	7.5	13.4	16.0	12.4	15.9	15.1
K=8	8.8	15.2	16.5	14.5	16.7	16.5
K=12	9.3	15.3	16.6	14.8	16.9	16.6
K=16	9.7	15.5	16.7	14.8	16.4	16.7
K=20	9.9	15.7	16.6	14.8	16.2	16.6

Source: Author's calculations

Table A3.3 Variance decompositions due to a monetary policy shock in model with equity inflows

	Equity inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	5.2	12.3	19.2	10.6	18.2	10.8
K=4	6.9	15.0	16.6	12.0	17.6	11.8
K=8	7.8	14.6	15.2	14.0	16.8	13.6
K=12	8.3	14.0	15.2	14.4	15.8	14.1
K=16	8.6	13.9	15.3	14.6	15.4	14.1
K=20	8.8	14.2	15.4	14.6	15.2	14.1

Source: Author's calculations

Table A3.4 Variance decompositions due to a capital flow shock in model with portfolio inflows

	Portfolio inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	15.4	10.3	9.6	16.7	11.2	12.3
K=4	15.5	15.9	15.5	17.2	13.0	13.0
K=8	15.7	18.1	17.7	17.3	15.5	13.5
K=12	16.1	18.5	17.6	17.1	15.9	13.7
K=16	16.3	18.3	17.4	17.2	15.7	13.9
K=20	16.4	18.1	17.5	17.4	15.4	14.3

Source: Author's calculations

Table A3.5 Variance decompositions due to a capital flow shock in model with debt inflows

	Debt inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	10.5	9.4	10.5	17.4	13.1	9.5
K=4	11.3	14.5	14.8	18.6	14.4	9.9
K=8	11.8	18.4	17.5	18.2	15.7	11.1
K=12	12.3	18.8	17.7	18.3	15.7	11.9
K=16	12.8	18.6	17.6	18.3	16.1	12.5
K=20	13.1	18.4	17.6	18.3	15.9	13.0

Source: Author's calculations

Table A3.6 Variance decompositions due to a capital flow shock in model with equity inflows

	Equity inflows	Credit growth	GDP growth	R/US dollar	Short-term rates	Long-term rates
K=1	17.3	10.2	9.1	16.0	10.2	11.5
K=4	17.0	15.8	14.0	17.4	12.3	12.4
K=8	16.9	18.0	16.5	17.1	14.1	13.6
K=12	17.1	18.3	16.8	17.4	15.5	14.0
K=16	17.2	18.2	16.8	17.3	16.2	14.4
K=20	17.2	18.0	16.9	17.4	16.3	14.8

Source: Author's calculations

Chapter 4 The international portfolio balance approach to money demand in South Africa

4.1 Introduction

The international portfolio balance approach to money demand suggests that the relative portfolio allocation among risky assets depends on domestic and non-resident agents' asset expected returns on domestic and foreign assets, compared to the own rate of return on money (deposits). The period post-global financial crisis was characterised by the decline to zero and in some instances negative levels in policy rates and long-term yields in most Advanced Economies (AEs) thus widening the interest rate differentials with most emerging market economies (EMEs). The international portfolio balance approach (FED model) associates the decline in excess returns on equities with the deviation of the price-earnings (P/E) ratio from the long-term government bond yield. The implication is that when investors expect returns to decline, they reallocate assets and thus resulting in shifts in equity and bond prices that restore equilibrium in the asset markets.

De Santis et al. (2008) augment the conventional money demand specifications by adding variables associated with cross-border capital flows to capture the impact of international portfolio allocation. They find that an increase in the Euro Area P/E ratio in excess of bond yields results in a decline in the Euro Area M3 money supply growth. This means that non-residents sell Euro Area assets to domestic residents and results in a decline in bank deposit holdings. The conclusion is that international capital flows induce portfolio shifts which impact the evolution of monetary aggregates and the money demand function. Furthermore, Fischer et al. (2008) show that correcting the money demand function for portfolio shifts between risky assets and money deposits forms an important part of signalling information contained in the income velocity of money. The authors argue that augmenting the money demand for portfolio shifts improved the information content of money demand and helped avoid potential monetary policy mistakes of inferring inflationary pressures and potential threats to price stability.

This chapter extends the specification of the conventional money demand function by exploring whether the international portfolio balance approach explains the South African money demand function. Furthermore, what role did the widening of the interest rate differential between South Africa (SA) and the United States (US), Euro Area, United Kingdom (UK) and Japan play in the domestic money demand function? How do portfolio shifts induced by changes in domestic and international asset price returns affect the money demand function?

To the best of our knowledge this is the first study to explore whether the international portfolio balance approach explains the evolution of the South African money demand function. We model money demand as part of the international portfolio choice of assets. In addition, post the global financial crisis the role of excess global liquidity, capital flow surges and external financial imbalances had become a topical policy issue for both price and financial stability. Contrary to existing literature such as Hall at al (2008), De Santis et al (2008) and Carstensen (2003, 2006) who included a measure of equity market price returns and volatility and confined their analysis to the US and Euro Area, this study explores the role of (i) asset price purchases by the G4 central banks alternatively (QE) and portfolio inflows on the money demand function and (ii) the interest rate differential between domestic and G4 foreign interest rates and asset price returns on the South African money demand function.

In adopting this approach, the chapter addresses (i) the sectorial re-distribution effects of money holding induced by the portfolio allocation shifts between the risky and safe haven motives for holding money and (ii) the money stock or holding effects induced by transactions between money creating counterparties. Hence this chapter contributes to the literature by augmenting the money demand function with domestic and foreign interest rate differentials and asset price returns to assess whether they convey important information.

We use the Johansen cointegrated VAR approach to estimate the various specifications of the money demand function and derive estimates of the money demand overhang and shortfall. Because the money demand functions are estimated largely based on the evolution of a number of asset price returns, this means that the derived money demand overhang and short-fall positions can be used to assess the sustainability of price and financial stability mandates conditional on the behaviour of asset prices. Hence, we assess whether the derived money demand overhang and shortfall can be interpreted as inflation or asset price risk indicators to price and financial stability. Thereafter, we apply the counterfactual VAR approach to infer the policy implications of the effects of portfolio flows, domestic and international asset price returns on the domestic money demand function.

We find that real money balances are positively linked to real income and negatively to the interest rate spreads as predicted by theory. Augmenting the money demand function with asset price returns yields the desired results of lowering the point elasticity for GDP. This means that they can explain developments in monetary aggregates via the substitution and portfolio balance effects. The cointegration relations derived from the money demand function augmented with asset price returns and interest rate differential suggest that there has been a persistent money demand overhang since 2008Q1. The implication is that both measures are picking up the role of asset price returns and interest rate differentials post-the financial crisis which is absent in the conventional money demand function as it still indicates a substantial and persistent money demand shortfall.

Furthermore, the responses of M3 and inflation to measures of dis-equilibria indicate that the asset market disequilibria incompatible with the long-term inflation behaviour. This means that the inclusion of asset returns in the behaviour of the money demand explains the effects of perpetual structural changes and financial innovation. In addition, developments in asset price dis-equilibria can undermine macroeconomic stability. Augmenting the money demand function with asset price returns yields the desired results of lowering the point elasticity for GDP. The inclusion of asset returns in the behaviour of the money demand explains the effects of perpetual structural changes and financial innovation. The augmented money demand functions can explain developments in monetary aggregates via the substitution and portfolio balance effects. Thus, the augmented money demand functions can pick up the role of asset price returns and interest rate differentials post-the financial crisis which is absent in the conventional money demand function. Developments in asset price dis-equilibria can undermine macroeconomic stability. We therefore conclude that there is valuable, and policy relevant information contained in the augmented money demand functions

The rest of the chapter is organised as follows, section two presents the literature review followed by the discussion of the methodology for estimation, the data, and stylised facts. Section four presents the empirical results followed by the conclusion and policy implications.

4.2 The portfolio balance approach to money demand: Theoretical framework and literature review

The Tobin portfolio balance approach to money demand starts from the premise that the demand for broad money is part of the wealth portfolio allocation. Under this approach money as a safe asset and other risk assets such equities, bonds and the real estate constitute part of wealth. Investors are faced with the intertemporal budget constraint on the holdings of assets and changes in their returns are important in the transmission channels of monetary policy. As a result, the standard money demand framework and the conventional specification of the money demand function need to augment and extended to account for a broader set of opportunity cost variables in order to explain the portfolio allocation shifts between money and other assets such as equities and bonds. This means that income and wealth cannot be interchangeably used as determinants of transactions money demand. The wealth effect associated with an increase in wealth results in increased demand for all assets. On the other hand, the income effect associated with an increase in income induces an increase in the demand for money at the expense of other assets. Hence, both income and wealth should be part of the specification of the money-demand function.

Furthermore, in open economies transactions between domestic and non-resident money holders due to the differential between safe and risky asset excess returns expected by non-resident and domestic agents on the same asset explains the portfolio allocation effect and changes in the aggregate money stock. The analysis of the asset choice in a two-country simple Tobin portfolio framework in De Santis (2008) considers the structure of asset markets as a key element. Wealth owners hold a diversified portfolio consisting of money, as well as risky domestic and foreign assets (stocks and bonds). The model considers five assets (i) domestic equities and bonds (ii) foreign equities and bonds and (iii) domestic money. The representative economic agents in the domestic economy maximise utility subject to an intertemporal budget constraint. Given the opportunity cost of holding money and a constant consumption/wealth ratio, the portfolio allocation of each representative agent is proportional to the Sharpe ratios. The resulting money demand is given by (i) wealth effect (ii) portfolio allocation effect and the (iii) firms' valuation effect.

This means that in the long run, money balances are a positive function of relative disposable wealth and of the differentials between the Sharpe ratios expected by foreign and domestic agents. The implication is that, if the attractiveness of non-monetary assets increases, foreign demand for monetary assets will crowd out domestic demand. Purchases of assets from domestic residents by non-residents lead to an increase in domestic money holdings. But money balances are a negatively related to the firms' aggregate asset value, meaning that the differential between risk-adjusted excess returns expected by non-resident and domestic agents on the same asset in an open economy can result in changes in aggregate M3 holdings. On the other hand, in a closed economy, when the risk-adjusted excess returns on assets rise they result in transfer money from the purchaser to the seller of the asset, thus leaving the aggregate stock of money unchanged.

De Santis et al. (2008) explicitly model euro area net external asset flows underlying portfolio shifts and assume that an increase in expected excess domestic (Euro area) and/or foreign assets (US) returns in the US can affect the demand for money. Because the increase in risk-adjusted excess returns on domestic and/or foreign assets rise induce non-resident investors to buy domestic and/or foreign assets from domestic agents, the portfolio balance effects of an increase in risk-adjusted excess returns result in changes in the demand for money. In this framework, returns on domestic and foreign assets, as well as the own return on M3 influence the domestic money holdings. They show that accounting for excess returns for safe and risky assets yields a stable money demand relationship for the Euro Area within the context of international asset price dynamics.

Fischer et al. (2008) show that correcting the money demand function for portfolio shifts between risky assets and money deposits forms an important part of signalling information contained in the income velocity of money. Augmenting the money demand for portfolio shifts improves the information content of money demand for inflationary pressures and price stability. This means that money demand models should be redefined to allow for portfolio shifts into and out of monetary assets. In this regard, Carstensen (2003, 2006) included a measure of equity market volatility. De Bondt (2009) added unemployment to capture household precautionary motives for holding money. Greiber and Lemke (2005) extract a common factor from a broad set of volatility and survey measures and use it as a synthetic indicator of uncertainty in the Euro Area money demand function.

4.3 The Johansen cointegration approach

The Johansen cointegration approach starts with the VAR of order p in Equation 4.1

$$y_t = \mu + A_1 y_{t-1} + \cdots . + A_p y_{t-p} + \varepsilon_t \qquad (4.1)$$

Where y_t is an $n \times 1$vector of variables that are integrated of order one I(1); ε_t is an $n \times 1$vector of innovations. The VAR in Equation 4.1 can be expressed as Equation 4.2.

$$\Delta y_t = \mu + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \ \Delta y_{t-1} + \varepsilon_t \qquad (4.2)$$

Where, $\prod = \sum_{i=1}^{p} A_i - \mathrm{I}$ and $\Gamma_i = - \sum_{i=1}^{p-1} A_j$. If the coefficient matrix $\prod$ has a reduced rank $r < n$then there exists $n \times r$matrices α and βeachwith rank $r$such that $\prod = \alpha\, \beta'$ and $\beta' y_t$ is stationary, r is the number of cointegration relationships. The elements of $\alpha$are the adjustment parameters in the vector error correction model. For a given r the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the largest $r$canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences. The trace test and the maximum eigenvalue test are the two likelihood ratio tests for the significance of the canonical relations and the reduced rank of the Π matrix. The trace test tests for the null hypothesis of $r$cointegrating vectors against the alternative hypothesis of n cointegration vectors. On the other hand, the maximum eigenvalue test tests the null hypothesis of r conintergating vectors against the alternative hypothesis $r + 1$ cointegration vectors.

For example, in the VECM system $y_t = \left(y_{1,t} \quad y_{2,t}\right)'$ where $y_{1,t}$ is an I (1) and $y_{2,t}$ is an I(1) at least one cointegrating vector given by $\beta = (0\ \ 1)'$ and the Π matrix has full rank then all n variables in the system are stationary. The result is a stationary process or cointegrating relation. The cointegration relation gives the only linear combination of both non-stationary processes which is stationary. Hence the Johansen procedure which allows for correction for serial correlation in the errors is preferred compared to the single Equation procedures.

In the VAR in Equation 4.1 there always exists an error correction representation of the form $y_t = y_{t-1} + \Delta y_t$ and the long run relationship in Equation 4.3

$$\Delta y_t = \Pi\, y_{t-1} + \sum_{i=1}^{p-1} \Phi_i^{\,*}\, \Delta y_{t-1} + \varepsilon_t \quad (4.3)$$

There is an adjustment to the equilibrium y^*or long-term relation described by the cointegrating relation $\Delta y = 0$ and the long-run relation $\Pi_y^{\,*} = 0$ or $\Pi y^* = \alpha(\beta' y^*) = 0$. The long-run relationship does not hold perfectly in $(t-1)$ and there is a deviation (error) given by $\beta' y_{t-1} = \xi_{t-1} \neq 0$ and the adjustment coefficients in α multiplied by the errors in $\beta' y_{t-1}$ induce an adjustment in Δy_t towards equilibrium. The adjustment in $y_{1,t}$ in t to ξ_{t-1} deviation from the long run in $t-1$ is given by Equation 4.4

$$\Delta y_{1,t} = (0.5)\, \xi_{t-1} \; and \; y_{1,t} = \Delta y_{1,t} + y_{1,t-1} \qquad (4.4)$$

If $\xi_{t-1} > 0$ then the error is positive term meaning that $y_{1,t-1}$ is too large which decreases the guarantee of convergence back to the long-run path. But if $\xi_{t-1} < 0$ then the error is negative term meaning that $y_{1,t-1}$ is small and not explosive and increases the guarantee of convergence back to the long-run path.

4.3.1 The counterfactual scenario approach

In this chapter we use the counterfactual analysis is based on the historical decompositions. A historical decomposition approach separates the contributions of shocks on the variable of interest into the base forecast (or trend), own contributions and contributions from other variables. To accomplish this, the model is re-estimated but the effect of the shock of interest is kept constant in the model. When the effect of the shock is held constant, the difference between the baseline and the counterfactual is the response of the variable of interest in the absence of the shock of interest. The counterfactual response of the variable of interest is derived from the subtraction of the contribution of the shock of interest to the variable of interest. The counterfactual response of the variable of interest can be compare it to that derived when the shock is active in the model. The difference between the impulse responses is then interpreted as the role attributed to the shock of interest.

4.4 Data and stylised facts

The sample is for the period **1995Q1 to 2015Q4** and similar to De Santis et al (2008) we use the SA, US, UK, Euro Area and Japan (i) three-month rates and long-term bond yields to calculate the deposit rate spread or the opportunity cost of holding and the interest rate differential between SA and these countries; and (ii) the price earnings ratios as proxies for the Sharpe ratios. Theoretically, the portfolio shares and allocation of all assets depends on the Sharpe ratios which capture the risk associated with asset prices. We use SA M3 money supply, GDP, GDP deflator, net-portfolio and gross portfolio inflows expressed as per cent of GDP. We use the twelve-month negotiable certificate of deposit (NCD) and the SA ten-year government bond yields to calculate the deposit rate spread. The data is sourced from the IMF IFS and South African Reserve Bank databases. All growth rates are at an annual rate.

The domestic M3 money supply is deflated with the GDP deflator. All variables enter the estimations in log form except for the interest rates. Table 4.1 shows the results of the unit root tests for the variables used in the estimations. We establish that the variables are I (1).

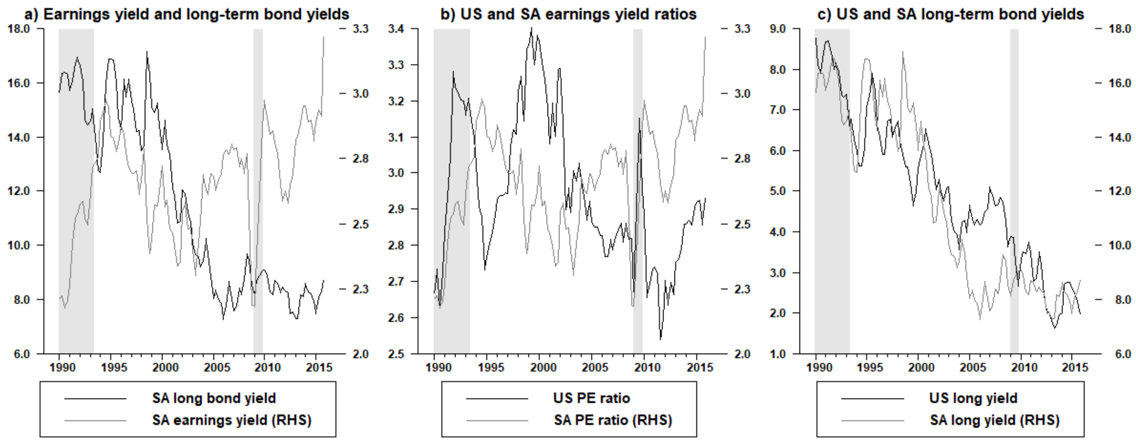
Table 4.1 Unit root tests

Variable	PP	ADF
SA NCD rate	I (1)	I (1)
US three-month rate	I (1)	I (1)
UK three-month rate	I (1)	I (1)
Euro Area three-month rate	I (1)	I (1)
Japan three-month rate	I (1)	I (1)
SA ten-year yield	I (1)	I (1)
US ten-year yield	I (1)	I (1)
UK ten-year yield	I (1)	I (1)
Euro area ten-year yield	I (1)	I (1)
Japan ten-year yield	I (1)	I (1)
SA GDP growth	I (1)	I (1)
SA GDP deflator	I (1)	I (1)
SA M3 growth	I (1)	I (1)
SA PE ratio	I (1)	I (1)
US PE ratio	I (1)	I (1)
UK PE ratio	I (1)	I (1)
Euro Area PE ratio	I (1)	I (1)
Japan PE ratio	I (1)	I (1)
SA portfolio inflows	I (1)	I (1)

Note: Significance at 5 per cent **, at 10 per cent*. Source: Author's calculations

Figure 4.1 shows that the relationship between SA P/E ratio and ten-year government bond yield diverged since 2003. On the other hand, the US and SA P/E ratio diverged during the miod-1990s but have since moved in the same direction with SA P/E ratios higher than those in the US. Similarly, the long-term bond yields in the two countries have tended to trend in the same direction and have persistently declined since the 1990s. The trends observed mean that the international portfolio balance approach to money demand can be partly explained by the divergence of the asset prices leading to the substitution amongst assets and wealth effects within the domestic and international asset portfolios.

Figure 4.1 SA and U.S bond yields and PE ratios



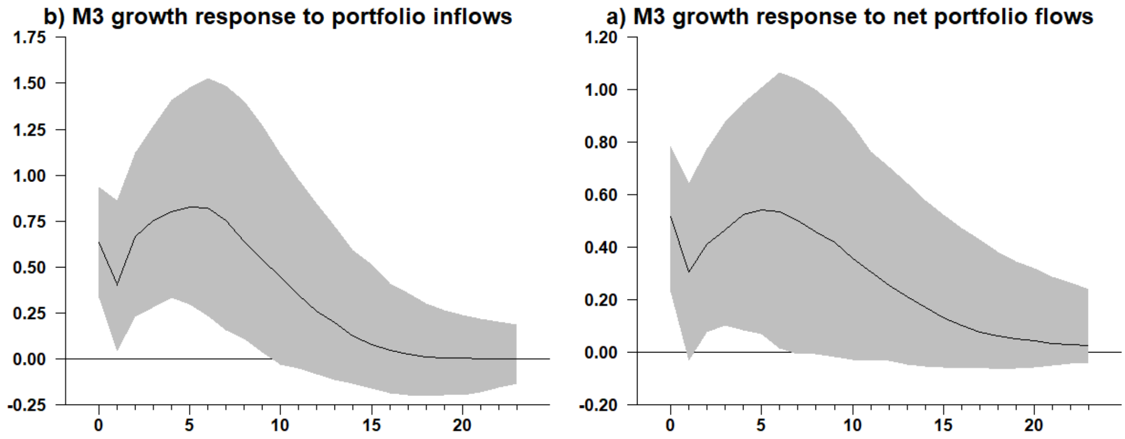
Source: South African Reserve Bank and author's calculations

4.4.1 The impact of portfolio flows on the demand for money

Prior to the empirical estimation of the money augmented money demand function we show the impulse responses on M3 growth to positive shocks to gross and net portfolio inflow shocks. This is to assess how M3 growth responds to a surge in portfolio flows. De Santis et al (2008) show that part of the breakdown in the relationship between M3 growth and inflation in the Euro Area was because of the strong positive link between net cross border capital (portfolio) flows and M3 growth. The substitution portfolio balance effect and substitution effect largely due to heightened financial market and geopolitical uncertainty resulted in portfolio shifts impacting developments in the monetary aggregates.

We estimate a recursive VAR for the period **1995Q1 to 2015Q4** with gross and net portfolio flows, GDP growth the spread. The model is estimated with two lags chosen by AIC. The impulses are generated from 10 000 Monte Carlo draws. The counterfactual responses are responses of M3 growth in the absence of net and gross capital flow shocks. The historical contributions show the evolution of the contributions of gross and net capital flow shocks to M3 growth over time. We only present and discuss the responses of M3 growth. Figure 4.2 shows that M3 growth increases with a delay of about one quarter in response to positive shocks portfolio flows. The peak effects of positive capital flow shocks occur between five and six quarters. The responses imply that indeed cross-border portfolio flow transactions do affect growth in money supply.

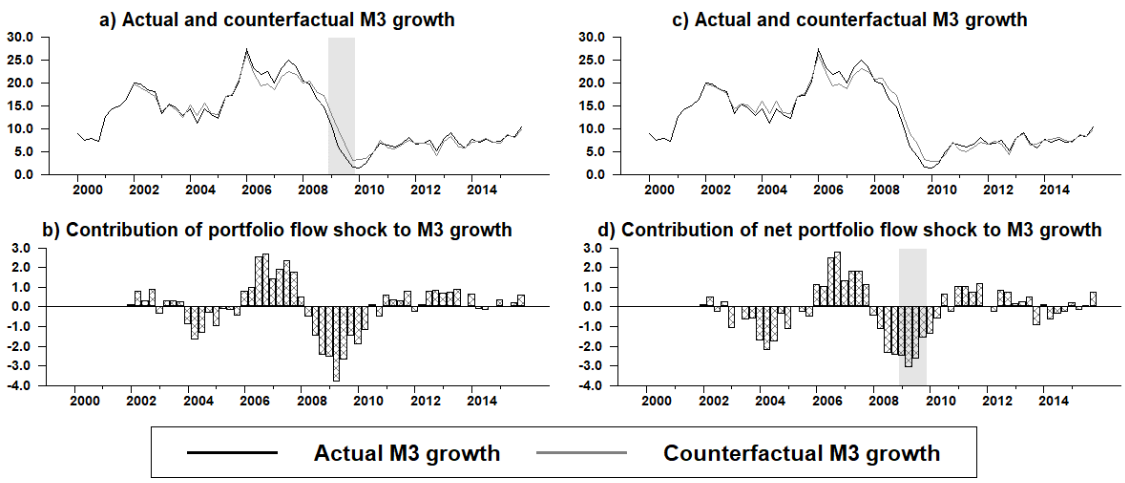
Figure 4.2 M3 growth responses to gross and net portfolio flows



Source: Author's calculations

On the other hand, the counterfactual responses and historical decompositions in Figure 4.3 indicate that between 2006Q1 and 2008Q1 portfolio flows contributed as much as 3 per cent to the increase in M3 growth. This trend was reversed during recession in 2009 as they contributed to decline in M3 growth.

Figure 4.3 Actual and counterfactual M3 growth



Source: Author's calculations

Furthermore, since 2010Q1 portfolio flows has contributed less than 1 per cent to the increase in M3 growth. This implies that despite QE interventions by central banks and the increase in portfolio flows, monetary assets offered extremely limited returns compared to other asset classes hence the muted contribution of portfolio shocks to M3 growth.

4.4.2 The money demand function specifications

The estimation of the money demand functions starts by estimating the conventional money demand function in Equation 4.5

$$(m - p) = \beta_0 + \beta_1 GDP + \beta_2 \, (IR\ spread) \qquad (4.5)$$

Where $(m - p)$ is the log of the stock of real money balances (money supply M3 deflated by the GDP deflator P_t) and y is real GDP growth. The $IR\ spread$ is the difference between the ten-year yield on the government bond and the 12-month NCD rate and captures the opportunity cost of holding money. To assess the role of the international portfolio balance approach on the money demand, Equation 4.6 is estimated.

$$(m - p) = \beta_0 + \beta_1 GDP + \beta_2 \, (PE^{SA}) + \beta_3 \, (IR\ spread^{SA}) + \beta_4 \, (PE^{US}) + \beta_5 \, (spread^{SA\ US}) \qquad (4.6)$$

From a theoretical perspective, the model in Equation 4.6 suggests that the relative portfolio allocation among risky assets depends on asset returns expected by domestic and non-resident agents on domestic and foreign assets compared to the own rate of return on money (deposits). Where, PE^{SA} and PE^{US} are the SA and US price earnings ratios and $spread^{SA\ US}$ is the difference between the SA and US ten-year government bond yields. The specification in Equation 4.6 suggests that domestic residents as holders of money balances maximize their returns by holding both domestic and foreign currencies assets. In addition, the domestic and foreign interest rates and asset price returns variables capture capital mobility. An increase in the foreign interest rates and returns subsequently leads to a decline in the demand for domestic assets. In essence, Equation 4.6 suggests that the demand for domestic monetary assets cannot be realistically estimated without considering the impact of foreign factors.

We also augment Equation 4.6 and include UK, Euro Area and Japan PE ratios and ten-year government bond yields to assess for robustness of the estimated money demand function to model parameter changes and sample size. We adjust the sample size to start in 2001Q1 to 2015Q4 because of the availability of data to calculate the Euro area PE ratios to extract a common factor for the UK, Euro area and Japan. To avoid biased estimations, we extract the common component of the UK, Euro Area and Japan PE ratios and ten-year government bond yields by using the principal component analysis and use the derived factors in the estimations of the money demand function as shown in Equation 4.7

$$(m-p) = \beta_0 + \beta_1 GDP + \beta_2 (PE^{SA}) + \beta_3 (IR\ spread^{SA}) + \beta_4 (PE^{UK\ EA\ Jap}) + \beta_5 (spread^{UK\ EA\ Jap}) \qquad (4.7)$$

Where, $PE^{UK\ EA\ Jap}$ is the common factor for the price earnings ratios for the UK, Euro Area and Japan; and $spread^{UK\ EA\ Jap}$ is the difference between the SA and the factor for UK, Euro Area and Japan ten-year government bond yields.

4.4.3 Cointegration rank tests

De Santis et al (2008) argue that returns on asset prices rule out the presence of a deterministic trend in the long-run equilibrium for bond and stock prices. This means that the tests for the cointegration rank will exclude a deterministic trend. The cointegration rank test for Equation 4.5 in Table 4.2 indicates that the maximum eigenvalues and the trace tests show that there is one cointegration equation. Similarly, the augmented money demand functions in Equation 4.6 and 4.7 show that there are two cointegration equation for the specification that includes US, UK, Euro Area and Japan P/E ratios and long-term bond yields.

The cointegration rank and equations suggest that although the model is estimated as a system only one long-run relationship exists between the variables included in the model for the sample period. We interpret this long-run relationship as the money demand equation. The economic interpretation of the long-run relationship is that there is at least some form of arbitrage that exists between the bond yields, returns on equities and money (monetary assets) across countries. The equity returns, and bond yields are key drivers of the money supply developments. As a result, the positions of dis-equilibria can be interpreted within the asset price and monetary developments nexus.

Table 4.2 Johansen test for cointegration rank tests

H_o: $Rank \leq p$	Trace	Max-Eigenvalues
	Equation 4.5	
$p = 0$	31.82	21.95
	(0.03) **	(0.04) **
$p \leq 1$	9.86	9.25
	(0.29)	(0.27)
	Equation 4.6 SA and US variables only	
$p = 0$	95.75	40.07
	(0.00) **	(0.00) **
$p \leq 1$	69.81	33.87
	(0.06) **	(0.13) **
	Equation 4.7 SA, US, UK, Euro Area and Japan variables included	
$p = 0$	95.75	40.078
	(0.00) **	(0.00) **
$p \leq 1$	69.82	33.88
	(0.18) **	(0.35) **

Note: ** indicates significance at 5 per cent significance level. Source: Author's calculations

Table 4.3 shows the VECM results from various estimated models. The real money balances are positively linked to real income and negatively to the interest rate spreads as predicted by theory. The VECM results in Table 3.3 indicate that the point elasticity for GDP ranges between 1.88 and 1.096. The income elasticity of GDP is more than one but declines significantly in the models that include asset price returns and foreign interest rates. This implies that the inclusion of asset price returns and interest rate differentials explain most of the variation in money demand that is not captured by the income velocity of money.

4.4.4 Cointegration results

The SA interest rate spread ranges between -0.05 and -0.02 and those of the foreign spreads are between -0.05 and -0.11. The magnitudes of the coefficients for GDP and the interest rate spread are comparable to Hall et al (2008), Beyer (2009), De Santis et al. (2008) and Brand and Cassola (2004) amongst other studies. The implication of the estimated coefficients is that the income effect is larger than the interest rate differential effect.

Furthermore, asset price returns are negatively related to money demand and their coefficients range between -0.013 and -0.153. The coefficients are slightly higher than those of the interest rate differentials but lower than those of income. This means that the substitution effect due to the asset returns is significant but slightly smaller in comparison to the portfolio balance effect induced by income effects. However, both the substitution effects and international portfolio balance effects play a role in determining the demand for money.

Table 4.3 Cointegration equation for the conventional money demand function

	Conventional money demand	Augmented with SA US variables	Augmented with SA, UK, EA and Japan variables
LGDP	1.878 (31.461) **	1.300 (11.92) **	1.096 (9.226) **
SA spread	-0.049 (-6.475) **	-0.031 (-5.626) **	-0.015 (-3.861) **
SA US spread		-0.054 (-5.115) **	
SA UK EA Jap spread			-0.110 (-10.373) **
SA PE ratio		-0.014 (-2.661) **	-0.153 (-2.214) **
US PE ratio		-0.013 (-2.185) **	
SA UK EA Jap PE ratio			-0.014 (-1.918) **
ECT	-0.09 (-2.313) **	-0.179 (-5.34) **	-0.255 (-6.468) **

Note: ** indicates significance at 5 per cent significance level. Source: Author's calculations

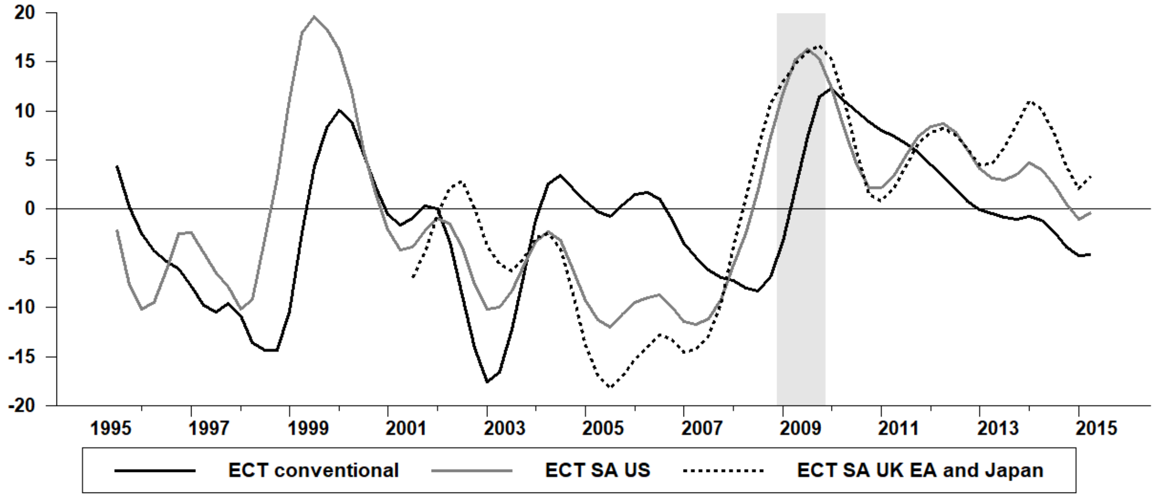
The ECT terms are less sluggish than those implied by the conventional money demand function which suggests that dis-equilibria in the money demand function corrects at a rate of 9 per cent per quarter compared to 18 per cent and 26 per cent in models that include asset price returns and interest rate differential. This means that the inclusion of asset price returns and interest rate differentials in the money demand results in a slightly higher rate of correction of the dis-equilibrium positions.

4.4.5 What do the money demand dis-equilibrium measures derived from different wealth equations suggest?

As stated earlier, the FED model associates the declines in excess returns on equity price and bond yields with the deviation of the price/earnings ratio from the long-term (ten-year government) bond yield. By implication, this means that investors reallocate assets in response to expected falls in returns, causing stock and bond prices to move in a manner that restores equilibrium in the asset markets. The cointegration relationships of the ECT terms reported in Table 4.3 are shown in Figure 4.3 and indicate that that the currently real money balances derived from the conventional money demand function are below the long run trend. This means that there is a shortfall in the money demand by almost 5 per cent compared to the recent overhang of 10 per cent during 2009Q1 and 2013Q4.

On the other hand, the cointegration relations derived from the money demand function augmented with asset price returns and interest rate differential suggest that there has been a persistent money demand over-hang since 2008Q1 which has varied between 15 and 10 percent. First, the implication is that both measures are picking up the role of asset price returns and interest rate differentials post-the financial crisis which is absent in the conventional money demand function as it still indicates a substantial and persistent money demand shortfall. The performance of financial assets post-2009 possibly indicates the role of various rounds of QE from central banks of financial assets. It is common knowledge that bond yields and equity price in particular performed better than other assets classes.

Figure 4.4 Estimates of excess and shortfall in money demand



Source: Author's calculations

Since the models including asset price returns explains monetary developments in a system that includes the evolution of a broad set of asset returns, this means that models are picking up the developments in money demand conditional on the behaviour of asset prices. The dis-equilibria positions possibly indicate the asset market disequilibria which is incompatible with the long-term asset price behaviour. Growth in money supply must be analysed in a system that includes a broader set of asset price developments for it to be policy relevant.

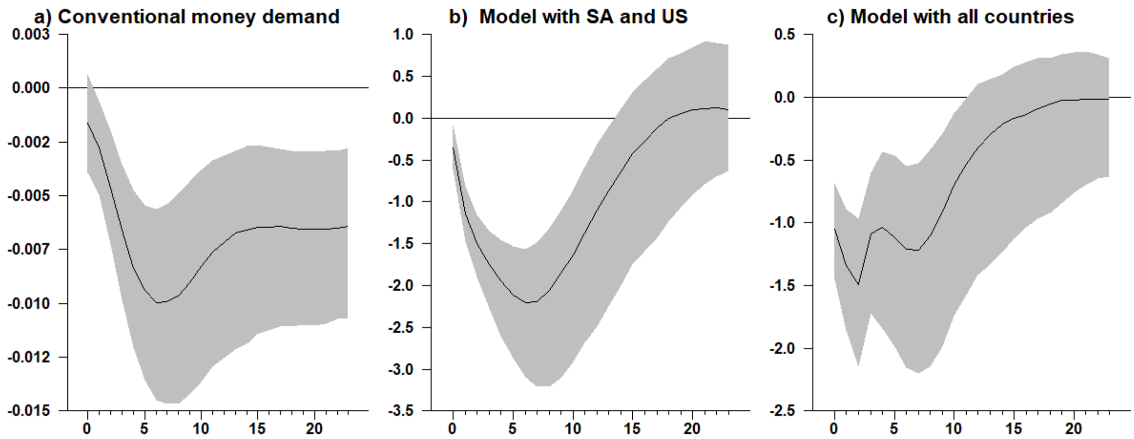
4.5 Evidence from impulse responses: The impact of money demand dis-equilibria position on money growth

We estimate the VAR specified in Equation 4.8 to assess the role of the disequilibria positions on the money demand function or growth real and nominal growth in M3. We use the estimated dis-equilibria positions estimated from Equations 4.5, 4.6 and 4.7.

$$Y_t \quad \{ECT^{conv}\ GDP\ M3\ spread\} \qquad 4\ 8$$

Where, ECT^{conv} is the dis-equilibria position derived from Equation 4.5, GDP is output growth and the spread is the twelve-month negotiable certificate of deposit (NCD) and the SA ten-year government bond yield. In later estimations we replace the dis-equilibria derived from conventional money demand with $ECT^{SA\ US}$ which is derived from the model which includes SA and US returns and $ECT^{SA\ UK\ EA\ Jap}$ is dis-equilibrium position derived for the model that includes the asset returns from the UK, Euro Area and Japan. The analysis focuses on the impulse and counterfactual responses for money supply growth. Figure 4.5 shows that M3 growth declines in response to all measures of dis-equilibria.

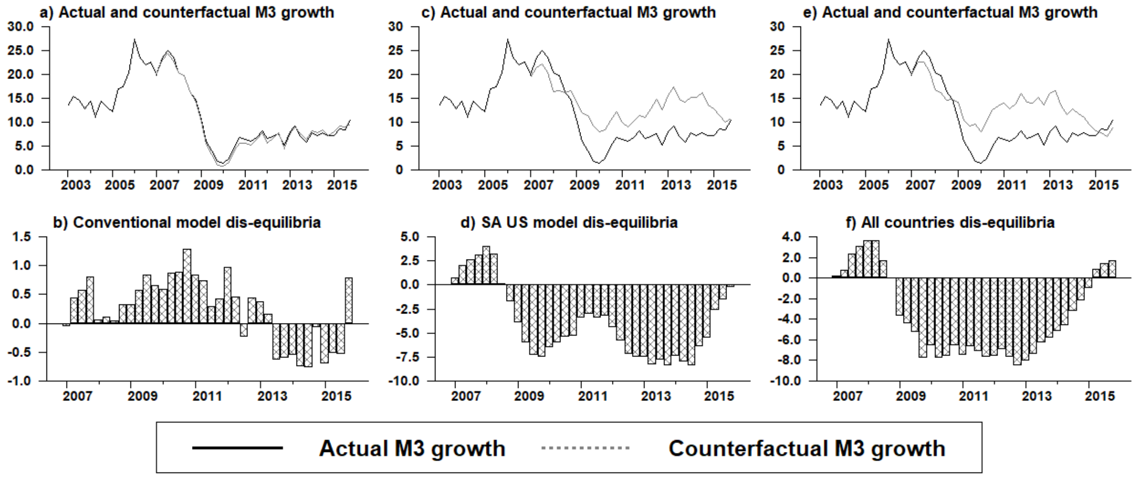
Figure 4.5 Responses of M3 growth to money demand dis-equilibria



Source: Author's calculations

The decline is more pronounced in the case of a model with the SA and US asset price returns possibly due to the size of the US and dominance in financial markets. Furthermore, Figure 4.6 shows how the contributions of dis-equilibria shocks from different models have evolved over time. The trend displayed by the contributions of the dis-equilibria from the augmented money demand models shows that monetary asset price returns have been a drag in the money supply growth for the most part of 2009.

Figure 4.6 Actual and counterfactual M3 growth

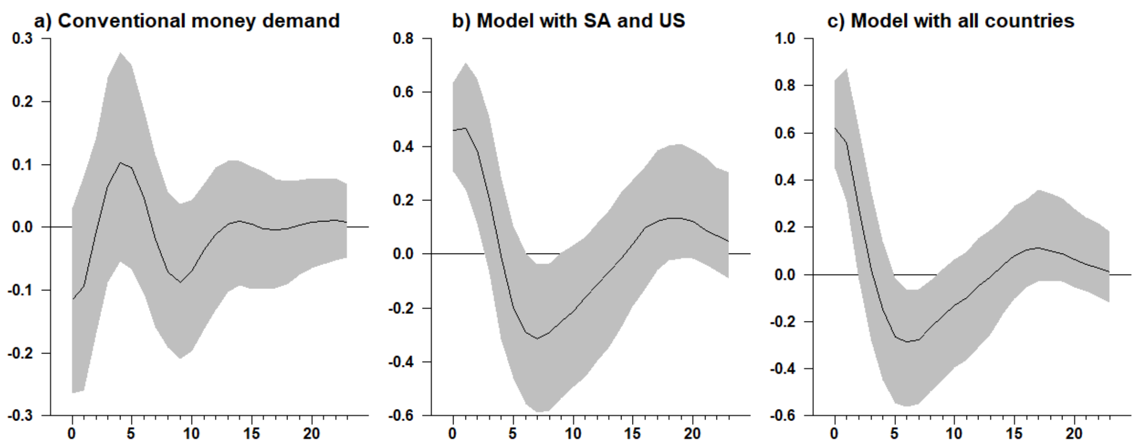


Source: Author's calculations

4.5.1 The impact of excess asset returns on the demand on inflation

We conclude this section by assessing the responses of inflation to positive shocks to the estimated dis-equilibria positions. We estimate a VAR specified in Equation 4.8 but extend the model by including inflation. Figure 4.6 shows that inflation increases more in response to the increases in dis-equilibrium positions and mostly so due to those derived from models with asset price returns.

Figure 4.7 Responses of inflation growth to money demand dis-equilibria



Source: Author's calculations

The responses to the conventional dis-equilibria suggest that although inflation increases it is not significant consistent with the observation that the conventional money demand function does not contain much information about inflation. Furthermore, this indicates that the augmented money demand functions contain more information about inflationary pressures.

4.6 Conclusion and policy implications

This chapter estimated the international portfolio balance approach to the South African money demand function. We estimated three VECM models representing the (i) conventional money demand function (ii) money demand function augmented with the South African and US asset price returns and interest rate differential (iii) money demand function augmented with the South African and UK, Euro Area and Japan asset price returns and interest rate differentials.

We find that real money balances are positively linked to real income and negatively to the interest rate spreads as predicted by theory. Furthermore, augmenting the money demand function with asset price returns yields the desired results of lowering the point elasticity for GDP. This means that they can explain developments in monetary aggregates via the substitution and portfolio balance effects. The cointegration relations derived from the money demand function augmented with asset price returns and interest rate differential suggest that there has been a persistent money demand over-hang since 2008Q1 which has varied between 15 and 10 percent. The implication is that both measures are picking up the role of asset price returns and interest rate differentials post-the financial crisis which is absent in the conventional money demand function as it still indicates a substantial and persistent money demand shortfall.

In addition, the responses of M3 and inflation to measures of dis-equilibria indicate that the asset market disequilibria incompatible with the long-term inflation behaviour. This means that the inclusion of asset returns in the behaviour of the money demand explains the effects of perpetual structural changes and financial innovation. Furthermore, developments in asset price dis-equilibria can undermine macroeconomic stability. Thus, there is valuable, and policy relevant information contained in the augmented money demand function.

Chapter 5 Wealth and asset price returns and the information content of the money demand function

5.1 Introduction

The money demand function captures the link between money growth and inflation. However, the information content of the money supply and the income velocity of money weakened in the 1990s in part due to financial liberalisation, globalisation, and changes in monetary policy frameworks. As a result, policymakers paid less attention to monetary aggregates as key variables in assessing inflationary pressures and forecasting inflation. But post-financial crisis, the role of monetary and credit aggregates is being revisited to assess whether there is a case to redefine and improve broad monetary aggregates for price and financial stability policy objectives.

Recent studies have adopted the wealth and portfolio balance approaches to the money demand specification. The idea being that money is part of a wide range of assets and wealth portfolio and that a wealth and portfolio analysis is required to understand the money demand process. Furthermore, portfolio allocation decisions by domestic and foreign investors generate international portfolio flows which affect the money demand function. Beyer (2009) shows that the inclusion of financial and housing wealth in the traditional money demand function improves the stability of the income velocity of money. De Santis et al. (2008) show that the Euro area money-demand function is stable once euro area and U.S. equity prices and bond yields are included in the model. In addition, the measures of excess M3 derived from the augmented model can forecast developments in inflation.

It is against this background that this chapter explores whether the inclusion of wealth and asset price returns in the money demand function can improve the ability of the money demand function to provide policymakers with important signals about potential risks to price and financial stability. Contrary to Hall et al (2007) we use three estimates of wealth household wealth, namely, aggregate wealth, financial wealth, and housing wealth. Furthermore, we complement the assessment of the wealth channel by augmenting the specification to estimate the portfolio-balance approach to the money demand function.

For policy analysis and implications, we assess the impact of dis-equilibria in the real wealth positions of households, equity price and real estate prices on the money demand. In addition, we estimate thresholds for the real money demand to assess how they exert non-linear GDP growth and inflation responses. To the best of our knowledge there is no empirical analysis of this nature in South Africa. Thus, the chapter contributes to existing literature by exploring the applicability of the wealth channel and portfolio-balance approaches to money demand in South Africa. The assessment of the wealth channel entails the inclusion of financial and non-financial wealth in the traditional money demand function. On the other hand, the portfolio-balance approach includes the price-earnings yields and house prices in the money demand function to capture expectations about asset returns. Augmenting the money demand function in this manner formally tests the anecdotal evidence that that financial innovation, liberalisation, wealth effects and the portfolio allocation effects are better able to explain the South African money demand function.

Second, we use the error correction terms as indicators of the money demand gaps derived from the estimated VECM models to assess the responses of the money demand function to disequilibria in real household wealth position, equity prices and house prices. Third, for policy analysis we estimate the thresholds at which real money demand exerts non-linear effects on GDP growth and inflation. We use the Balke (2000) approach to estimate the real money demand thresholds in models with different specifications including various real household wealth and asset price variables. Thereafter, we use the estimated thresholds in a thresholds VAR model to assess the non-linearities introduced on GDP and inflation responses.

We find that augmenting the money demand function with wealth and asset price variables matters. The impact of real asset prices and real wealth, in particular equity prices, result in a higher decline in the demand for real money balances compared to, for example real house prices. The increase in the dis-equilibria in the wealth position of households and asset prices results in a decline in the money demand. This means that the augmented money demand functions capture the substitution and wealth effects as postulated by the portfolio balance theory.

Furthermore, we establish that the wealth and asset prices augmented money demand functions are slow to adjust from dis-equilibria. This means that the disequilibrium takes longer when considering the role of real financial wealth than is the case under the conventional money demand function. This is consistent with the recent empirical evidence showing that financial cycles take longer to adjust. We establish that the real money demand threshold occurs around 5.90 per cent. Shocks to real money demand induce non-linearities in the responses of economic activity and inflation. Positive shocks to real money demand below the threshold of 5.90 per cent result in lower GDP growth and inflation.

The rest of the chapter is structured as follows: section two presents the literature review followed by the econometric techniques used in empirical analysis. Section four looks at the data followed by the empirical analysis and the conclusion and policy implications.

5.2 Literature review

Literature suggests that the link between money growth and inflation changes as monetary policy regimes change. De Grauwe and Polan (2005) show that the information content of money growth depends on the inflationary environment. The direct link between monetary aggregates, the income velocity of money and inflation is stronger during periods of high inflation as was the case during the Great Inflation in the 1970s and 1980s. This means that the degree to which money changes at a proportional rate as inflation becomes weaker in low-inflation regimes.

Benati (2009) shows that shift in the income velocity of money lead to a decline in the long-run correlation between inflation and money growth. In addition, the variability of inflation explained by money growth declines as the economy moves from a high to a low inflation regime. The implication is that a low correlation between money growth and inflation partly reflects structural shifts in the money and inflation relationship induced by monetary policy regime that have successfully managed to systematically stabilise inflation. Hence, Papademos and Stark (2010) argue that the decline in the income velocity of money and the correlation between money growth and inflation does not necessarily contradict the validity of the quantity theory and the important role of money growth in policy making. Teles et al (2016) find that the relationship between average inflation and the growth rate of money improves when the specification it is corrected for variation in output growth and the opportunity cost of money. However, in countries under the inflation targeting with considerably less inflation variability the quantity theory of money presupposed one-for-one relationship between money growth and inflation does not hold.

The empirical literature on the long-term relationship between monetary and credit aggregates and inflation can be divided into three broad strands. The first strand comprises studies that explore the usefulness of money and credit as leading indicators for inflation, economic activity, and banking crises. Studies such as Gerdesmeier et al. (1996) establish robust findings that domestic monetary and credit growth are leading indicators of growing financial imbalances and inflationary pressures. Similarly, Adrian and Shin (2009) show that global monetary developments are a key leading indicator of domestic asset price bubbles in industrialised countries. The effects are particularly potent when they coincide with booms in asset prices such as equity and property prices.

The second strand of studies focuses on the dynamic inter-linkages between monetary dynamics and asset price dynamics. Borio and Zhu (2008) provide evidence that the effect of money and credit on house prices is stronger during asset price booms than normally. This means that domestic credit growth significantly affects asset prices in particular, house prices. A third strand of studies focuses on the ability of monetary indicators to signal costly asset price booms or asset price busts. Adalid and Detken (2007) show that monetary and credit aggregates are leading indicators of unsustainable asset price developments.

The empirical studies of the money demand analysis established robust result that real money balances are positively linked to real income and negatively to interest rates. However, in the late 1980s and 1990s the instability in the money demand function resulted in the loss information the income velocity of money contained about economic activity and inflationary pressures. In recognition of this weakness Papademos and Stark (2010) establish that the extended money demand specifications are better able to account for portfolio shifts than their conventional predecessors. Moreover, they provide insight into the interrelationships between monetary developments, asset prices and financial structures that have been central to recent financial crisis. They show that strong growth of Euro area broad money between 2004 and 2007 can be explained by the rapid increase in asset prices and household wealth.

Bayer (2009) shows that the inclusion of wealth improves the stability of the money demand model in the Euro area. The study shows that wealth measures, in particular, housing wealth is an important explanatory variable of long-run money demand and can capture changes in the income velocity of M3 trend. De Santis et al. (2008) model net external assets by extending the conventional specifications of the money demand function. They include a broader set of variables that capture the opportunity cost of holding money to explain (i) portfolio shifts between money and securities holdings (ii) asset prices for domestic and foreign stocks and bond returns and (iii) interest rates of different maturities.

Koivu et al. (2005) attribute the decline in excess returns on stocks with the deviation of the price-earnings ratio from the long-term bond yield. This means that investors reallocate assets in response to expected falls in returns thus causing stock and bond prices to move and restore equilibrium in the asset markets. Similarly, De Bondt (2009) presents empirical evidence that equity has a positive effect on money demand through wealth effects and a negative substitution effect through expected returns equity market. On the other hand, the labour market has an impact via the precautionary motive. The conclusion is that equity and labour markets do matter for the money demand function.

Furthermore, McCallum and Nelson (2010) suggest changes in the relationship between interest rates (policy rates) and inflation, and therefore changes in the opportunity cost of holding money contributed to changes in the income velocity of money. Woodford (2003) shows that when the Taylor rule satisfies the Taylor principle i.e. increasing the real interest rate in reaction to upward inflationary pressures, a unique equilibrium emerges where inflation is on target and output at its potential. Furthermore, in relating monetary aggregates to systematic monetary policy changes, Svensson (2000) shows that the optimal policy aimed at stabilising inflation around the target does respond to monetary developments to the degree they contain information about inflationary pressures and economic activity.

Gerdesmeier et al. (2002), use the P^* framework is that characterises inflation as a function of the real money gap i.e. the difference between current and long-run real balances to show that monetary policy decisions are affected by monetary developments. They establish that monetary developments can exert a substantial influence on interest rate decisions due to the high costs associated with ignoring such developments. To capture the influence of foreign variables in determining an appropriate money demand function, recent studies have considered the impact of the exchange rate, foreign interest rate, price earnings ratio, price dividend ratio and long-term bond yields.

Table 5.1 Key findings of money demand studies in South Africa

	Technique	Sample	Coefficient				
			GDP	CPI	SR	LR	wealth
Jonsonn (2001)	SVEC	1970Q1 to 1998Q2	1.14		0.02	-0.04	
Ricci (2005)	VECM	1970Q1 to2002Q4	1.03	1.07	0.01	-0.04	
Nell (1999)	VECM	1965Q1 to 1997Q4	1.28			-0.1	
Wesso (2002)	VECM	1971Q1 to 2000Q4	1.84		-5.11	-2.76	
Todani (2005)	VECM	1980Q1 to 2003Q4	3.20		6.30	-6.30	
Hall et al (2007)	VECM and TVC	1970Q1 to 2006Q4	1.46		-0.02		0.31

Note: SR is the short-term interest rate and LR is the long-term interest rate.

For instance, Carruth and Sanchez-Fung (1997) and Chowdhury (1997) and Jonsonn (2001) include the exchange rate in the money demand function to captures the impact of the currency substitution effect. The expected depreciation of the exchange rate leads to a decline in the demand for domestic money and an increase in the demand for foreign money. De Santis et al (2008) use the Euro Area and US price earnings ratio, ten-year government bond yields to link the money demand function and net portfolio flows. This approach is used to approximate Sharpe ratios and expectations of excess returns.

Several South African studies have investigated the stability of the money demand function and the information content of M3 money supply for inflation. A summary of the sample, technique used, variables included, and the sizes of the estimated coefficients is presented in Table 5.1. For instance, Nell (1999) finds a stable long-run relationship between money, prices, income, and interest rates in South Africa. Jonsson (2001) includes the exchange rate in the specification of the money demand function and found evidence of a stable money-demand relationship. Wesso (2002) used established a time varying income coefficient in the money demand function consistent with an increasing degree of financial intermediation. Similarly, Ricci (2005) established a stable money demand function and the income elasticity close to one. On the other hand, Todani (2007) estimated high income elasticity and attributed this to omitted variable bias. In addition, he established a stable money demand function for the period 1980Q1 1998Q4 and instability after this period.

With regards to the potential role of wealth in the money demand function, Aron et al (2006) present evidence of the presence of the wealth effect in the consumption function in South Africa. While the study did not establish the role of wealth in the money demand function per se, Hall et al (2008) used the stock-market valuation as a proxy for the level of wealth. They found that the portfolio-balance specification of M3 demand is stable for the period 1970Q1 to 2006Q4. Furthermore, they conclude that the exclusion of wealth in the money demand function leads to biased estimates and that M3 growth does provide useful information about medium to long-term inflation.

5.3 The Johansen vector error correction approach

The Johansen cointegration approach starts with the VAR of order p in Equation 5.3

$$y_t = \mu + A_1 y_{t-1} + \cdots . + A_p y_{t-p} + \varepsilon_t \qquad (5.3)$$

Where y_t is an $n \times 1$vector of variables in the VAR model that are integrated of order one I (1), alternatively, stationary when differenced once; ε_t is an $n \times 1$vector of innovations. The VAR in Equation 5.3 can be expressed as Equation 5.4.

$$\Delta\, y_t = \mu + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i\ \Delta\, y_{t-1} + \varepsilon_t \qquad (5.4)$$

Where, $\prod = \sum_{i=1}^{p} A_i -$ I and $\Gamma_i = - \sum_{i=1}^{p-1} A_j$. If the coefficient matrix $\prod$ has a reduced rank $r < n$then there exists $n \times r$matrices $\alpha\ and\ \beta$each with rank $r$such that $\prod = \alpha\, \beta'\ and\ \beta' y_t$ is stationary, r is the number of cointegration relationships. The elements of $\alpha$are the adjustment parameters in the vector error correction model. For a given r the maximum likelihood estimator of βdefines the combination of y_{t-1} that yields the largest $r$canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences.

The trace test and the maximum eigenvalue test are the two likelihood ratio tests for the significance of the canonical relations and the reduced rank of the Π matrix. The trace test tests for the null hypothesis of $r$cointegrating vectors against the alternative hypothesis of n cointegration vectors. On the other hand, the maximum eigenvalue test tests the null hypothesis of r conintergating vectors against the alternative hypothesis $r + 1$ cointegration vectors.

For example, in the VECM system $y_t = \begin{pmatrix} y_{1,t} & y_{2,t} \end{pmatrix}'$ where $y_{1,t}$ is an I (1) and $y_{2,t}$ is an I(1) at least one cointegrating vector given by $\beta = (0\ \ 1)'$ and the Π matrix has full rank then all n variables in the system are stationary. The result is a stationary process or cointegrating relation. The cointegration relation gives the only linear combination of both non-stationary processes which is stationary. Hence the Johansen procedure which allows for correction for serial correlation in the errors is preferred compared to the single equation procedures.

In the VAR in Equation 5.3, there always exists an error correction representation of the form $y_t = y_{t-1} + \Delta y_t$ and the long run relationship in Equation 5.5

$$\Delta y_t = \Pi\, y_{t-1} + \sum_{i=1}^{p-1} \Phi_i{}^{*}\, \Delta y_{t-1} + \varepsilon_t \quad (5.5)$$

There is an adjustment to the equilibrium y^*or long-term relation described by the cointegrating relation $\Delta y = 0$ and the long-run relation $\Pi_y{}^* = 0$ or $\Pi y^* = \alpha(\beta' y^*) = 0$. The long-run relationship does not hold perfectly in $(t-1)$ and there is a deviation (error) given by $\beta' y_{t-1} = \xi_{t-1} \neq 0$ and the adjustment coefficients in α multiplied by the errors in $\beta' y_{t-1}$ induce an adjustment in Δy_t towards equilibrium. The adjustment in $y_{1,t}$ in t to ξ_{t-1} deviation from the long run in $t-1$ is given by Equation 5.6

$$\Delta y_{1,t} = (0.5)\, \xi_{t-1}\ and\ y_{1,t} = \Delta y_{1,t} + y_{1,t-1} \qquad (5.6)$$

If $\xi_{t-1} > 0$ then the error is positive term meaning that $y_{1,t-1}$ is too large which decreases the guarantee of convergence back to the long-run path. But if $\xi_{t-1} < 0$ then the error is negative term meaning that $y_{1,t-1}$ is small and not explosive and increases the guarantee of convergence back to the long-run path.

5.3.1 Tests for a break in the series, delay parameter, and the threshold

The first step in the estimation of the threshold VAR model (TVAR) and the STAR models is to formally test for the presence of threshold-type non-linearity in the data. To avoid dealing with the thresholds directly, Tsay (1989) proposes a conventional F test based on an auxiliary regression. The tests for the existence of the thresholds and non-linearity in the data are done for the null hypothesis of no threshold or breakpoint in the series. But the threshold needs to be identified first under the alternative hypothesis. As a result, we use the (i) Arranged Autoregression and Tsay (1998) F-test (ii) Hansen Threshold test and (v) STAR test, (iii) Andrews–Quandt test and Andrews-Ploberger test and (iv) Zivot and Andrews (1992) and Lumsdaine-Papell (1997).

The arranged autoregression and Tsay (1989) F-test avoid dealing with the thresholds directly and instead use the conventional F test based on an auxiliary regression. The Tsay (1998) approach uses arranged autoregression with recursive least squares (RLS) estimation in Equation 5.7.

$$y_t = x_t\, \emptyset^{(j)} + \sigma^{(j)} \epsilon_t\ if\ r_{j-1} < z_t \leq r_j \qquad (5.7)$$

Where, $X_t = \left(1, y_{t-1}, y_{t-2}, y_{t-p}\right)$, $j = 1,2,3, k\ and - \infty = r_0 < r_1 < \cdots r_k - \infty$. The thresholds $r_0, r_1, \ldots r_{k-1}$divide the domain of the threshold z_t into k different regimes. In each different regime, the time series y_t follows a different $AR\ (p)$ model. When the threshold variable $z_t = y_{t-d}$ with the delay parameter d, the dynamics or regime ofy_t is determined by its own lagged values of y_{t-d}. Since the thresholds values r_i are unknown, the Tsay (1989) approach arranges for all $t = \max(d, p) + 1, \ldots n$ where n is the sample size such that the equations are arranged according to the threshold variable y_{t-1} can take any value in the $Y_d = (y_n, \ldots, y_{n-1})$ with $h = \max(1, p + 1 - d)$ and

$$y_{\pi_i} = x_{\pi_i} \emptyset + \sigma\, \hat{\varepsilon}\pi_i \qquad (5.8)$$

For, $i = 1,2,3, \ldots .n', n' = n - d - h + 1$ is the sample size for the arranged autoregression π_i is the index in the original sample such that $y_{\pi_{i-d}}$is the i_{th} smallest value in y_d. To test for threshold non-linearity the Tsay (1989) computes the RLS estimates for $\widehat{\emptyset}$ in Equation 5.8 such that if there is no threshold nonlinearity, the residuals $\hat{e}_{\pi_i}$ should be white noise asymptotically and orthogonal to x_{π_i} . But if y_t does not follow an $AR(1)$ process and $j > 1$ then the RLS estimates of $\widehat{\emptyset}$ are biased and $\widehat{\Psi}$ in the auxiliary regression in Equation 5.9 will be statistically significant and the conventional F statistic for testing $\Psi = 0$ can be used as a test for threshold nonlinearity.

$$\hat{e}_{\pi i} = X'_{\pi i}\, \Psi + \mu_{\pi i} \qquad (5.9)$$

Once the null hypothesis for of no-threshold is rejected the delay parameter d and the threshold $r_i\ for\ i = 1,2, \ldots, k - 1$ can be estimated using least squares. As long as there are enough observations on each side of the threshold (each regime) the least squares estimates are consistent. The delay parameter $d$is chosen such that Equation 5.10.

$$d = argmax_{v \in s} F\ (p, v) \qquad (5.10)$$

Where, $F\ (p, v)$is the F stat with an $AR(p)$ and the delay parameter equal to $s\ and\ v$ is a set value of d. On the other hand, the Hansen (1999) procedure estimates multiple regimes together with other model parameters and valid confidence intervals can be constructed for the estimated threshold. The Hansen (1999) approach facilitates for the estimation of exogenous thresholds and recommends 10 per cent of the total number of observations during the grid search for the threshold to ensure that each regime contains a minimum number of observations. The Hansen test trims the higher values of the variable of interest from influencing the threshold value by removing influence of outlying observations. This threshold method removes 15 per cent of large and small values at both ends of the time series of interest. The threshold is determined from the remaining 70 per cent of the observations.

The Andrews-Ploberger and Andrews-Quandt tests assess for the structural break tests in a linear regression. These tests use the Hansen approximations for p-values to test for a single structural break at an unknown point within the sample. A series of LM statistics are generated for breaks at each of the points of the data set. The Andrews-Quandt test uses maximum of the LM statistics to test for structural breaks. Whereas the Andrews-Ploberger uses the geometric mean as the test statistic to establish the structural break point. These test statistics have highly non-standard distributions.

5.3.2 The threshold vector autoregression

We estimate a two-regime threshold VAR model specified in Equation 5.11

$$\begin{aligned} Y_t = [A_1 Y_t + B_1(L) Y_{t-1}] I(y_{t-d} \leq \gamma_1) + [A_2 Y_t \\ + (B_2(L) Y_{t-1}] I(\gamma_1 < y_{t-d} \leq \gamma_2)\ \varepsilon_t \quad \ldots\ldots\ldots.(5.11) \end{aligned}$$

Where Y_t is a vector of endogenous variables, $B_1(L)\, B_2(L)\ and\ B_3(L)$ are lag polynomial matrices, ε_t is a vector of innovations to the non-structural TVAR, the threshold variable y_{t-d} determines the household debt regimes given by γ_1 and γ_2. $I_t\,[.]$ is an indicator that partitions regimes such as $I(y_{t-d} \leq \gamma_1)$ equals 1 when $y_{t-d} \leq \gamma_1$ or 0 otherwise i.e. is the indicator that assumes the value of one when the d-lagged threshold variable y_t is lower than the threshold critical value $\gamma_1\ or\ \gamma_2$and 0 otherwise. The indicator $I_t\,[.]$ is a transitional variable that identifies the two regimes based on the value of y_{t-d} relative to γ which is the endogenously estimated unknown parameter.

In Equation 5.11 is a function of household debt conditions as well as an element in Y_t. Because Y_t is a vector of endogenous variables, the TVAR allows household debt to switch within regimes also due to shocks to other variables in the model. Therefore, shocks to other endogenous variables can all determine whether the economy is in a tight household debt regime or not. This means that the shock to any element ε_t can induce a regime switch in the model hence the identification of the model matters.

5.3.3 Non-linear impulse responses

The system estimated in the TVAR can change regimes by computing the generalized impulse response functions GIRF as in Equation 5.12

$$GIRF_k^{(i)} = E\left[Y_{t+k}|\epsilon_t^{(i)}, \Omega_{t-1}\right] - E\left[Y_{t+k}|\epsilon_t^{(i)}, |\Omega_{t-1}\right], for\ k = 0,1, \dots, \quad (5.12)$$

Where, the initial condition Ω_{t-1} determines the regime that the system is initially in. In Equation 5.9 $\epsilon_t^{(i)}$ is the realized shock which can trigger a regime switch, different initial conditions, different sizes and signs of shocks which result in asymmetric impulse responses. To capture the potential asymmetry, each structural shock enters the model with a different sign (positive and negative) and different sizes (one and two standard deviations). The analysis of the collective non-linear impulse responses becomes what moves the economy from one stage of the business cycle to the next.

5.4 Data and stylized facts

The sample is for the period 1990Q1 to 2015Q4 and we use M3 money supply, GDP, inflation, GDP deflator, gross household wealth, household financial and net wealth, SA and US policy rates, twelve-month negotiable certificate of deposit (NCD), SA and US ten-year government bond yield, SA and US price-earnings ratio (P/E). We calculate the deposit rate spread as the difference between the ten-year government bond and the twelve-month NCD rate. The data is sourced from the South African Reserve Bank database and all growth rates are at annual rates.

Like De Santis et al (2008) we use the SA and US price earnings ratios as proxies for the Sharpe ratios for the two countries. Theoretically, the portfolio shares and allocation of all assets depends on the Sharpe ratios which capture the risk associated with asset prices. The wealth variables and M3 deflated with the GDP deflator. All the variables enter the estimations in log form except for interest rates.

Table 5.2 Order of integration and unit root tests

Variable	PP	ADF
NCD rate	I (1)	I (1)
SA ten-year yield	I (1)	I (1)
GDP	I (1)	I (1)
GDP deflator	I (1)	I (1)
Inflation	I (1)	I (1)
M3	I (1)	I (1)
Total wealth	I (1)	I (1)
Financial wealth	I (1)	I (1)
Net wealth	I (1)	I (1)
SA PE ratio	I (1)	I (1)
House prices	I (1)	I (1)

Note: Significance at 5 per cent **, at 10 per cent*. Source: Author's calculations

Table 5.2 shows the results of the unit root tests for the variables used in the estimations. We establish that the variables are integrated of the order one i.e. they are I (1).

5.4.1 The income velocity of M3

The income velocity of money in Equation 5.13 captures the quantity equation

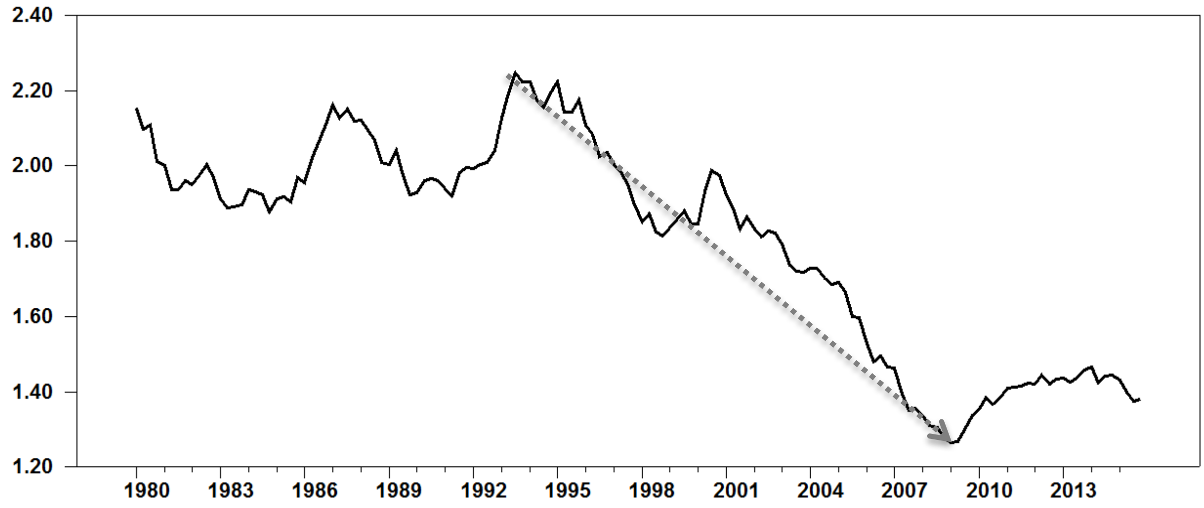
$$MV = Py \qquad (5.13)$$

Where, M is the total stock of money, V is the per-period turnover of the money stock which must be equal the nominal value of income and Py is real GDP. The income velocity of M3 can be estimated via a linear Equation 5.14.

$$Income\ velocity\ of\ M3 = -(m - p - y) \qquad (5.14)$$

Where, m is the log of real M3 balances and y is the log of real GDP. Figure 5.1 shows that the income velocity was stable between 1980Q1 and 1993Q4 but was on a long-term decline from 1994Q1 to 2009Q2 and the downward trend changed post-2010Q1.

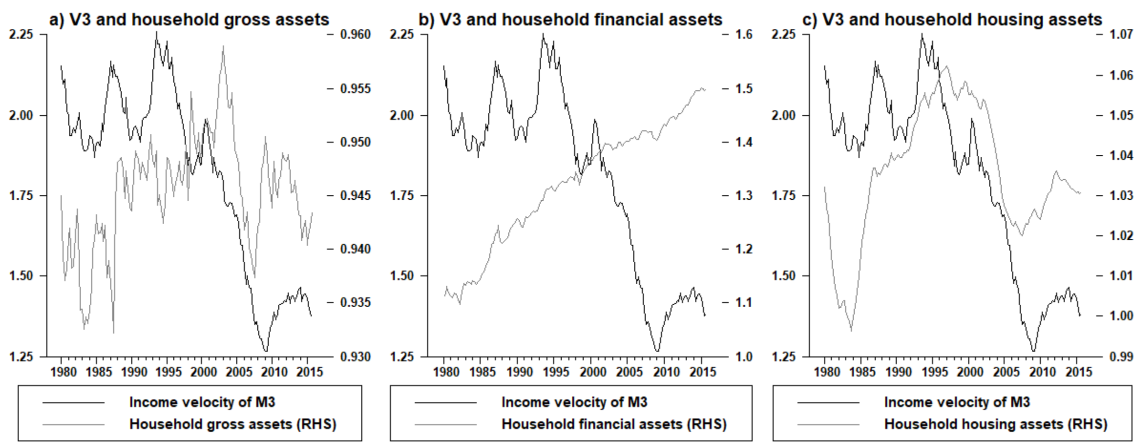
Figure 5.1 Income velocity of M3



Source: Author's calculations

This means that the theoretical assertion of the one-to-one movement between money growth and inflation changed. What caused the changes in the long-term income velocity of money? In Figure 5.2 the relationship between the income velocity of M3 and various measures of household wealth. The trends indicate that aggregate and housing household wealth is highly correlated with the income velocity of M3 compared to with financial wealth. This means that these wealth variables will be able to explain changes in the income velocity but with varying degrees.

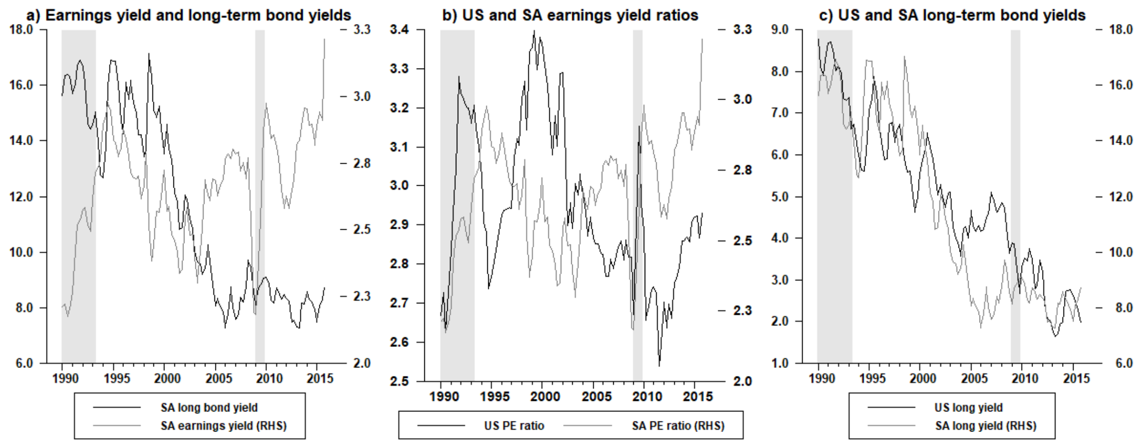
Figure 5.2 The income velocity of M3 and household wealth variables



Source: South African Reserve Bank and author's calculations

At the same time Figure 5.3 suggests that the tight positive correlation between SA long-term yields and the PE ratio broke down in 2003 and the two variables have diverged. On the other hand, the SA and US PE ratios decoupled between 1994 and 2008 but have since moved together in the same direction. Similarly, the long-term bond yields are highly correlated.

Figure 5.3 SA and U.S bond yields and PE ratios



Source: South African Reserve Bank and author's calculations

This means that the portfolio balance approach to money demand can be partly explained by the divergence of the asset prices leading to the substitution amongst assets and wealth effects within the domestic and international asset portfolios.

5.5 The money demand function specifications

We start by estimating the conventional money demand function[21], where, $(m - p)$ is the log of the stock of real money balances (money supply M3 deflated by the GDP deflator P_t), y is the real GDP. The $IR\ spread$ is the difference between the ten-year yield on the government bond and the 12-month NCD rate and captures the opportunity cost of holding money.

$$(m - p) = \beta_0 + \beta_1 GDP + \beta_2\,(IR\ spread) \qquad (5.15)$$

To assess the role of wealth, the money demand function in Equation 5.15 is augmented with real household wealth variables, real aggregate wealth (RAW), real financial wealth (RFW) and real

[21] See Calza et al (2001) for further details.

housing wealth (RHW) in different estimations.

$$(m-p) = \beta_0 + \beta_1 GDP + \beta_2 (RAW) + \beta_3 (IR\ spread) \qquad (5.16)$$

Finally, to assess the role of the asset price returns and the portfolio balance approach on the money demand, Equation 5.17 is estimated. The portfolio balance approach to money demand emphasizes that economic agents hold money as part of a portfolio of assets that offer a different combination of risk and return. For instance, money offers safe nominal return compared to the prices of other assets such as equities, bonds, and real estate. The specification in Equation 5.17 is based on the assumption of the portfolio theories that the demand for money depends on the risk and return of money and other assets. This means that the demand for money will depend on real wealth, the expected real return on other assets such as equities, bonds, and the real estate. However, an increase in the expected real returns of other asset prices will reduce the money demand as other assets become more attractive relative to monetary assets.

On the other hand, an increase in real wealth increases money demand since higher wealth implies that a larger portfolio of wealth can be allocated on various alternative assets.

$$(m-p) = \beta_0 + \beta_1 GDP + \beta_2 (RAW) + \beta_3 (PE) + \beta_4 (RHP) + \beta_5 (IR\ spread) \qquad (5.17)$$

Where, PE is the ALSI price earnings ratio and RHP is the house prices. The price earnings ratio and house prices are deflated with the GDP deflator. The specification in Equation 5.17 suggests that domestic residents as holders of money balances maximize their returns by holding a range of assets. An increase in other asset price returns is expected to lead to a decline in the demand for monetary assets. Equation 5.17 suggests that the demand for money cannot be realistically estimated without considering the impact of other asset prices over and above the impact of household wealth. In the empirical analysis we use the speciation in Equation 5.17 and change it by replacing RAW with RFW as a robustness test.

5.5.1 Cointegration rank tests

The cointegration rank test for Equation 5.15 in Table 5.3 indicates that the maximum eigenvalues and the trace tests show that there is one cointegration equation. Similarly, the augmented money demand functions in Equation 5.16 show that there is one cointegration equation for the specification that includes real aggregate and housing wealth. On the other hand, the results indicate that there are at two cointegration equations for the specification that includes real financial wealth. However, the results of the existence of two cointegration ranks are based on the specification that includes a deterministic trend. De Santis (2008) shows that for specifications that include equity prices and bonds excluding the deterministic trend in the Johansen test for rank order yields appropriate order of integration results. Indeed, when we exclude the deterministic trend the test shows the existence of one rank at most.

Table 5.3 Johansen test for cointegration rank test

H_o: $Rank \leq p$	Trace	Max-Eigenvalues
	Equation 5.15	
$p = 0$	31.82	21.95
	(0.03) **	(0.04) **
$p \leq 1$	9.86	9.25
	(0.29)	(0.27)
	Equation 5.16 including real aggregate wealth (RAW)	
$p = 0$	67.23	36.16
	(0.00) **	(0.00) **
$p \leq 1$	31.08	25.80
	(0.04) **	(0.01) **
$p \leq 2$	5.28	5.25
	(0.78)	(0.71)
	Equation 5.16 including real financial wealth (RFW)	
$p = 0$	70.22	41.05
	(0.00) **	(0.00) **
$p \leq 1$	29.17	23.64
	(0.06) **	(0.03) **
	Equation 5.16 including real housing wealth (RHW)	
$p = 0$	51.96	28.22
	(0.02) **	(0.04) **
$p \leq 1$	23.74	17.32
	(0.21)	(0.16)

Note: ** indicates significance at 5 per cent significance level. Source: Author's calculations

5.5.2 Cointegration results

We estimate the VECM using two lags as chosen by the AIC and HQ information criteria. Table 5.4 shows the results of the VECM for Equation 5.15 and 5.16. The estimated models for Equation

5.16 include real aggregate, financial and housing household wealth.[22]

Table 5.4 Cointegration equation for the conventional money demand function

	Conventional money demand	Augmented with RAW	Augmented with RFW	Augmented with RHW
LGDP	1.878 (31.461) **	1.866 (16,384) **	1.636 (11.043) **	1.85 (38.17) **
RAW		0.0339 (5.329) **		
RFW			0.031 (6.197) **	
RHW				0.003 (1.50) *
Spread	-0.049 (6.475) **	-0.064 (4.058) **	-0.002 (0.198) ***	-0.04 (6.45) **
ECT	-0.09 (2.313) **	-0.032 (2.405) **	-0.033 (3.708) **	-0.124 (-4.019) **

Note: ** indicates significance at 5 per cent significance level. RAW = real aggregate wealth; RFW = real financial wealth; RHW = real housing wealth; ECT = error correction term. Source: Author's calculations

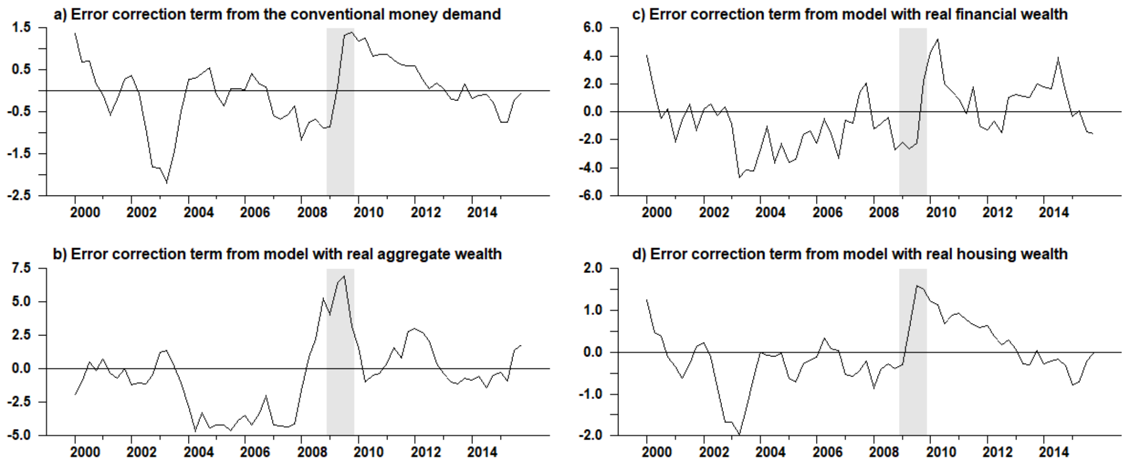
The results in Table 5.4 indicate that real money balances are positively linked to real income and negatively to the interest rate differential (spread). The VECM results indicate that the point elasticity for GDP ranges between 1.87 and 1.64. The income elasticity of GDP is more than one and the coefficient for the interest rate spread implies that interest rates are relevant for the money demand function and capture the opportunity cost of holding money. The interest rate spread is -0.064 and -0.002. The magnitudes of the coefficients for GDP and the interest rate spread are comparable to Hall et al (2007), Beyer (2009), De Santis et al. (2008) and Brand and Cassola (2004) amongst other studies.

5.5.3 What do the money demand dis-equilibrium measures derived from different wealth equations suggest?

The results of the ECT coefficients in Table 5.4 indicate that (i) the cointegration relationship $\Delta(m-p)$ capture the money demand function as the ECTs are negative and significant. The coefficients range -0.03 and -0,124 meaning that the real money balances correct for deviations from the long-term trends at a rate of 3 and 12 per cent per quarter. The cointegration relationships derived in Table 5.4 are shown in Figure 5.4 and indicate that the currently real money balances are below the long run trend. This means that there is a shortfall in the money demand by almost 5 per cent compared to the recent overhang during 2009Q1 and 2013Q4.

[22] We estimated a VECM for real household net wealth and the results are comparable to those derived using real aggregate wealth.

Figure 5.4 Estimates of excess and shortfall in money demand



Source: Author's calculations

The money demand disequilibria estimated via various equations are mean reverting. The conventional money demand and the demand function augmented with the real housing wealth yield remarkably similar money demand dis-equilibrium positions corroborating the trends in Figure 5.2. Their trends suggest that the money demand dis-equilibria has declined since 2009Q1 and has not corrected since. This means that developments in household real housing wealth explain much of the decline in the income velocity of M3. This result is comparable to Beyer (2009) who established strong evidence for wealth and substitution effects due to housing wealth in the Euro area.

However, the money demand dis-equilibria derived from models augmented with aggregate and financial wealth suggest that the dis-equilibria has retained the mean reverting characteristic since the financial crisis. The money demand dis-equilibria have corrected since 2009Q1 and are currently almost neutral. The implications of the results are that both measures are picking up the role of financial asset price inflation post-the financial crisis which is absent in the conventional money demand function and that augmented with housing wealth which are still indicating a substantial and persistent money demand short-fall. Second, the results suggest the presence of the substitution effects among asset classes since real aggregate and financial wealth will mostly reflect the valuation effects due to non-monetary financial assets. The performance of financial (equity and bonds) assets post-2009 possibly indicates the role of various rounds of QE from central banks of financial assets. It is common knowledge that equity price performed better than other assets classes such as housing which would be included in real aggregate wealth.

Furthermore, the results indicate that inclusion of wealth variables matters. First, the extension of the money demand functions via the substitution and wealth channel is supported by the data. Second, the estimated income elasticities are lower in models with real wealth variables compared to those estimated under the conventional money demand function. This implies that the inclusion of the wealth variables lowers the sensitivities of income in the money demand function in particular with respect to the real financial wealth. This may be due to the role of financial wealth in the decisions about portfolio allocation. Third, the slow speed of adjustment means that the disequilibrium takes longer when considering the role of real financial wealth than is the case under the conventional money demand function and that augmented with real housing wealth. This is consistent with the recent empirical evidence showing that financial cycles take longer to adjust. Last, from the interaction of monetary policy and financial stability perspective this means that the extension of the money demand function can capture aspects related to asset price inflation and wealth channels of the transmission mechanism.

5.5.4 Are the results sensitive to changes in the specification and model size?

As a robustness test this section augments the money demand function by including the role of asset price returns for real equity and house prices in Equation 5.17. The cointegration rank tests in Table 5.5 indicate one cointegration vector.

Table 5.5 Johansen test for cointegration rank test

H_o: $Rank \le p$	Trace	Max-Eigenvalues
	Equation 8.17 (RAW)	
$p = 0$	79.00	39.21
	(0.00) **	(0.01) **
$p \le 1$	39.79	26.59
	(0.23)	(0.07)
	Equation 8.17 (RFW)	
$p = 0$	94.96	45.05
	(0.00) **	(0.00) **
$p \le 1$	49.91	25.85
	(0.07)	(0.08)

Note: ** indicates significance at 5 per cent significance level. Source: Author's calculations

5.5.5 Cointegration results

We estimate a VECM with two lags chosen by the AIC and HQ information criteria. Table 5.6 shows that the results conform to theoretical predictions, real wealth irrespective of how it is measured is positively related to the money demand. On the other hand, real price-earnings and house prices indicate that a negative relationship exists between returns on these assets and money demand. The implication is that there are substitution effects between the assets in line with the predictions of the portfolio balance approach to the money demand.

Table 5.6 Cointegration equation for money demand function augmented with asset price returns

	$(m-p) = GDP, RAW, PE, RHP, spread$	$(m-p) = GDP, RFW, PE, RHP, spread$
LGDP	1.89 (44.69) **	1.64 (-15.48) **
RAW	0.04 (-6.78) **	
RFW		0.01 (-4.67) **
RPE	-0.08 (-2.99) **	-0.08 (5.55) **
RHP	-0.002 (-1.93) **	-0.004 (3.18) **
Spread	-0.07 (4.86) **	-0. 10 (2.48) **
ECT	-0.08 (-2.43) **	-0.02 (-2.09) **

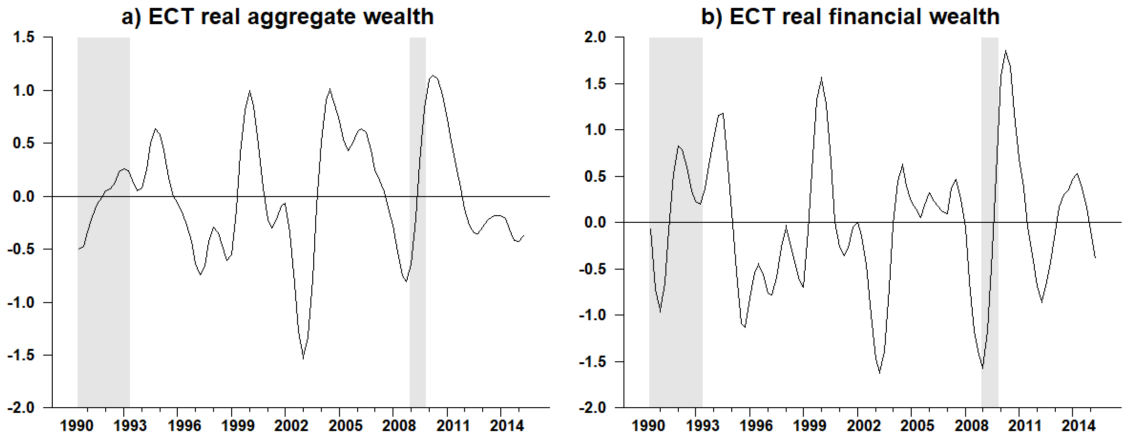
Note: ** indicates significance at 5 per cent significance level RAW = real aggregate wealth; RFW = real financial wealth; RPE = real price-earnings ratio; RHP = real house prices; ECT = error correction term. Source: Author's calculations

Furthermore, the coefficients for GDP and the interest rate spread are not that different to those derived from the earlier estimations in Table 5.4. This implies that the change in the variables and the model size does not result in significantly different results for the money demand function. The coefficients for the asset prices are comparable whether real aggregate or financial wealth is included in the estimations. But equity price returns result in a higher decline in the demand for real money balances compared to real house prices. A one per increase in equity price returns results in a decline of 8 per cent in the real money demand compared to 4 per cent due to real house prices.

Similarly, the coefficient for the interest rate spread which captures the opportunity cost of holding money is higher in the model that includes real financial wealth. A one per increase in the interest rate spreads leads to a 10 per cent decline in the money demand in the model with real financial wealth compared to 7 per cent in the model with real aggregate wealth. The coefficients for the

ECTs indicate that the dis-equilibrium in the money demand due to real financial wealth persists and takes a slightly longer period to correct compared to that which includes real aggregate wealth. The estimated of the money demand dis-equilibria positions derived from the two estimations are shown in Figure 5.5 and show that consistent with earlier estimations that there is a shortfall in the money demand.

Figure 5.5 Estimates of excess and shortfall in money demand



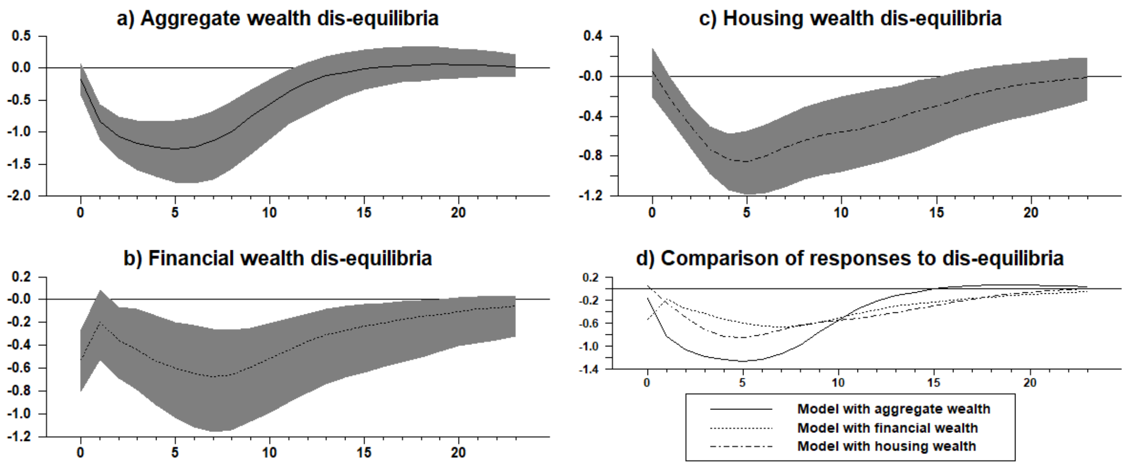
Source: Author's calculations

In addition, the results suggest that adjustments due to real aggregate wealth have been more persistently negative compared to those due to real financial wealth. This is largely because house prices have declined more since the financial crisis and have not recovered to levels pre-financial crisis. On the other hand, equity prices recovered all the losses during the crisis and have surpassed historic record levels hence the mean reversion post-2009Q1.

5.5.6 Money demand responses to dis-equilibria in household wealth

In this section we analyze the responses of money demand to dis-equilibrium positions in the household real wealth positions as measured by the error terms in Figure 5.6. We assess the impact of a one standard positive deviation shock in the real household aggregate, financial and housing wealth on the real money demand. We estimate a VAR with the ECT for real aggregate, financial and housing wealth, real M3 growth, GDP growth and the spread. The ECTs are included individually in different estimations. The estimations are for the sample period 1990Q1 to 2015Q4. The impulses are generated from 10 000 Monte Carlo draws.

Figure 5.6 M3 responses to dis-equilibria in the household wealth positions



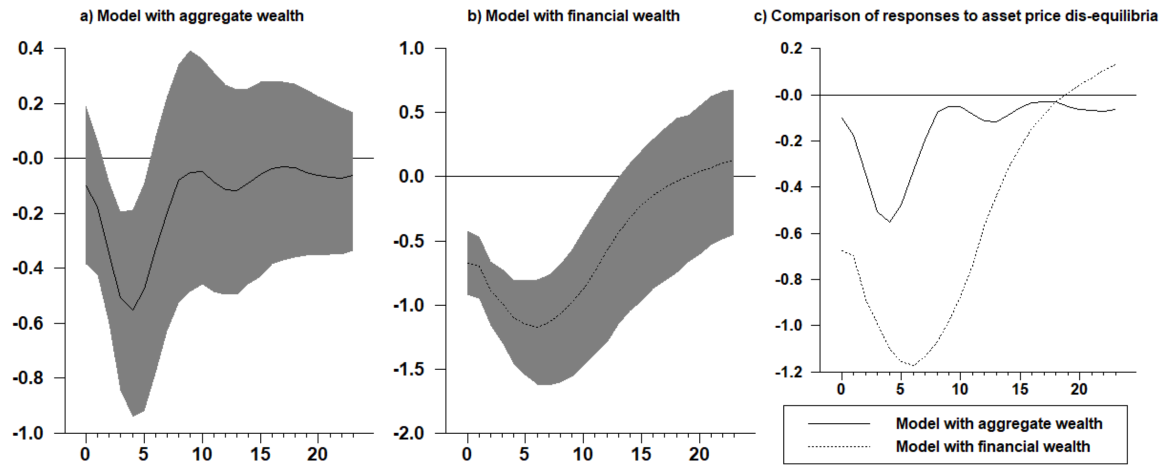
Source: Author's calculations

Figure 5.6 shows that a one standard deviation increase in the dis-equilibria each wealth components results in a decline in the money demand but more so due to aggregate wealth and housing wealth consistent with the substitution effects. The demand for real money balances declines more due to increase in aggregate real wealth and this is largely driven by the increase in real housing wealth compared to real financial wealth.

Similarly, we analyze the responses of money demand to dis-equilibrium positions in real asset prices as measured by the error terms in Figure 5.7. The impulses are the responses of real money demand to a one standard positive deviation shock in real equity price and real estate prices measured by the price-earnings ratios and real house prices. The estimated VAR includes the ECT for asset prices in Equation 5.17 which include real household aggregate and financial wealth, real M3 growth, GDP growth, real price-earnings ratio, real house prices and the interest rate spread. The ECTs are included individually in different estimations. The estimations are for the sample period 1990Q1 to 2015Q4.

Figure 5.7 shows that a one standard deviation increase in the dis-equilibria in asset prices results in a decline in the money demand. The decline is more due to an increase in asset prices in a model that includes household real financial wealth compared to real aggregate wealth. Nonetheless, the decline in the demand for real money balances persists due to an increase in asset prices in a model that includes household real aggregate wealth. The results corroborate earlier findings in models that included various measures of real household wealth. The increase in real household wealth and real asset prices results in wealth effects and substitution effects as predicted by the portfolio balance approach to money demand.

Figure 5.7 M3 responses to dis-equilibria in asset prices



Source: Author's calculations

5.6 TVAR evidence

We conclude the study by assessing the impact of real money demand thresholds derived from Equations 5.16 and 5.17. First, we establish the real money demand threshold values using the Balke (2000) approach and use the estimated threshold values in a TVAR. The established real money demand threshold values demarcate the low and high real money demand regimes. We use the TVAR to establish the responses of GDP growth and inflation in the different money demand regimes. The sample period spans 1990Q1 to 2015Q4. Table 5.7 shows that the Balke (2000) approach establishes thresholds that range between 4.34 per cent and 5.90 per cent for the three different estimated models. We use the 5.90 per cent threshold in the estimation of the TVAR.

Table 5.7 Tests for real money demand threshold

Test	Model with RAW	Model with RFW	Model with RHW
Balke (2000)	5.90	4.34	5.90

Test	Model with RAW	Model with RFW
Balke (2000)	5.90	5.03

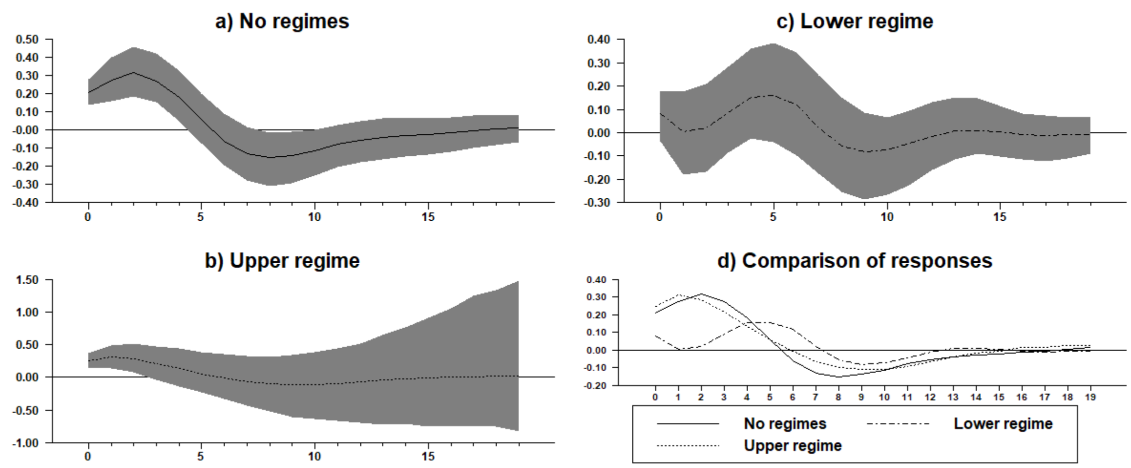
Note: RAW = real aggregate wealth; RFW = real financial wealth; RHW = real housing wealth. Source: Author's calculations

5.6.1 Real money demand threshold effects in a model including real financial wealth

To streamline the results and given the fact that the thresholds established using real aggregate and housing wealth are comparable, we only present and discuss the results generated using real financial and housing wealth. We analyze the responses of GDP growth and inflation in a TVAR specified as in Equation 5.16. The variables included in the TVAR are real M3, GDP, inflation, real financial and housing wealth; and interest rate spread. Real financial and housing wealth is included separately in different models.

Figure 5.8 and Figure 5.9 show that there are clear differences in the GDP and inflation responses to real money demand shocks in different real money growth regimes. It is evident that GDP growth increases more in the model with none and high real money demand regime compared to the low regime. GDP growth responses are more than half less in the low real money demand regime.

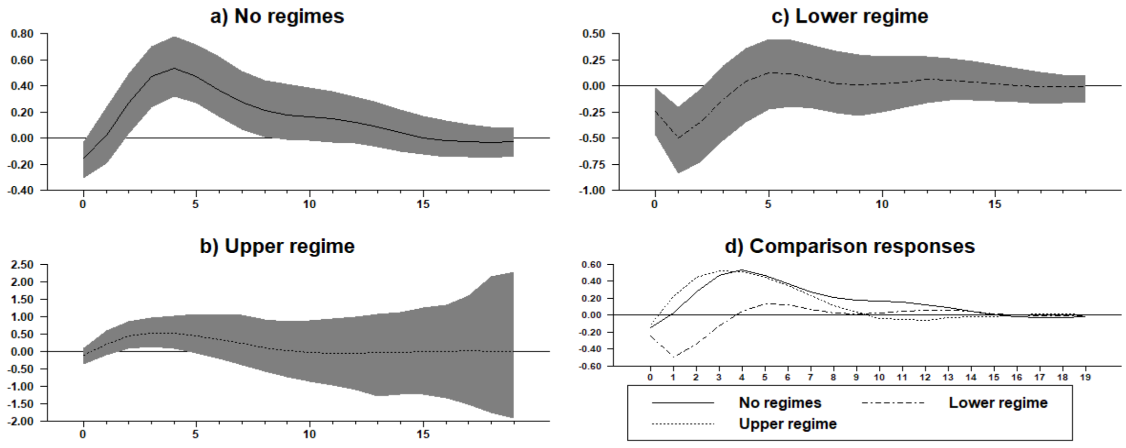
Figure 5.8 GDP responses to real money demand shocks in different regimes



Source: Author's calculations

On the other hand, inflation increases more in the no and high real money demand regimes and peaks around five quarters. Inflation declines and remains persistently low in the low real money demand regime consistent with low economic activity in Figure 5.9.

Figure 5.9 Inflation responses to real money demand shocks in different regimes

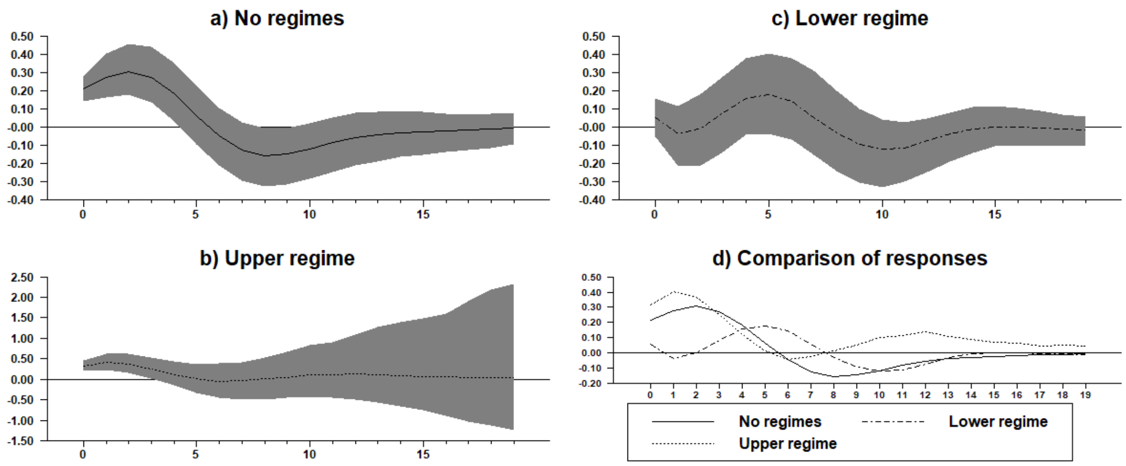


Source: Author's calculations

5.6.2 Real money demand threshold effects in a model including real housing wealth

A comparison of the results of the impulse responses of GDP growth and inflation due to positive shocks to real money demand in Figure 5.10 and Figure 5.11 shows that the real money demand regimes matter. Like the responses in the previous section, GDP growth responds more when there are no and in the high real money demand regimes. Furthermore, at peak response GDP growth increases more in the model that includes housing wealth compared to that which includes financial wealth. The higher responses could be associated with the higher wealth and collateral effects due to housing wealth.

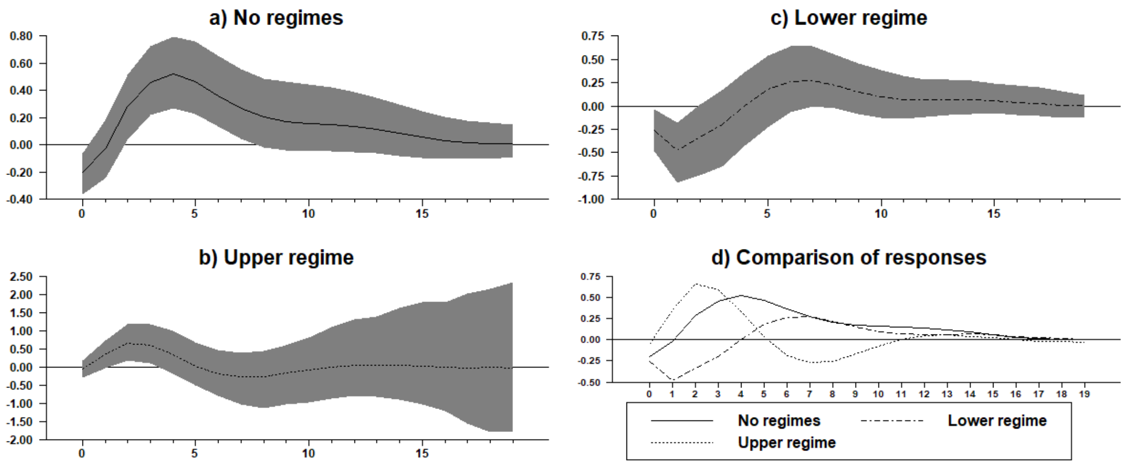
Figure 5.10 GDP responses to real money demand shocks in different regimes



Source: Author's calculations

Furthermore, the comparison of the inflation responses in Figure 5.11 indicates that inflation trajectories are comparable to those in the model with financial wealth. But inflation increases tend to persist in the model with no regimes but are very transitory in the high real money demand regime. In addition, in the low money demand regime, inflation declines and increases more thereafter compared to the model with financial wealth. This means that the effects of real financial and housing wealth exert different inflation responses, and this is consistent with the characteristics of the wealth and collateral channels involved.

Figure 5.11 Inflation responses to real money demand shocks in different regimes



Source: Author's calculations

5.7 Conclusion and policy implications

The chapter assessed the applicability of the wealth and portfolio balance approach to money demand function in South Africa. We find that inclusion of wealth and asset price variables matters for the economic and policy interpretation of the money demand function. The extension of the money demand functions via the wealth and asset price variables is supported by the data. The impact of positive shocks to real asset prices and real wealth, in particular equity prices, result in a higher decline in the demand for real money balances compared to, for example real house prices. In addition, increase in the dis-equilibria in the wealth position of households and asset prices results in a decline in the money demand. This means that the augmented money demand functions capture the substitution and wealth effects as postulated by the portfolio balance theory.

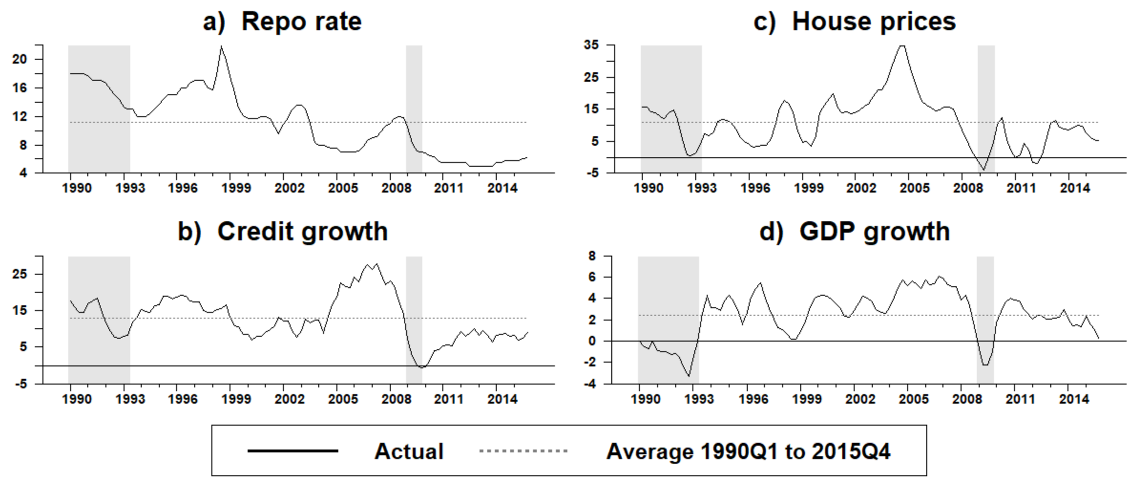
The slow speed of adjustment in the money demand equilibria in models augmented with real wealth and asset prices means that the disequilibrium takes longer when considering the role of real financial wealth than is the case under the conventional money demand function. This is consistent with the recent empirical evidence showing that financial cycles take longer to adjust. Furthermore, shocks to real money demand induce non-linearities in the responses of economic activity and inflation. Positive shocks to real money demand below the threshold of 5.90 per cent result in lower GDP growth and inflation. The policy implication from the interaction of monetary policy and financial stability perspective, is that the augmented money demand function can capture aspects related to asset price inflation and wealth channels of the monetary policy transmission mechanism.

Chapter 6 Testing the balance sheet channel for monetary policy transmission

6.1 Introduction

An economy can be hit by multiple shocks at the same time at any given point. As a result, for appropriate policy responses policy makers need to understand the extent to which multiple shocks neutralize or reinforce each other. Post-financial global crisis the policy rate was lowered to historic low levels as shown in Figure 6.1. However, it is evident that GDP and credit growth did not rebound much but remained below long-term trend levels. If interest rates were lowered to historic low levels and credit and GDP growth did not respond as expected, what shocks had a neutralizing effect between monetary policy and loan supply shocks? What was the role of aggregate demand and supply shocks?

Figure 6.1 Repo rate, credit, house prices and GDP growth



Source: South African Reserve Banks and author's calculations

This chapter explores the role of four shocks, namely, monetary policy, loan supply, aggregate demand, and supply shocks on the evolution of credit and GDP growth. The trends observed pre-recession are starkly different to those post the recession. What could explain these vast differential responses of financial and real economic variables to accommodative monetary policy shocks? We determine the role of loan supply effects pre- and post-financial crisis and its interaction with monetary policy, aggregate supply, and demand factors via a historical contributions approach. The counterfactual scenarios and historical contributions enable us to identify periods during which the different shocks moved in different (same) directions and neutralized (reinforced) each other's contributions.

6.1.1 The financial regulatory and macroeconomic policy landscape post the financial crisis

The period post-financial crisis has been characterized by economic and regulatory policy uncertainties both globally and domestically. As a result, consumer and business confidence have been at low levels suggesting the economic landscape characterized by cautious attitudes to spending and new investment spending. Furthermore, these developments could have been exacerbated by the necessary deleveraging process, as households and companies took drastic measures to repair highly geared balance sheets. The concurrence of these factors highlights the need to disentangle of the role of multiples shocks related to aggregate supply and demand factors in the evolution of financial and real economic growth. For instance, it is necessary to understand the separate roles of credit demand and supply factors in propagating or mitigating the effects of accommodative monetary policy shocks. At the same time, aggregate demand and supply shocks can also neutralize or propagate the effects of other shocks.

Hristov et al. (2012) show that an increase in the price of credit may reflect an increase in the demand for credit or a tightening in the supply of credit. In the case of the increase in demand, policymakers may respond by increasing the policy rate to contain aggregate demand pressures. On the other hand, in cases of tight credit supply conditions, policymakers may intervene by loosening monetary policy settings to ease financial conditions in the economy. Thus, understanding the main shocks that are driving developments in credit markets and the real economy is important as it enables policymakers to design appropriate intervention tools. Furthermore, the implications for real economic activity may vary depending on whether credit dynamics are driven by supply or demand factors.

Vast literature post financial crisis shows that looking at the policy rate alone as a measure of the estate of financial conditions can be misleading. Financial stress impairs through different channels of the transmission of monetary policy to the real economy. Thus, adversely affecting lending to consumers and firms, depresses investment, economic activity, and inflation. As a result, most studies find that financial conditions indices (FCI) enable earlier detection of credit supply and demand shocks. For instance, Paries et.al (2014) show that tight financial conditions following the global financial crisis and the euro area sovereign debt crisis resulted in adverse credit supply conditions. They present evidence that adding an FCI in the empirical estimations enables the appropriate identification of credit supply and demand shocks. Therefore, we construct a financial conditions index for South Africa to assess whether it captures credit supply shocks.

What does the evidence suggest is the role of financial conditions in the transmission of various shocks in South Africa? Recent literature shows that increasing borrowing costs, falling asset prices and changes in risk perceptions and tolerance affect consumption and investment expenditure. Tight financial conditions and falling asset prices via the wealth and inter-temporal substitution effects have a depressing effect on consumption. In addition, the higher external finance premium deters investment spending. Hatzius et al., (2010) argue that this means that a single variable such as the policy rate cannot fully capture the complexity of the wide range of financial variables. As a result, FCIs by combining key financial and real economic variables into a summary statistic are better equipped to analyze the state of financial conditions.

Against the backdrop of the simultaneous occurrence of loose monetary policy settings with sluggish credit and GDP growth, which channel had dominant effects in propagating or neutralizing effects on credit and GDP growth? To achieve this, we use the penalty function approach to sign restrictions to identify four shocks, namely, the aggregate demand, aggregate supply, monetary policy, and loan supply shocks. Hristov et al. (2012); Barnett and Thomas (2013) show that the simultaneous identification of structural shocks ensures that the loan supply shock captures the exogenous shifts of the loan supply curve rather than any endogenous reaction of the loan supply to one of the other shocks. Is there a balance sheet channel of monetary policy working via the housing market in South Africa? We contribute to existing literature by quantifying the relative effects and importance of supply and demand factors in the sluggish response of credit growth to monetary policy easing by incorporating the role of the housing market and banks' credit in the analysis.

How have these shocks affected the sectorial credit? We assess the impact of the four shocks, aggregate demand, aggregate supply, monetary policy and loan supply shocks on household and firms' credit growth. How have persistent demand and supply shocks determined the trajectory of credit and GDP growth post the recession in 2009? How different were these effects to those that existed during the credit boom between 2006 and 2008? We rely on the historical contributions based on the counterfactual scenarios to assess periods during which these shocks propagated or neutralized each other's effects.

Furthermore, exogenous shifts in the loan supply curve can have an impact on the evolution of asset prices and other financial variables that affect financial conditions.[23] Can the FCI capture some of these developments? This study contributes to the literature on understanding the contribution of financial conditions to the South African business cycles. While the Gumata et al (2012) and Thompson (2013a) estimated FCIs for South Africa, they did not empirically assess its impact on the business cycles and policy relevance. Furthermore, Balcilar et al (2014) did not assess whether Thompson, et al. (2013a) FCI propagated or neutralised the impact of shocks on credit and the real economy. The authors only investigate whether Thompson, et al. (2013a) FCI had asymmetric effects on output, interest rates and inflation.

Therefore, we construct an FCI for South Africa to assess whether it captures credit supply shocks. Caldara et al (2016) show that although uncertainty and financial shocks differ and are important drivers of economic fluctuations, increases in economic policy uncertainty is mostly associated with financial shocks. These financial shocks, tend to manifest in for example the widening of credit spreads and the depreciation of exchange rates. Literature shows that, various financial shocks can result in tightening in financial conditions. We use the SA policy uncertainty index constructed by Hlatshwayo and Saxegaard (2016) in the empirical estimations and compare its effects to those of the FCI.

We find that the constructed FCI is positively related to lending conditions, meaning that tight financial conditions imply tight lending conditions. In addition, the FCI is negatively related to the consumer and business confidence. Tight financial conditions lead to lower consumer and business confidence. Heightened uncertainty leads to tight financial conditions for prolonged periods. Loan supply and aggregate supply shocks played a dominant role in total and sectorial credit; and GDP growth pre-2009 consistent with the house price, equity price and commodity price booms. However, post-2009 aggregate supply shocks reinforced by loan supply shocks played a dominant role in depressing credit growth. Furthermore, tight financial conditions and heightened uncertainty shocks interact and are mainly transmitted via aggregate demand shocks as well. Tight financial conditions and heightened uncertainty shocks play a significant role in propagating adverse loan supply shocks and have depressing effects on aggregate demand and credit growth.

[23] Through for example, financial innovation, changes in the credit quality of bank's loan portfolios, risk perception; changes in regulation, Milcheva (2013).

Furthermore, we establish the existence of the balance sheet channel of monetary policy via the housing market. Mortgage advances decline more due to contractionary monetary policy and house prices decline more in response to adverse aggregate supply shock. The implication is that credit to the private sector declines mainly due to the deterioration in balance sheets of households and non-performing loans of banks more than the decline in the demand for credit. This does not mean that there the absence of the traditional monetary transmission mechanism. Rather the response of mortgage advances, house prices and non-performing loans suggest that contractionary monetary policy shock is propagated via the deterioration in collateral values and borrowers' net worth impact on the loan supply channel. The policy implication is that because housing plays an important role in the business cycle as a component of investment, wealth and demand via consumption policy interventions that support the banking system as well as the real economy need to be prioritized.

The rest of the study is structured as follows: section two reviews the literature on the identification of credit demand and supply shocks, aggregate demand and supply shocks and monetary policy shocks. Section three presents the methodology used in the empirical analysis and the construction of the financial conditions index. Sections four and five present the data and the empirical results. Section six conducts the robustness tests and section seven disentangles the role of structural shocks using counterfactual scenarios. Section eight concludes.

6.2 Literature review

Earlier empirical research has shown the difficulty in trying to disentangle the evolution of bank credit into loan supply and demand shocks (Bernanke and Getler, 1995). As a result, studies assessing the effects of credit supply and demand shocks adopt various approaches to identify these shocks. For instance, Kashyap et al. (1993) use a financing mix variable to identify the shocks. Helbling et al. (2011) adopt the sign restrictions approach because a change in the price or quantity of credit may be driven by either demand or supply shocks. Ciccarelli et al. (2015) use credit variables from bank lending surveys or confidential bank ratings to identify demand from supply shocks. Last, Amiti and Weinstein (2018) identify credit supply shocks by using micro-data.

6.2.1 What distinguishes the adverse monetary policy shock to other shocks?

What distinguishes the monetary policy shock to other shocks? Literature considers monetary shocks as well as shocks to aggregate supply and aggregate demand as the most important driving forces of the business cycle. Table 6.1 shows that a contractionary (tight) monetary policy shock leads to an increase in the central bank policy rate and other short-term money market interest rates. This has a negative effect on output, prices and the lending rate as bank interest rates are tied to the short-term interest rates. To distinguish between a contractionary monetary policy shock and an adverse aggregate supply shock, the sign restrictions imposed indicate that inflation is expected to decline following a negative monetary policy shock.

Table 6.1 Identification scheme for adverse monetary policy shocks

	Monetary policy	Aggregate supply	Aggregate demand	Loan supply
Policy rate	+	+	-	+
Lending rate	+	+	-	+
Inflation	-	+	-	?
Credit growth	**?**	**?**	**?**	**?**
GDP growth	-	-	-	-

However, adverse credit supply shocks are like adverse monetary policy shocks. Adverse credit supply shocks and adverse monetary policy shocks result in an increase in lending rates but can have a different effect on the quantities of credit. Barnett and Thomas (2013) show that in the case of adverse credit supply shocks, there tends to be quantity rationing effects present and these are absent under an adverse monetary policy shock. In the model we estimate in the empirical section we use the sign restrictions in Table 6.1 to identify the different shocks.

6.2.2 How is an adverse aggregate supply shock identified?

An adverse aggregate supply shock moves output and prices in opposite directions. As a result, the central bank reacts to an adverse aggregate supply shock by increasing the nominal interest rate. In Table 6.2 the distinguishing effect is that an adverse aggregate supply shock not only moves inflation and output in different directions, but it also elicits a contractionary monetary policy response via an increase in the central bank policy rate.

Table 6.2 Identification of an adverse aggregate supply shock

	Monetary policy	Aggregate supply	Aggregate demand	Loan supply
Inflation	-	+	-	+
Policy rate	+	+	-	?
Lending rate	+	+	-	+
Credit growth	?	?	?	-
GDP growth	-	-	-	-
Labour prod	?	+	?	-
NPLs	?	-	?	+

Helbling et al. (2011) use productivity and default rates or non-performing loans (NPLs) to distinguish a restrictive credit supply shock from an adverse aggregate supply shock. The authors place restrictions on productivity growth and non-performing loans. This sign restriction scheme ensures that an adverse credit supply shock is properly identified and truly reflects a credit supply contraction. This helps in making sure that an endogenous decline in credit due to lenders reducing credit in response to expectations of an increase in future default rates and/or a decline in future productivity is not mistakenly identified as an adverse credit supply shock. They identify a true aggregate supply shock as an increase in productivity and a loan supply shock as increase in default rates.

6.2.3 A negative aggregate demand shock

A negative aggregate demand shock is identified by assuming that output and prices move in the same direction in Table 6.2. In such cases, the central bank responds to a negative aggregate demand shock by lowering the central bank policy interest rate and this is transmitted to money markets via a decline in the lending rate. The decline in the central bank policy rate, short-term money market rates and lending rates in response to an adverse shock to aggregate demand is expected to stimulate credit demand and supply. However, Bean et al. (2010) show that the impact of accommodative monetary policy can be neutralized by the negative effects on an adverse aggregate demand shock which result in a fall in loan demand as aggregate income falls.

6.2.4 How is an adverse loan supply shock identified from other shocks?

How is an adverse loan supply shock identified from other shocks? To distinguish an adverse loan supply shock from the other shocks, studies assume that innovations to loan supply drive the loan rate and the loan volume in different directions. This assumption is also a sufficient condition for separating to loan supply shocks from exogenous shifts in loan demand. A negative loan supply shock induces a contraction in loan volume accompanied by an increase in the lending rate (or spread) and a decline in aggregate economic activity. As a result, the increase in the loan (lending) rate due to a restrictive loan supply shock ensures that this shock is properly identified and is different from an adverse aggregate demand shock. An adverse aggregate demand shock is associated with a fall in the loan (lending) rate.

However, the decline in GDP growth is usually less than the decline in credit growth in responses due to an adverse loan supply shock. This relative decline in credit growth compared to GDP growth also assists in distinguishing loan supply shocks from aggregate demand and supply shocks for which GDP growth is assumed to contract more strongly than credit growth. In addition, the increase in interest rate spreads associated with credit supply shocks distinguishes it from a tight monetary policy shock which can lower the interest rate spread. Eickmeier and Ng (2011) suggest that the increase of interest rate spreads to identify the credit supply shock reflects the increase in the credit risk premium.

6.2.5 How does inflation respond to an adverse loan supply shock?

Empirical findings are mixed as to what the responses of inflation are due to an adverse credit supply shock. Curdia and Woodford (2010), find that inflation falls after a restrictive loan supply shock and the policy rate is decreased in response, but the lending rate increases. Gertler and Karadi (2014); and Gilchrist et al. (2014) find similar inflation responses. On the other hand, Gerali et al. (2008); Atta-Mensah and Dib (2008) establish that inflation rises in response to an adverse loan supply shock. This results in an increase in the policy rate and the lending rate.

Studies that establish an increase in the inflation rate following an adverse loan supply shock attribute this to (i) an increase in marginal costs due to a simultaneous decline in investment spending by firms following a decline in lending, and an increase their labour demand, which pushes up wages; (ii) an increase in marginal costs as they are directly affected by the increase in the lending rate at which firms borrow funds in order to pay for intermediate good inputs; (iii) severe exchange rate depreciations which result in an increase in inflation. Albagli (2015) shows evidence that during the financial crisis, despite deterioration in labor market conditions and contraction in output contracted most emerging market economies experienced severe inflationary pressures due to the sharp exchange rate depreciation. Furthermore, inflationary pressures occurred despite a decline in commodity prices and aggregate demand.

6.2.5 Identification of tight financial conditions and heightened economic uncertainty shocks

A tightening in financial conditions is identified in the same way as a credit supply shock. Tight financial conditions are associated with depressing effects on credit and economic activity. At the same time, increases in economic uncertainty often occur alongside tightening financial conditions. Caldara et al (2016) show that economic policy and output growth uncertainty increase immediately in response to an adverse credit shock. This response suggests that fluctuations in economic policy and output growth uncertainty can arise endogenously in response to changes in broad financial market conditions. This implies a causal relationship between uncertainty and financial conditions since tight financial conditions shocks are remarkably like uncertainty shocks and credit supply shocks. Hence it is necessary to assess the joint interaction of changes in financial conditions and economic uncertainty effects on the macro-economy.

Furthermore, uncertainty shocks are characterised by the widening of credit spreads which indicates a tightening in financial conditions. In addition, the widening of credit spreads lowers credit demand and output in the same way that an adverse credit supply shock does. Arellano et al. (2012), Christiano et al. (2014), and Gilchrist et al. (2014), show that financial shocks and adverse credit supply shocks characterize the responses of a persistent decline in both output and inflation which is similar to that induced by uncertainty shock when financial stress is heightened.

For appropriate identification, Bloom (2009) identifies uncertainty shocks by placing the VIX index after the stock market return but before the real and nominal variables. This makes sure that the transmission of uncertainty shocks via VIX generates a sharp drop in industrial output followed by some overshooting once the financial channel opens. This response is consistent with the *"wait-and-see"* effect due to a positive uncertainty shock.

Baker et al. (2015) use the macroeconomic policy uncertainty index and find that unanticipated increases in policy uncertainty induce a persistent and significant decline in economic activity. Gilchrist et al. (2014) show that financial markets distortions are an important conduit through which uncertainty shocks can affect macroeconomic outcomes. This implies that uncertainty shocks are an important source of cyclical fluctuations. Hlatshwayo and Saxegaard (2016) show that increased policy uncertainty diminishes the responsiveness of exports to the REER and has short and long-run effects on export performance. Furthermore, they show that adjusting measures of competitiveness for uncertainty and supply-side constraints performs better than the REER in explaining exports performance.

As a result, we use the FCI constructed in this chapter and the SA economic policy uncertainty index constructed by Hlatshwayo and Saxegaard (2016) jointly in the VAR model to analyse the impact of financial conditions and uncertainty shocks as done in Caldara et al (2016). These authors use the penalty function approach and jointly identify uncertainty and financial conditions shocks sequentially. This means that the contemporaneous response of financial conditions to uncertainty shocks or vice versa is not ruled out. Caldara et al (2016) find that financial conditions shocks have a significant adverse effect on economic activity especially when they result in tightening of financial conditions. In addition, they establish a rise in uncertainty in response to a financial shock which means that changes in uncertainty are overly sensitive to changes in financial conditions.

Balcilar et al (2014) use Thompson, et al (2013a) FCI in LSTVAR models with inflation or output growth or interest rate as a switching variable. They find that the South African economy responds asymmetrically to financial shocks. Manufacturing output growth is more affected by financial shocks during recessions. On the other hand, inflation and interest rates respond more to financial shocks during upswings. Paries et al (2014) use a sign restriction approach to identify monetary policy and credit supply shocks via the FCI. They find that the inclusion of the FCI in the VAR can capture the adverse credit supply shocks. In addition, credit supply shocks resulted in a decline in economic activity and an increase in bank lending spreads during the global financial crisis.

Popescu and Smets (2010) include financial conditions and uncertainty in the specification of their model which adopts a recursive ordering approach to identify these shocks. The uncertainty variable is placed before the financial market risk index but after the block of macroeconomic variables. This ordering allows uncertainty shocks to elicit an immediate change in financial conditions but not vice versa. This also means that uncertainty shocks have small and temporary effects on output and financial risk premia. While on the other hand, financial disturbances have a considerably more persistent effect on economic activity.

6.2.6 How many restrictions are adequate to sufficiently identify the loan supply shock?

Bean et al. (2010) and De Nicolo and Lucchetta (2010) argue that imposing two restrictions is sufficient to adequately identify the loan supply shock. Whereas Helbling et al. (2011) argue that more restrictions are needed to properly identify shocks originating in the banking or financial sector. Paries et al (2014) show that the inclusion of the FCI improves the identification of credit supply shocks within Structural VAR models. As stated earlier, we use the combination of all these strategies to make sure that we have adequately identified both price and quantitative aspects of credit supply shocks.

In the estimations on the various VAR models, we set the period over which the sign restrictions are binding equal to minimum one quarter and maximum two quarters ($K = 2$). This is line with Hristov et al. (2012) who argue that this strategy accounts for the idea that the policy and the lending rates should not move in opposite directions over a longer time after the adverse credit shock. However, we tested the sensitivity of our results to four quarters in line with the assumption of persistent effects of shocks on the economy and found that the results are not significantly different.[24] All shocks are one standard deviation. Impulse response functions are drawn from 10 000 Monte Carlo draws and are kept if they satisfy the imposed restrictions. The models have two lags as chosen by AIC and SBC information criteria.

6.3 Methodology

We construct a financial conditions index and use it in the empirical estimations to capture the impact of changes in financial conditions of the real economic variables. We start this section by the discussion of the approach followed to construct the FCI.

6.3.1 The construction of the financial conditions index

We use the principal component analysis (PCA) to estimate the FCI. The FCI is computed as the common component of several financial variables used in the estimation of the common factor. The common component captures the greatest common variation in the variables, and it is interpreted as the FCI. The PCA method has the advantage that it allows summarizing a large information set into a single indicator.

The PCA approach extracts the common factor F_t that captures the greatest common variation in a group of P variables. The model is presented as:

$$X_t - \mu = \beta F_t + U_t \qquad (6.1)$$

Where μ is a p x 1 vector of the variables; means. B is a p x m matrix of the coefficients and F is a vector of m x 1 unobserved variables termed the common factors. U_t is p x 1 vector of errors.

[24] See Peersman (2005) and Uhlig (2003) amongst others.

The model assumes that the errors are orthogonal to the common factors [E (FU') = 0] and the common factors have zero mean E(F) = 0.

Given that the FCI reflects information about the state of the economy, it should be purged of the feedback of economic activity. This allows the FCI to capture pure financial shocks and not the influence of past economic activity. This endogeneity problem is addressed by purging the estimated common factor of this feedback by regressing F_t on current GDP growth (Y_t) as shown in Equation 6.2.

$$\widehat{F_t} = \text{y}Y_t + V_t \tag{6.2}$$

Where V_t is uncorrelated with $Y_t$and V_t is the estimated FCI which only reflects the exogenous shifts in the financial conditions.

6.3.2 The pure and penalty function approaches to sign restriction

We use the pure and penalty function approaches to sign restriction. The sign restriction approach requires imposing a set of economically plausible restrictions and the leaves the question of interest unrestricted. The penalty function heavily penalizes choices that violate the imposed signs and constraints (Uhlig, 2005). The approach minimizes a criterion function which penalizes impulse responses violating the sign restrictions, with respect to the identifying weights. This contrasts with the pure sign restriction approach where all the impulse responses that obey the imposed signs are considered equally likely. This means that the penalty function approach uses an additional criterion to select the best of all impulse vectors. In addition, the penalty function approach can be used to sharpen the impulse responses in cases where the error bands are relatively wide for some variables (Rafiq and Mallick, 2008).

The sign restriction approach starts with a reduced form VAR in Equation 6.3

$$Y_t = B_{(1)}\, Y_{t-1} + B_{(2)} Y_{t-2} + \cdots + B_{(l)} Y_{t-i} + u_t, t = 1, \ldots T \tag{6.3}$$

Where, Y_t is a $m \times 1$ vector of data at time $t = 1 - l, \ldots., T, B_{(i)}$ are coefficient matrices of size $m \times m$ and u_t is the one-step ahead prediction error with variance-covariance matrix Σ_{cov}. If there are m fundamental innovations which are mutually independent and normalized to be of variance 1 and written as a vector v of size $m \times$ 1with $E[vv'] = I_m$. We need a matrix A such that $u_t = Av_{t.}$ The $j - th$ column of A represents the immediate impact on all variables of the $j - th$

fundamental innovation, one standard error size. The restriction on A emerges from the covariance structure in Equation 6.4

$$\Sigma = E[u_t\, u_t']\, A'\, AA' \qquad (6.4)$$

There are $m\ (m-1)/2$ degrees of freedom in specifying A and restrictions are needed to achieve identification. In the case of identifying a single shock, this means that we need to find a single column $a \in \mathbb{R}^m$ of the matric A in Equation 6.4 which satisfies some restrictions that identify that particular shock. The vector $a \in \mathbb{R}^m$ is an impulse vector if there is some matrix A, so that $AA' = \Sigma$ and a is a column of A. If $x_i, i = 1, \dots., m$ be the eigenvectors of $\sum$ normalized to form an orthonomal basis of $\mathbb{R}^m$. Let $\lambda_i, i = 1, \dots., m$ be the corresponding eigenvalues. Then a is an impulse vector if and only if there are coefficients $\alpha_i, i = 1, \dots, m$ with $\sum_{i=1}^{m} \alpha_i^2 = 1$ so that

$$a = \sum_{i=0}^{n} \left(\alpha_i \sqrt{\lambda_i}\right)\, x_1 \qquad (6.5)$$

Where the $v_t^{(a)} = b' u_t$ is the scale of the shock at time t in the direction of the impulse vector $a$and $v_t^{(a)} a$ is the part of u_t which is attributable to that impulse vector. These tools can perform variance decompositions or counterfactual scenario. The identification of the impulse vector corresponding to shocks of interest can be done via the pure sign restriction approach and the penalty function approach.

6.3.3 Pure sign restriction approach

The pure sign restriction approach imposes the sign restrictions on the impulse responses. Unlike the recursive identification approach, the sign-restrictions approach does not require the number of shocks to be equal to the number of variables. Furthermore, Caldara and Kamps (2010) show that the sign restriction approach does not impose any linear restrictions on the contemporaneous relation between reduced-form and structural disturbances. Rather, Mountford and Uhlig (2009) impose signs directly on the impulse responses.

The pure sign restriction VAR approach chooses a horizon $K \geq 0$ and takes a joint draw from the posterior for the VAR parameters as a uniform distribution over the $(m-1)$ dimensional sphere $(\alpha_1, \dots., \alpha_{m-1}), \sum \alpha_i^2 = 1$. The impulse vector in Equation (6.4) is constructed and the impulse responses $r_{k,j}$ at horizon $k = 0, \dots., K$for the variables $j$in the VAR. If the all the impulse responses satisfy the sign restrictions, all the draws are kept. If not, they are discarded. This process is repeated sufficiently often based on the draws kept. The error bands are then calculated based on the draws that are kept. Fratzcher et al. (2013) show that the orderings of the variables do not alter the results as the results are independent of the chosen decomposition of $\sum$.

6.3.4 The penalty function approach to sign-restriction

The penalty function approach is an alternative to the pure sign restriction approach used to select one solution out of the set of pure sign restriction solutions. Caldara and Kamps (2008) show that the penalty function approach is used in literature to numerically solve constrained nonlinear optimization problems for which closed form analytical solutions may be hard to obtain or may not exist at all. The difference is that the penalty function approach replaces the sign restrictions with a continuous penalty function that permits but (heavily) penalizes choices that violate the imposed signs. This means that the constrained problem is replaced with an unconstrained one. Caldara and Kamps (2008) indicate that in essence, the penalty function criterion solves a constrained optimization problem. The penalty function procedure finds the impulse vector that maximizes the forecast error variance of some variables in the VAR, subject to the imposed sign restrictions. In addition, Mountford and Uhlig (2009) indicate that that imposing sign restriction on the impulse responses does not produce sharp inference. Hence, it may be necessary to use the penalty function approach to sharpen the impulse responses.

The penalty function approach chooses a horizon $K \geq 0$ and the penalty function is defined as in Equation 6.6

$$f\ (x) = \begin{cases} x & if\ x\ \leq 0 \\ 100 * x\ if\ x \geq 0 \end{cases}, \qquad (6.6)$$

The penalty function penalizes positive responses in linear proportion and rewards negative responses in linear proportion but at a slope 100 times smaller than the slope for penalties on the positive. This means that the penalty on the coefficients of the wrong sign is 100 times larger than that on the correct sign. Furthermore, Uhlig (2005) states that the penalty function approach leaves the reduced form VAR untouched and prefers large responses that are far away from the imposed sign restrictions. As a result, it will identify a unique impulse vector conforming to the imposed sign restrictions for any given VAR.

6.4 Data and stylized facts

The study uses quarterly data for the period 2000Q1 to 2015Q4. We use are total credit, credit to households and companies, GDP growth, headline inflation, repurchase rate for monetary policy and the prime rate for the lending rate; non-performing loans and the FCI constructed in the chapter. The data used in the empirical estimations is sourced from the South African Reserve Bank database. For economic uncertainty we use the SA economic policy uncertainty index constructed by Hlatshwayo and Saxegaard (2016) shown in Figure A6.1 in the appendix.[25]

6.4.1 The estimated financial conditions index

The variables used in the construction of the FCI differ to those included used in Gumata et al (2012), Thompson et al. (2013) and Kasai (2011). The data used to construct the FCI includes domestic and US variables. The SA variables are the nominal effective exchange rate (NEER), terms-of-trade including gold, Absa house prices, the All-share price index, credit extended to the private sector. We included the NEER and the terms-of-trade to capture (i) the degree of openness (ii) the exchange rate impact on monetary and financial conditions and the (iii) impact of commodity prices on financial conditions and real economic activity. Furthermore, we include house prices given that housing market can act as a conduit for the transmission of shocks as well as an independent source of shocks for the broader economy. Changes in house prices can affect the tightness of the collateral constraint and credit supply conditions for the household sector.[26] In turn, conditions in the mortgage market affect consumption, residential investment and overall economic activity through some form of the financial accelerator mechanism.

First, we include VIX to capture global investor risk perceptions. Second, we include the asset purchases by the US Fed to also capture the conduct of unconventional monetary policy after the Fed Funds rate hitting the zero-lower bound. The inclusion of US asset purchases captures the role of US monetary policy in global liquidity and financial conditions given the fact that the US dollar is a dominant invoicing currency. Furthermore, we also include the spread between the SA and US ten-year government yield to capture changes in the sovereign risk which also affect financing condition for government. Risk perceptions and tolerance can affect market the risk premia and lead to changes in financial conditions. Combining these variables into a summary statistic of the financial conditions enhances the analytical capabilities of the empirical analysis

[25] See Hlatshwayo and Saxegaard (2016) on the methodology and construction of the SA policy uncertainty index.

[26] See also Aoki et al., (2004); Lacoviello and Neri (2010).

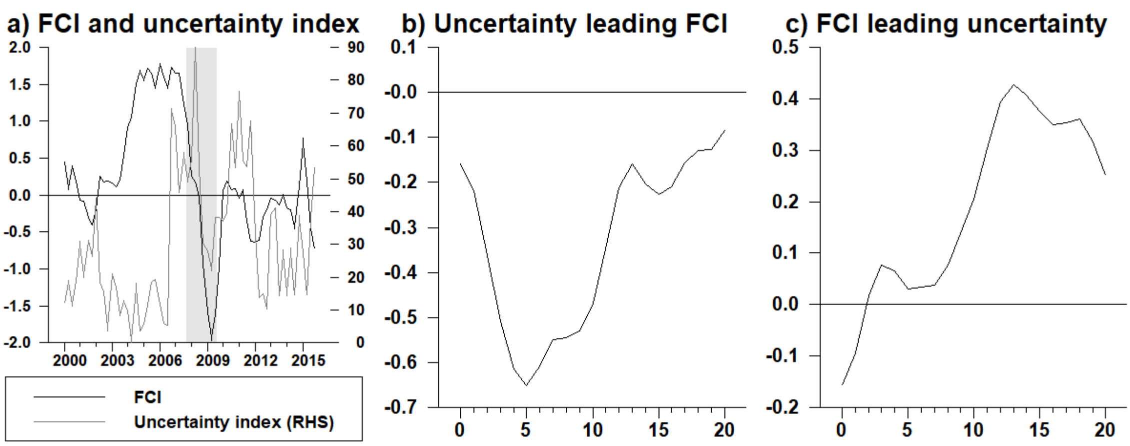
while contributing to existing literature and available FCIs for South Africa.

The FCI is estimated for the period 1986Q1 to 2015Q4. Prior to estimation the data series are demeaned and standardized prior to estimations. We purge the estimated FCI of feedback from GDP and thus eliminate any endogeneity. We show the number of factors chosen by the Bai and Ng (2002) criteria in Table A6.1 and the factor loadings in Figure A6.1.

6.4.2 What is the nature of the relationship between the FCI and uncertainty?

We stated earlier that an increase in economic uncertainty often occur alongside tightening financial conditions. Furthermore, Caldara et al (2016) show that uncertainty increases in response to an adverse credit or financial shock. Does the constructed FCI possess these properties? Figure 6.2 shows the estimated FCI over the business cycle phases. The interpretation of the FCI is that when it is at zero, it suggests that financial conditions are neutral. This means that financial conditions are neither tight nor loose. On the other hand, if the FCI records negative (positive) values, the meaning is that financial conditions are tight (loose).

Figure 6.2 FCI and uncertainty



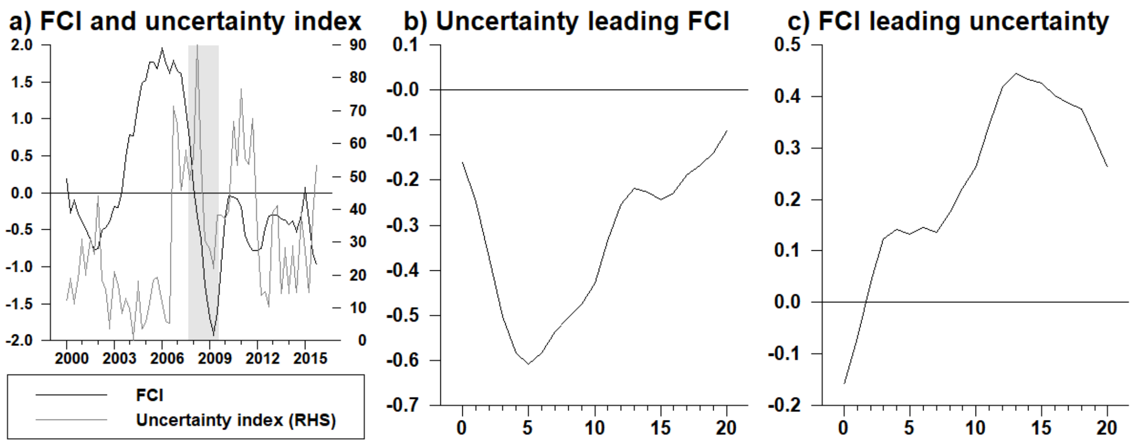
Source: Hlatshwayo and Saxegaard (2016) and author's calculations

Figure 6.2 plots the FCI together with the uncertainty index in (a) and parts (b) and (c) show the cross correlations when FCI leads (lags) the uncertainty index. As suggested by studies in literature, we establish a causal relationship between uncertainty and financial conditions. Figure 6.2 (b) and (c) show that heightened uncertainty leads to tight financial conditions for prolonged periods.

6.4.3 How does the FCI relate to lending conditions, business, and consumer confidence?

We stated earlier that tightening in financial conditions are identified in the same way as adverse credit supply shock. This means that tight financial conditions are associated with depressing effects on credit and economic activity. Does the constructed FCI exhibit these bilateral relationships with lending conditions? First, Figure 6.3 shows that there is a positive relationship between the FCI and lending conditions. This means that tight financial conditions in part imply tight credit lending conditions and adverse credit supply shocks as shown in part (c).

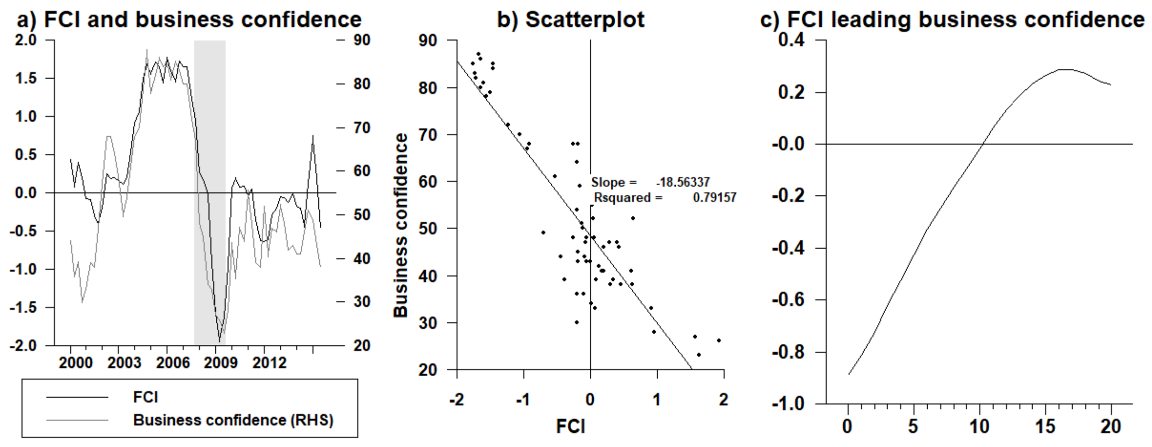
Figure 6.3 FCI and lending conditions



Source: South African Reserve Bank and author's calculations

In addition, Figure 6.4 shows that tight financial conditions are negatively related with business conditions. The implication is that, as suggested by Arellano et al. (2012), Christiano et al. (2014), and Gilchrist et al. (2014) tight financial lead to a persistent decline in economic activity.

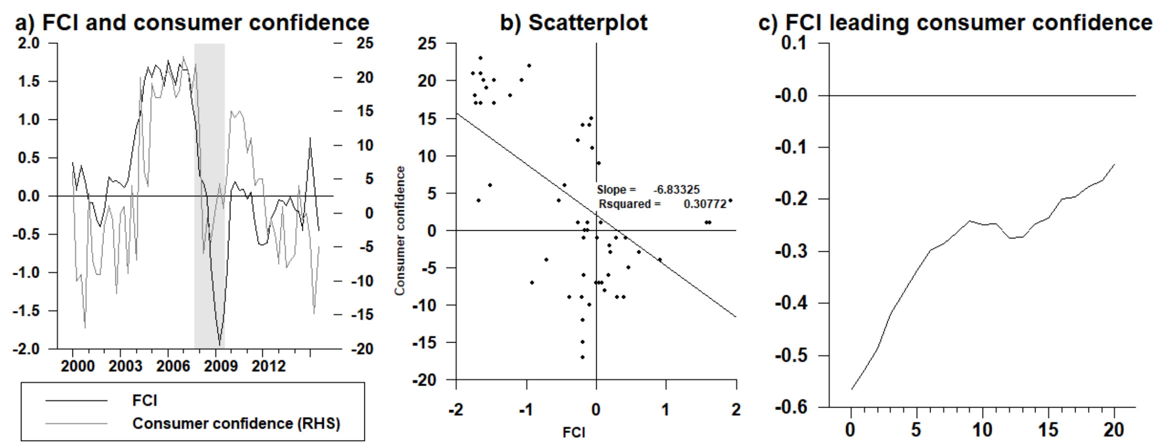
Figure 6.4 FCI and business confidence



Source: South African Reserve Bank and author's calculations

Similarly, in Figure 6.5 tight financial conditions are negatively related to consumer confidence. This implies that tight financial are also transmitted to the real economy via the consumer confidence channel.

Figure 6.5 FCI and consumer confidence



Source: South African Reserve Bank and author's calculations

Overall, the stylised facts indicate that the estimated FCI does capture the salient features of real economic activity in South Africa. Indeed, there is preliminary evidence of a causal relationship between heightened uncertainty, tight financial conditions adverse credit supply shocks and economic activity.

6.5 Empirical results

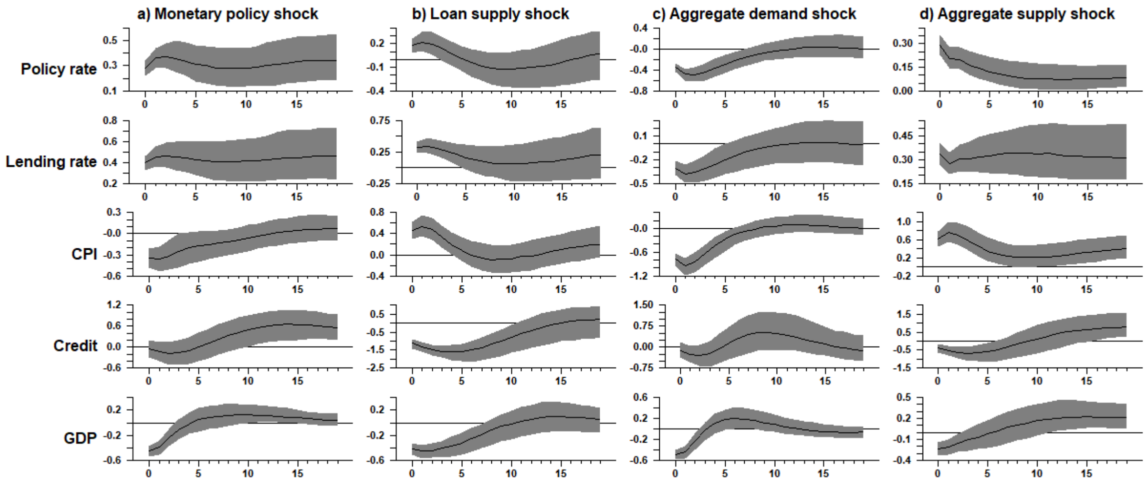
We start the empirical analysis by estimating a five variable VAR in Equation 6.7. The imposed sign restrictions are as shown in Table 6.2.

$$Y_t = \{repo, lend, CPI, GDP, credit\} \ldots\ldots\ldots\ldots\ldots (6.7)$$

Where, $repo$ is the repo rate, lend is the lending rate, cpi is headline inflation, GDP is GDP growth and credit is total credit growth. Similarly, in models where we estimate the role of sectorial credit, we replace total credit with credit to households and companies. The VAR models are estimated for the period 2000Q1 to 2015Q4 and have two lags chosen by AIC/SBC/BIC and the impulse are generated from 10 000 Monte Carlo draws and are responses to a one standard deviation shock. The monetary policy shock is a contractionary monetary policy shock, the loan supply, aggregate demand, and supply shock are adverse shocks. The model is estimated via the pure and penalty function approaches to sign restriction. However, in the discussion we only present the results generated via the penalty function approach.

Figure 6.6 presents the results and the impulse responses suggest that the model obeys the imposed sign restrictions. Of interest are the responses of credit which is restricted in all models. The responses to a contractionary monetary policy and adverse loan supply, aggregate supply and demand shocks indicate that credit growth declines more due to a loan supply shock followed by the aggregate supply shock. This means that adverse loan supply shocks due to the combined effects of increases in the price of loans via interest rate margins and a decline in quantities via strict lending criteria exert disproportionate effects on the amount of credit granted by banks. The results concur with empirical finding sin other studies that show that even though adverse credit supply shocks are like adverse monetary policy shocks they can have a different effect on the quantities of credit. Indeed, adverse credit supply shocks exert a disproportionate effect on the quantity of loans (like a credit crunch) which is not evident under a monetary policy shock.

Figure 6.6 Responses of variables to four shocks in the benchmark model

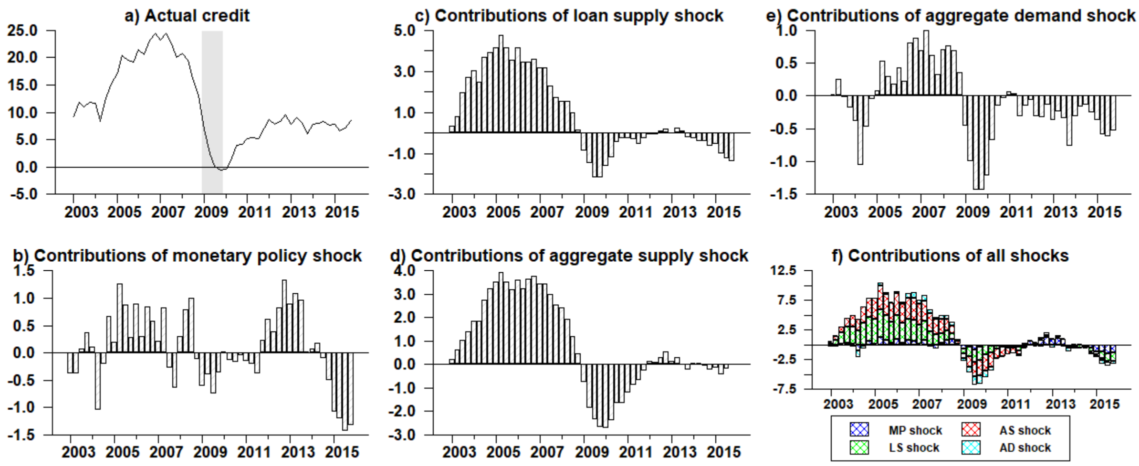


Source: Author's calculations

Of interest as well are the responses of credit to aggregate demand shocks. Even though the policy rate and the lending rate decline in response to an adverse (decline) aggregate demand shock, credit declines and is insignificant throughout the entire forecast horizon. The implication is that decline in the policy rand lending rates does not have significant stimulatory effects. It is possible that the impact of accommodative monetary policy is neutralized by the negative effects of the adverse aggregate demand shock on GDP growth. These findings concur with Bean et al (2010) who show that adverse aggregate demand shocks because they result in the decline in GDP growth and a fall in income exert additional downward pressure on credit volumes via the decline in the demand for credit.

Furthermore, the historical contributions of various shocks in the evolution of credit shown in Figure 6.7 indicate that loan supply and aggregate supply shocks contributed more to credit growth pre-2009. At peak during this credit boom, loan supply and aggregate supply shocks contributed around 5 percentage and 4 percentage points, respectively compared to an average of 0.5 percentage points due to monetary policy and aggregate demand shocks.

Figure 6.7 Contributions of shocks to credit growth



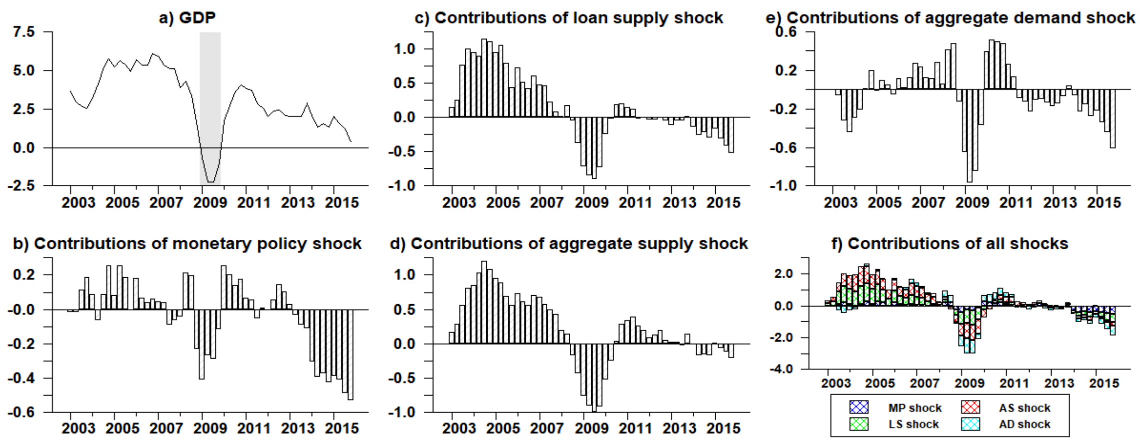
Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.

Source: Author's calculations

The results of the contributions of credit supply and aggregate supply shocks in Figure 6.7 (c), (d) and (f) concur with findings of the concurrence of house, equity and commodity price booms pre-2009 and the manner in which these booms reinforced each other on credit growth. Furthermore, we showed in the stylized facts that pre-2009, financial and lending conditions were loose and imply that banks were supplying more credit. Similarly, post-2009 it is evident that financial and credit conditions have been tight most of the time and business and consumer confidence have been low hence the negative contributions of credit supply and aggregate demand shocks in Figure 6.7 (c), (e) and (f). Overall, the contributions of the shocks shown in Figure 6.7 (f) suggest that all shocks have been moving in the same direction and making negative contributions to credit growth post-2009.

A similar picture is evident in Figure 6.8 on the contributions of shocks to GDP growth pre- and post-2009. But the brief positive contributions of aggregate supply and monetary policy shocks post-2009 have turned negative and all shocks are negatively contributing to GDP growth.

Figure 6.8 Contributions of shocks to GDP growth

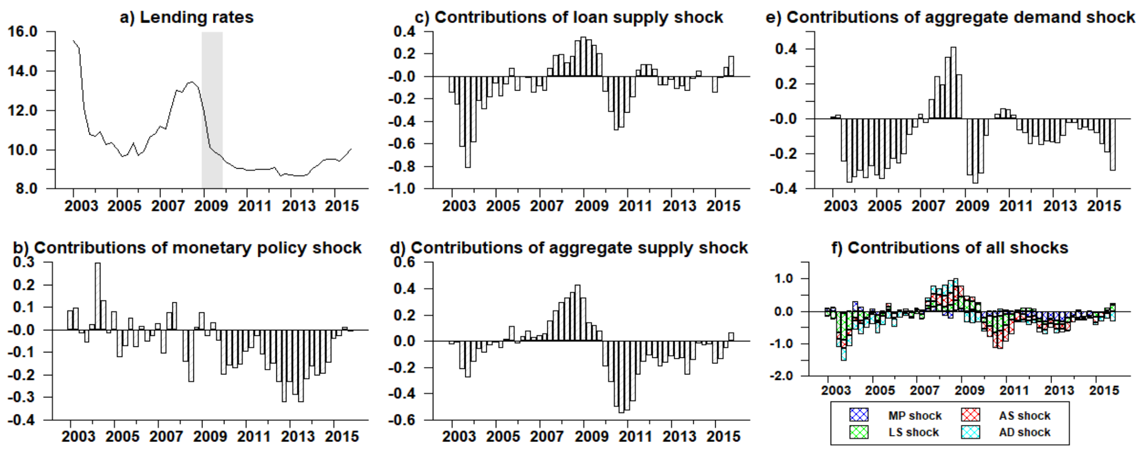


Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.

Source: Author's calculations

Despite the historic low levels of policy rates shown in Figure 6.1 loan supply shocks were exerting downward pressure on credit growth in Figure 6.7, GDP growth in Figure 6.8 and lending rates in Figure 6.9.

Figure 6.9 Contributions of shocks to lending rates



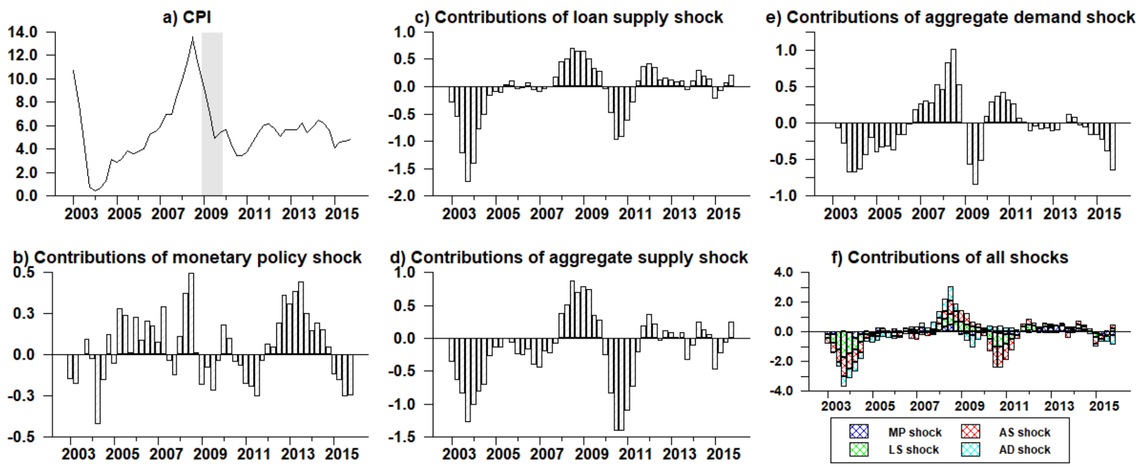
Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.

Source: Author's calculations

This means although monetary policy was accommodative as evidenced by the decline in the policy rate, credit and financial conditions were not as loose and stimulatory as lending rate margins increased and exerted downward pressure on credit growth. The results indicate the existence of the balance sheet channel in the transmission of adverse loan supply and aggregate supply shocks.

We explore the role of credit risk as proxied by non-performing loans and productivity shocks in later sections of the chapter.

Figure 6.10 Contributions of shocks to inflation



Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.
Source: Author's calculations

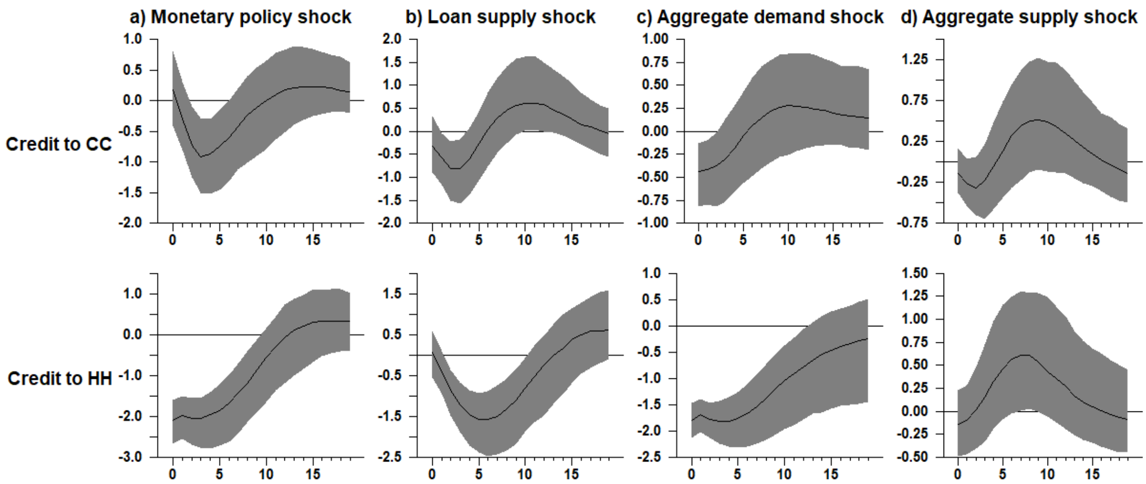
Furthermore, despite the inconclusive nature of empirical evidence on the impact of loan supply shocks on inflation, the historical contributions in Figure 6.10 suggest that they have made positive contributions to post-2009 although these effects were neutralized by aggregate demand shocks.

6.5.1 Are there differences in the response of sectorial credit to all shocks?

To assess the impact of all the shocks on sectorial credit, we estimate the model in Equation 6.7, but we replaced total credit with credit household and companies in different models. The aim is to assess the relative degree of the sensitivity of sectorial credit to different shocks. An analysis of this nature will also assist in the understanding of the sectorial dynamics and macro-prudential polices aimed at dealing with sectorial aspects of credit.

First, we show evidence from impulse responses in Figure 6.11 and the evidence suggests that indeed there is heterogeneity in the responses of sectorial credit to different shocks. For instance, credit to households declines more due to contractionary monetary policy, loan supply and aggregate demand shocks compared to credit to companies. The responses of credit to households are almost twice due to adverse monetary policy, loan supply and aggregate demand shocks. Furthermore, the impact of these shocks persists compared to the duration on credit to companies.

Figure 6.11 Responses of credit to households and companies to four shocks in the benchmark model

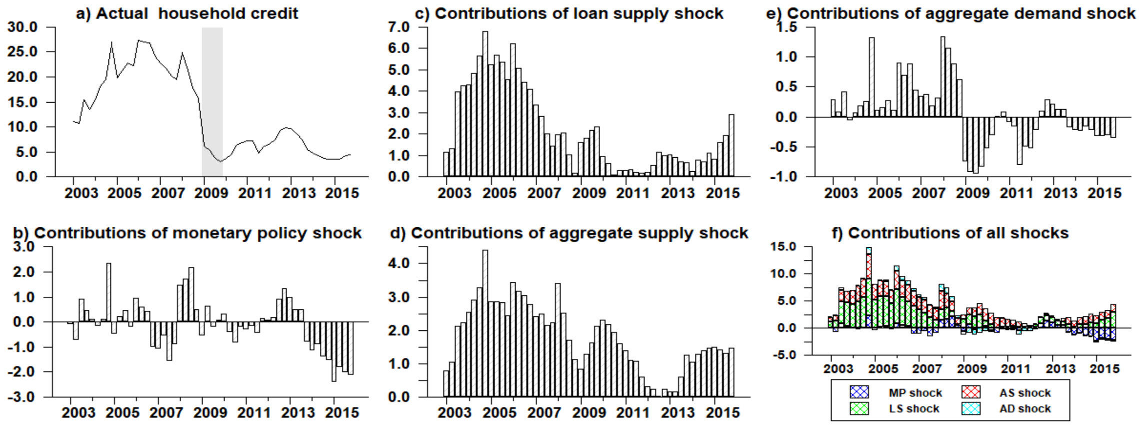


Note: CC = companies and HH = households.

Source: Author's calculations

In addition, the historical contributions in Figure 6.12 show that loan supply and aggregate supply shocks persistently contributed above 4 percentage points and 3 percentage points to household credit between 2003Q1 to 2008Q4. Aggregate demand shocks also made persistent positive shocks to household credit although they were relatively lower to loan supply and aggregate demand shocks.

Figure 6.12 Contributions of shocks to credit to households

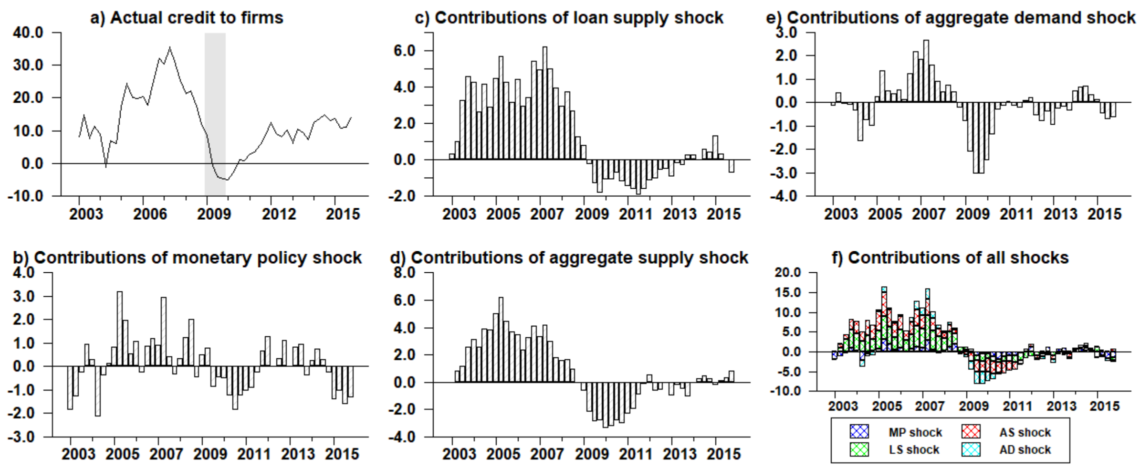


Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.

Source: Author's calculations

On the other hand, the historical contributions of shocks to credit to companies suggest that loan supply and aggregate supply shocks were not as stimulatory as they were relative to credit to households. This means that the channels of the transmission of shocks that relax credit constraints on sectorial credit are different. Locaviello and Minnetti (2008) attribute this to the non-responsiveness of housing loans which is partly due to long-term relationships between banks and customers. They posit that banks can insulate their loan portfolios from monetary shocks by absorbing interest increases via unchanged interest rate margins. We explore the role of mortgage advances in later sections.

Figure 6.13 Contributions of shocks to credit to firms



Note: MP = monetary policy, LS = loan supply, AD = aggregate demand and AS = aggregate supply.

Source: Author's calculations

However, post-2009 evidence suggests that adverse loan supply and aggregate supply shocks have had a negative impact on both sectors. But it seems that the impact was more severe on credit to companies relative to households. Evidence suggests that aggregate supply shocks contributed more to the decline in credit to companies relative to loan supply shocks. The results are consistent with the commodity price slump, subdued global growth and investment spending to the degree that they are captured by aggregate supply shocks. In turn the impact of adverse aggregate supply shocks via the increase in the credit risk premium and the financial accelerator mechanism as indicated by the contributions of the loan supply shocks exerted downward pressure on credit to companies. Hence loan supply shocks played an important role but were not a dominant factor.[27]

Overall, the results presented by the sectorial responses to the various shocks and the historical contributions indicate the presence of heterogeneity in the responses to different shocks. Indeed, the evidence presented in this section suggests that the provision (supply) of loans by banks and aggregate supply shocks played a dominant role in lowering credit growth post-2009. The implication is that balance sheet constraints affecting households and companies were the dominant channel in the transmission of adverse loan supply shocks compared to demand shocks. These channels require different policy interventions hence we explore the role of the financial conditions and policy uncertainty, balance sheet and bank lending channels in the next sections.

6.5.2 Is the impact of tight financial conditions different to that of heightened uncertainty?

What is the impact of tight financial conditions and uncertainty shocks on total credit and sectorial credit? We showed earlier in the stylized facts that tight financial conditions and heightened uncertainty shocks reinforce each other but we do not know what their effects on total and sectorial credit growth or GDP growth is. We empirically explore the role of tight financial conditions and heightened uncertainty in a VAR specified in Equation 6.8.

$$Y_t = \{repo, lend, CPI, GDP, credit, Uncert, FCI\} \dots \dots \dots \dots . (6.8)$$

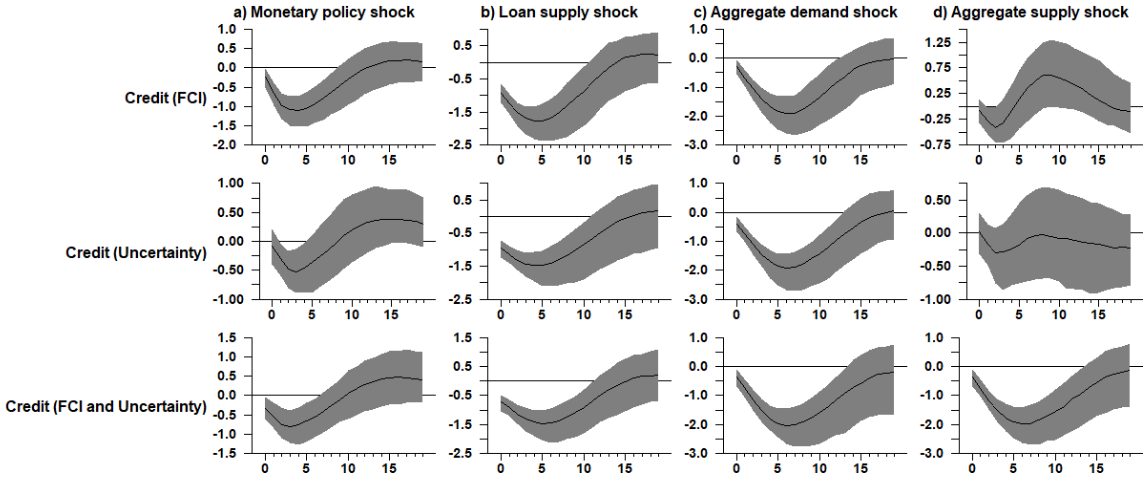
Where, $repo$ is the repo rate, lend is the lending rate, cpi is headline inflation, GDP is GDP growth, credit is total credit growth, FCI is the financial conditions index estimated in the chapter and uncert is the uncertainty index. For comparison of the combined effects of tight financial conditions and heightened uncertainty we estimate six variable VAR models specified as in

[27] Hristov et al. (2012); Finlay and Jaaskela (2014) report similar results.

Equation 6.8 but with the FCI and uncertainty included separately. This will help us to get a better understanding of the role of the two variables. We adopt the same approach for models assessing the impact of credit to households and companies where we just replace total credit with sectorial credit.

The VAR models in this section are estimated for the period 2000Q1 to 2015Q4 and have two lags chosen by AIC/SBC/BIC criteria. The VAR impulse are generated from 10 000 Monte Carlo draws. The impulse responses to a one standard deviation shock. The monetary policy shock is a contractionary monetary policy shock, the loan supply, aggregate demand, and supply shock are adverse shocks. The tight financial conditions and heightened uncertainty are identified as adverse loan supply and aggregate demand shocks. The models are estimated via the pure and penalty function approaches to sign restriction. In the discussion we only present the responses of credit. The estimated FCI does not have a structural interpretation hence it has to be included in an encompassing model to estimate the transmission and the impact of tight financial conditions. Furthermore, since the FCI represents information from several financial variables, it is expected to improve the extraction of other shocks. Vast literature argues that including the FCI into the VAR estimations reduces the risk of omitting important financial information at the disposal of the monetary policy maker. Figure 6.14 indicates that indeed the simultaneous estimation of financial conditions and uncertainty shocks exerts different effects on credit. Credit growth declines more and the effects are more persistent when tight financial conditions and heighted uncertainty shocks are included in the model.

Figure 6.14 Responses of credit to tight financial conditions and heightened uncertainty shocks

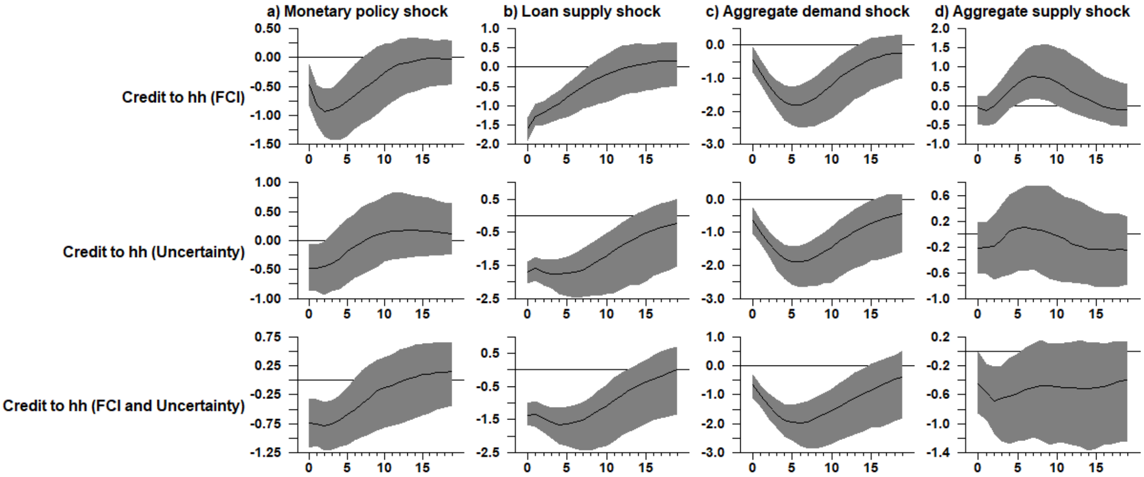


Source: Author's calculations

The impact of the simultaneous estimation of tight financial conditions and heightened uncertainty shocks is also evident on credit to household and firms in Figure 6.15 and 6.16. Whereas the impact of tight financial conditions and uncertainty shocks is negative but insignificant under the aggregate supply shock when these shocks are estimated individually, their responses are pronounced and persistent when they are estimated together in the same model.

It is evident that tight financial conditions and heightened uncertainty shocks work via aggregate demand shocks as well. These results are consistent with Leduc and Liu (2015) who establish that uncertainty partly operates via the aggregate demand channel. They show that nominal rigidities interact with the demand channel that arises from nominal rigidities to propagate the uncertainty shocks. In the presence of price rigidities, heightened uncertainty leads to a decline in aggregate demand. Hence, they conclude that heightened uncertainty shocks partly act like negative aggregate demand shocks.

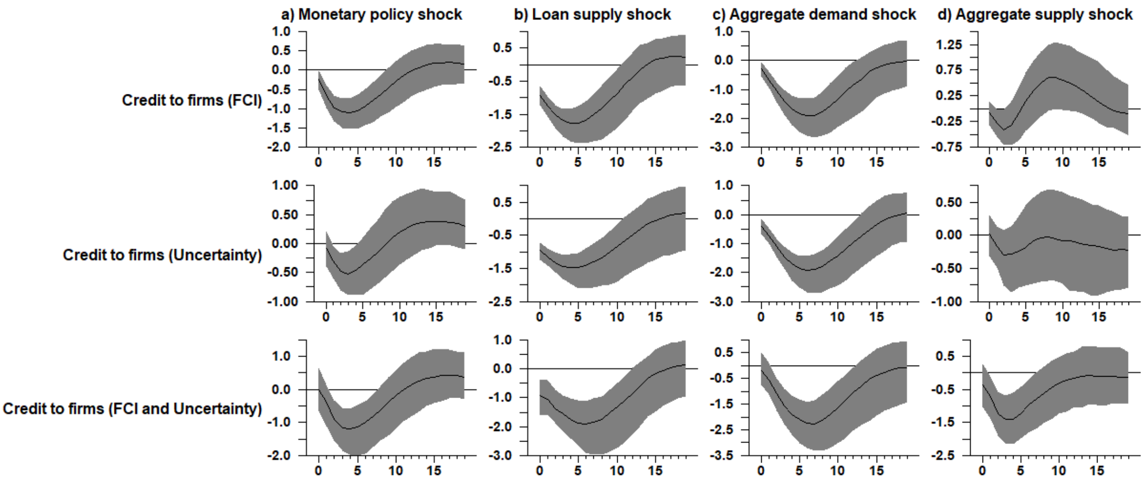
Figure 6.15 Responses of household credit to tight financial conditions and heightened uncertainty shocks



Source: Author's calculations

Similarly, Arellano et al. (2012), Christiano et al. (2014), and Gilchrist et al. (2014), show that financial shocks and adverse credit supply shocks characterize the responses of a persistent decline in both output and inflation which is similar to that induced by uncertainty shock when financial stress is heightened.

Figure 6.16 Responses of corporate credit to tight financial conditions and heightened uncertainty shocks



Source: Author's calculations

We therefore conclude that financial conditions and uncertainty shocks play a significant role in propagating adverse loan supply shocks. Tight financial conditions and heightened uncertainty shocks interact and have depressing effects on aggregate demand and credit growth. The results are consistent with Caldara et al (2014) who find that financial conditions shocks have a significant adverse effect on economic activity especially when they result in tightening of financial conditions. Arise in uncertainty in response to a financial shock which means that changes in uncertainty are extremely sensitive to changes in financial conditions.

6.5.3 Is there a credit channel via the balance sheet channels in the housing market?

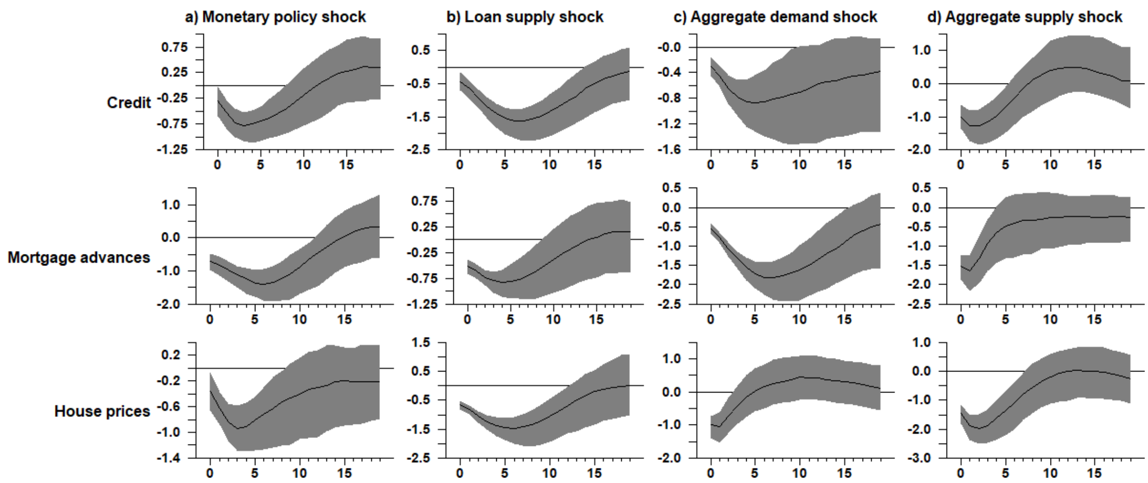
We stablished earlier that balance sheet constraints affecting households and companies were the dominant channel in the transmission of adverse loan supply shocks compared to demand shocks. This section follows the Locaviello and Minnetti (2008) approach to identify the presence of the balance sheet channels via the housing market. We estimate a VAR model specifies as shown in Equation 6.9:

$$Y_t = \{repo, lend, CPI, GDP, credit, HP, Mortg \;\; \ldots \ldots (6.9)$$

Where, $repo$ is the repo rate, lend is the lending rate, cpi is headline inflation, GDP is GDP growth, credit is total credit growth, HP is the nominal house prices and mortg is mortgage advances. For comparison of the response of total credit and mortgage advances we include both variables in the model. This will help us to get a better understanding of the role of contractionary monetary policy shocks and lending spreads on total credit and mortgage advances.

The VAR models in this section are estimated for the period 2000Q1 to 2015Q4 and have two lags chosen by AIC/SBC/BIC criteria. The VAR impulse are generated from 10 000 Monte Carlo draws. The impulse responses to a one standard deviation shock. The monetary policy shock is a contractionary monetary policy shock, the loan supply, aggregate demand, and supply shock are adverse shocks. The model is estimated via the pure and penalty function approaches to sign restriction. In the discussion we only present the responses of credit, mortgage advances and house prices. In Figure 6.17 we find that indeed total credit declines more than mortgage advances in response to the loan supply shock at peak response. On the other hand, mortgage advances decline more due to contractionary monetary policy and house prices decline more in response to adverse aggregate supply shock.

Figure 6.17 Responses of credit, mortgage advances and house prices to four shocks



Source: Author's calculations

The implication of the results is that because mortgage advances constitute a large share of banks' portfolios, banks' shield existing mortgage clients but adjust the spread to new loans as total credit declines more. As suggested by Locaviello and Minnetti (2008) this could be due to long-term relationships between banks and customers. However, the increase in the spread on new loans could reflect the impact of deterioration in collateral values and net worth as shown by the decline in house prices. The results therefore support the existence of the balance-sheet channel. Contractionary monetary policy increases the interest rate spread, the external finance premium as evidenced by the decline in house prices thus affecting the net worth and the collateral channels.

6.5.4 How severe is the deterioration in borrowers' net worth and credit risk for banks?

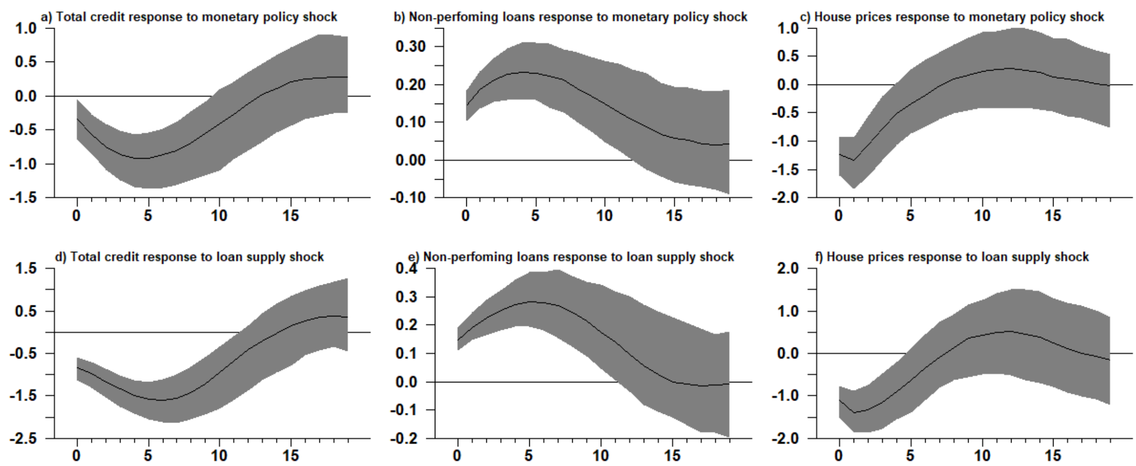
We established that banks seem to shield their mortgage portfolios from contractionary monetary policy shocks but increase the spreads on new loans due to the deterioration in collateral values and borrowers' net worth. Is this evident in the response of banks' credit risk as proxied by non-performing loans? To answer this question, we estimate a VAR model specifies as shown in Equation 6.10.

$$Y_t = \{repo, lend, CPI, GDP, credit, NPLs, HPs \ \dots\dots (6.10)$$

Where, $repo$ is the repo rate, lend is the lending rate, cpi is headline inflation, GDP is GDP growth, credit is total credit growth, HP is the nominal house prices and NPLs is non-performing loans. We are more interested in the response of total credit response to contractionary monetary policy shocks and adverse loan supply shocks in the presence of credit risk and deterioration in in house prices. The VAR model is estimated for the period 2000Q1 to 2015Q4. The VAR has two lags chosen by AIC/SBC/BIC and the impulse are generated from 10 000 Monte Carlo draws and are responses to a one standard deviation shock. In the discussion we only present the responses of credit, non-performing loans and house prices to monetary policy and loan supply shocks.

In Figure 6.18 we find that credit declines more due to loan supply shocks in the presence of deterioration in credit risk (increase in NPLs) and net worth (decrease in house prices). The response to the loan supply shock at peak response is more than that to monetary policy shock. This provides further evidence of the balance-sheet view that the financial position of households and other borrowers is the potent channel through which monetary policy and the loan supply channel (increase in lending spreads and the external finance premium) interact to affect the real economy.

Figure 6.18 Responses of credit, non-performing loans and house prices



Source: Author's calculations

The implication is that credit to the private sector declines mainly due to the deterioration in balance sheets of households and non-performing loans of banks more than the decline in the demand for credit. This does not mean that there the absence of the traditional monetary transmission mechanism. Credit growth declines in response to contractionary monetary policy consistent with the decline in loan demand. But the response of mortgage advances, house prices and non-performing loans suggest that contractionary monetary policy shock is propagated via the deterioration in collateral values and borrowers' net worth impact on the loan supply channel Because housing plays an important role in the business cycle as a component of investment, wealth and demand via consumption policy interventions that support the banking system as well as the real economy need to be prioritised.

6.6 Conclusion and policy implications

Against the backdrop of historic low interest rates post-2009 and the seemingly muted response of credit and GDP growth, this chapter explored the role of the concurrence of adverse monetary policy, loan supply, aggregate demand, and supply shocks. We used pure and penalty function approach to sign restriction to identify these structural shocks. First, before conducting empirical analysis we construct the financial conditions index (FCI) to capture the role of diverse variables compared to just the analysis of the policy rate or lending rates. We find that the constructed FCI is positively related to lending conditions, meaning that tight financial conditions imply tight lending conditions. In addition, we establish that the FCI is negatively related to the consumer and business confidence. The correlation analysis suggests that tight financial conditions lead to lower consumer and business confidence. At the same time evidence suggest that the FCI is positively related to policy uncertainty. In fact, cross correlations indicate that heightened uncertainty leads to tight financial conditions for prolonged periods.

The empirical analysis suggests that loan supply and aggregate supply shocks played a dominant role in total and sectorial credit; and GDP growth pre-2009 consistent with the house, equity and commodity price booms. However, post-2009 aggregate supply shocks reinforced by loan supply shocks played a dominant role in depressing credit growth. The impact of the adverse shocks was particularly severe on credit to companies relative to households. Furthermore, we establish that tight financial conditions and heightened uncertainty shocks interact and are mainly transmitted via aggregate demand shocks as well. Tight financial conditions and heightened uncertainty shocks play a significant role in propagating adverse loan supply shocks and have depressing effects on aggregate demand and credit growth.

Furthermore, we establish the existence of the balance sheet channel of monetary policy via the housing market. Mortgage advances decline more due to contractionary monetary policy and house prices decline more in response to adverse aggregate supply shock. The implication is that credit to the private sector declines mainly due to the deterioration in balance sheets of households and non-performing loans of banks more than the decline in the demand for credit. This does not mean that there the absence of the traditional monetary transmission mechanism. Rather the response of mortgage advances, house prices and non-performing loans suggest that contractionary monetary policy shock is propagated via the deterioration in collateral values and borrowers' net worth impact on the loan supply channel. The policy implication is that because housing plays an important role in the business cycle as a component of investment, wealth and demand via consumption policy interventions that support the banking system as well as the real economy need to be prioritized.

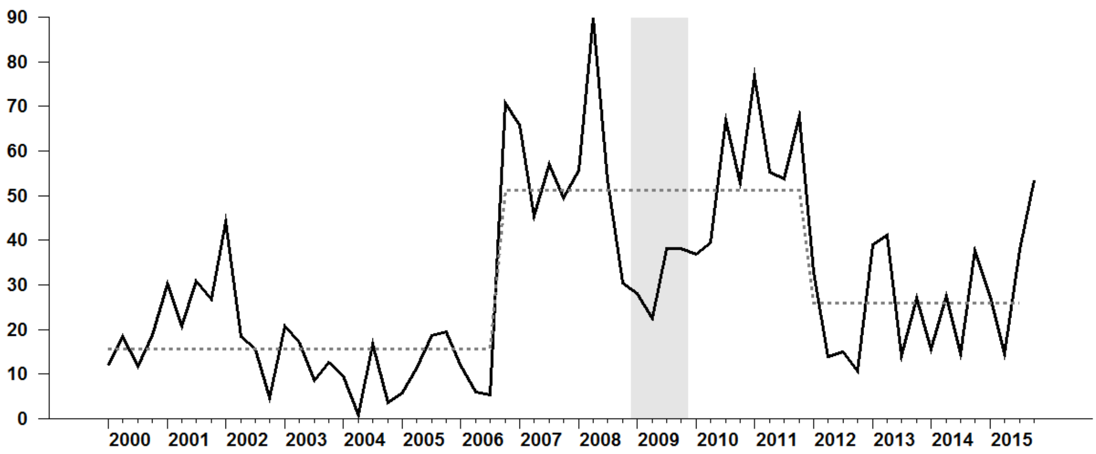
Appendix

Table A6.1 The Bai and Ng (2002) criteria for the selection of the number of factors: FCI

Number of factors	Eigenvalues	Proportion of variation explained
Global investor risk perception		
1	3.458	3.075
2	0.685	0.966
3	0.578	0.863

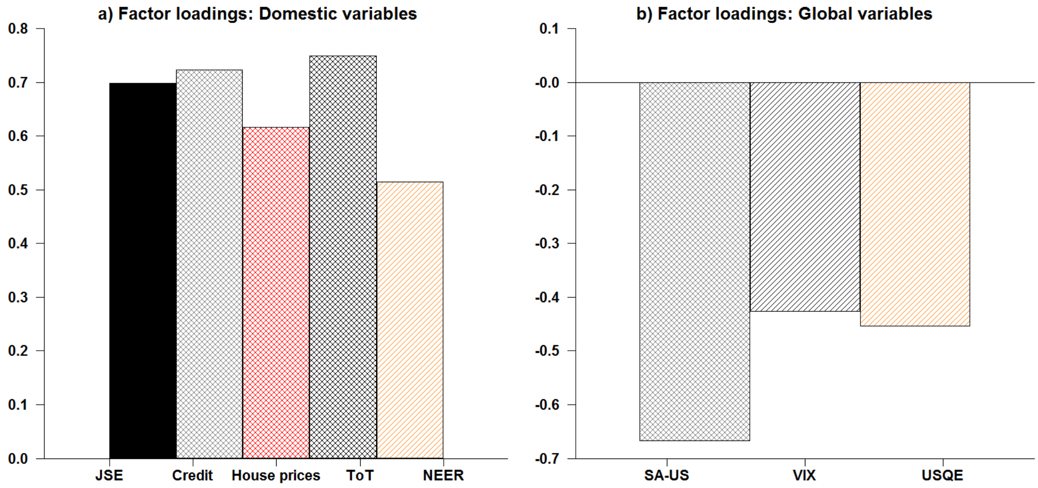
Source: Author's calculations

Figure A6.1 South African economic policy uncertainty



Source: Hlatshwayo and Saxegaard (2016) and author's calculations

Figure A6.2 Factor loadings for FCI



Source: Author's calculations

Chapter 7 Household debt and the macro-economy: Does household debt exert non-linear effects on output growth?

7.1 Introduction

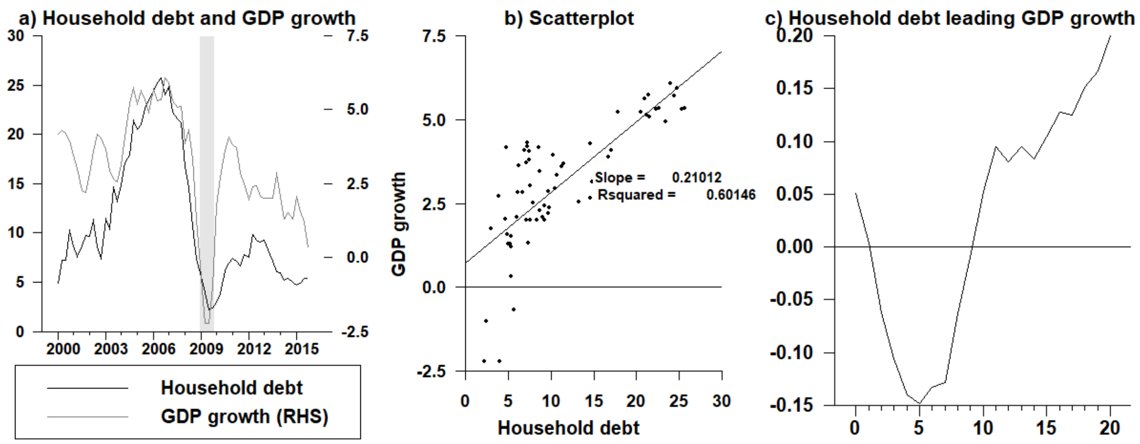
Does the level of household debt growth impact GDP? If so, is there a threshold of household debt that induces non-linear GDP growth responses depending on the household debt regimes? The period preceding the global financial crisis was characterized by a large accumulation of debt by households. Most empirical literature subsequent the global financial crisis shows that sudden and large increases in debt pre-crisis are partly responsible for much of the subdued output growth environment. Koo (2015) and Rogoff (2014) argue that the recession that followed the financial crisis was not a typical business cycle recession. It was a balance sheet recession associated with the bust phase of the financial cycle. This hypothesis puts the role of credit growth, balance sheets and the hangover from the super-cycle of imprudent debt accumulation as key factors underlying the sluggish growth post the financial crisis.

Furthermore, Mian et al (2015) show that an increase in the household debt-to-GDP ratio predicts subsequent lower output growth and higher unemployment. They conclude that household debt is a source of instability and lower economic growth. What role did household debt play in the evolution of output growth post 2009? Are the dynamics in domestic household debt best characterized by the credit demand or supply hypothesis? Does household debt exert threshold non-linear effects of output growth? What are the implications for price and financial stability?

Theoretically, there are two broad hypotheses that relate household debt to GDP growth and the business cycles. First, the credit demand hypothesis posits a positive relationship between current household borrowing and future income. This means that household borrowing is driven by productivity or technology shocks that increase expected future income, spurring higher consumption and borrowing in anticipation. Second, the credit supply hypothesis holds that higher household borrowing is driven by an expansion in the availability of credit. The existence of financial frictions, constraints and nominal rigidities can result in the changes in households borrowing that also affect GDP growth. Furthermore, theory shows that loan supply and aggregate demand shocks exert different effects on household debt. Hence it is important to distinguish these tow effects in the data. In addition, the results and policy implications of such an analysis can be very informative for the design of macro-prudential and financial regulatory tools aimed at dealing with the macro-economic effects of the supply and demand for credit in pursuit of the financial stability objective.

Figure 7.1 show that there exists a positive relationship between household debt and GDP growth.[28] The scatterplots indicate that on a bilateral basis, growth in household debt explains 60 per cent of changes in GDP growth. In addition, the cross-correlations suggest that there are persistent lag effects in the dynamics of the relationship. This means that although household debt explains a significant proportion of movements in GDP growth, there are dynamics and non-linearities involved that are bilateral relationship is unable to capture.

Figure 7.1 Household debt and GDP growth, 2000Q1 to 2015Q4

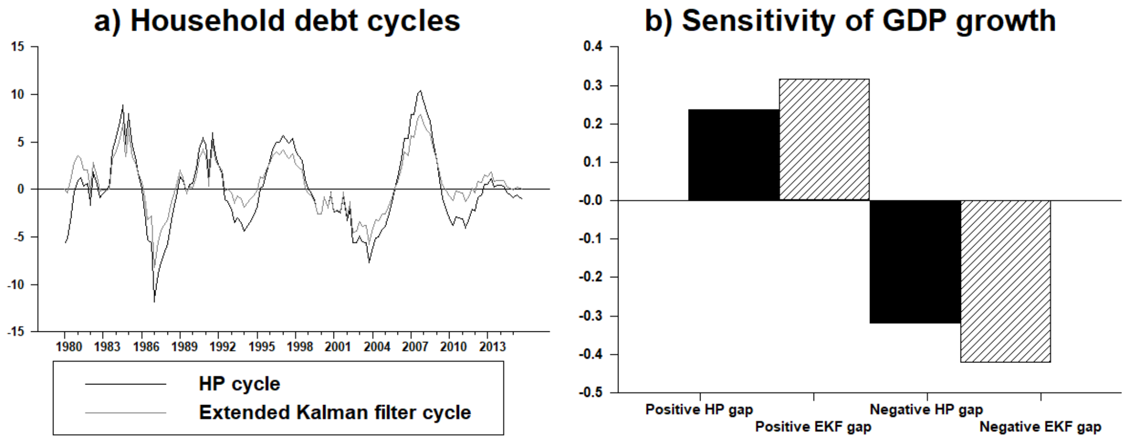


Source: South African Reserve Bank and author's calculations

However, the positive relationship depicted in Figure 7.1 does not tell us anything about the impact of severe deviations of household debt from long-term trends on GDP growth. To demonstrate this, Figure 7.2 shows the household debt cycles and how they relate to GDP growth. In Figure 7.2(a) the cycles are derived by using the Hodrick-Prescott and extended Kalman filters for the period 1980Q1 to 2015Q4. The positive (negative) cycles show periods during which the level of household debt was above (below) the long trend level.

[28] We show long-term trends from 1980Q1 to 2015Q4 in Figure A7.1 and the trends post the financial crisis Figure A7.2 in the appendix.

Figure 7.2 Household debt cycles and GDP growth



Source: Author's calculations

It is evident that there are four cycles during which household debt was persistently above trends (debt overhang) and that the recent trend during 2004 to 2010 was the highest positive deviation on record. The HP and the extended Kalman filters estimate that the deviation was at 10 per cent at peak. The sensitivity of GDP growth to positive and negative deviations shown in Figure 7.2(b) is based on the linear regressions coefficients of positive (negative) household gaps[29] indicate that there are potential asymmetries. Indeed, positive (negative) household debt gaps result in an increase (decline) in GDP growth, but it is also evident that the GDP growth sensitivity is different. GDP growth is more sensitive to negative household debt gaps compared to positive gaps. We show that the same trends are evident in sub-samples 2000Q1 to 2015Q4 and 2010Q1 to 2015Q4 in Figure A7.3 and Figure A7.4 in the appendix.

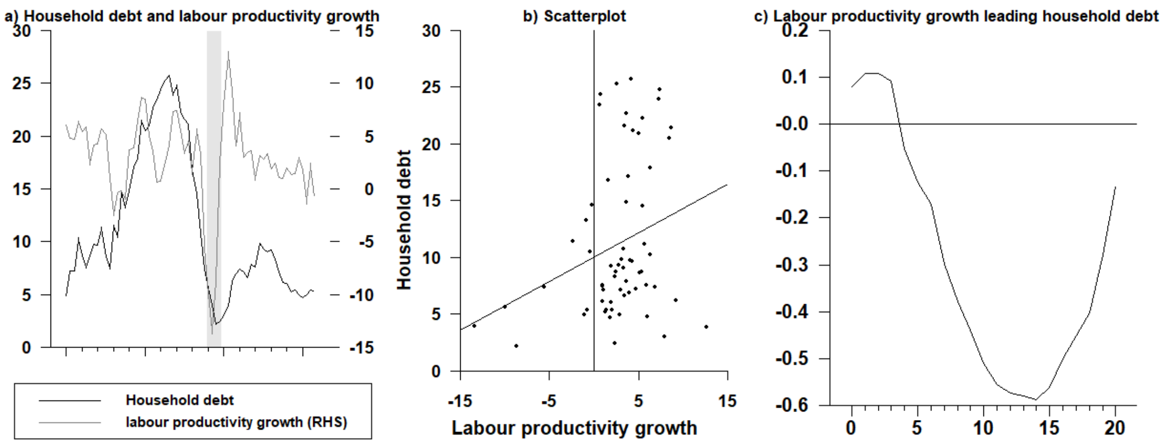
Mian et al (2015) posit that there are two broad hypotheses that relate household debt to GDP growth and the business cycles. First, the credit demand hypothesis posits a positive relationship between current household borrowing and future income. This means that household borrowing is driven by productivity or technology shocks that increase expected future income, spurring higher consumption and borrowing in anticipation. Second, the credit supply hypothesis holds that higher household borrowing is driven by an expansion in the availability of credit. The existence of financial frictions, constraints and nominal rigidities can result in the changes in households borrowing that also affect GDP growth.

[29] We generated dummy variables for periods of positive and negative household debt gaps for the HP and extended Kalman filter cycles and regressed them on GDP growth.

Hence, we use the penalty function approach sign restriction in this chapter to distinguish between the credit demand and credit supply hypotheses. This is a policy relevant and important aspect because it underpinned by different processes that require distinct policy interventions. For instance, under the credit supply hypothesis it is possible that households may over-extend themselves during a credit supply boom, thus necessitating the use of macro-prudential regulations and tools to deal with positive (adverse) credit supply shocks.

Figure 7.3 shows that household debt is positively related to labor productivity growth. When labor productivity growth increases it is followed by an increase in household debt. However, the r-square of the relationship is relatively low meaning that there are other variables that play an even bigger role in the increase in household debt.[30]

Figure 7.3 Household debt and labour productivity growth, 2000Q1 to 2015Q4

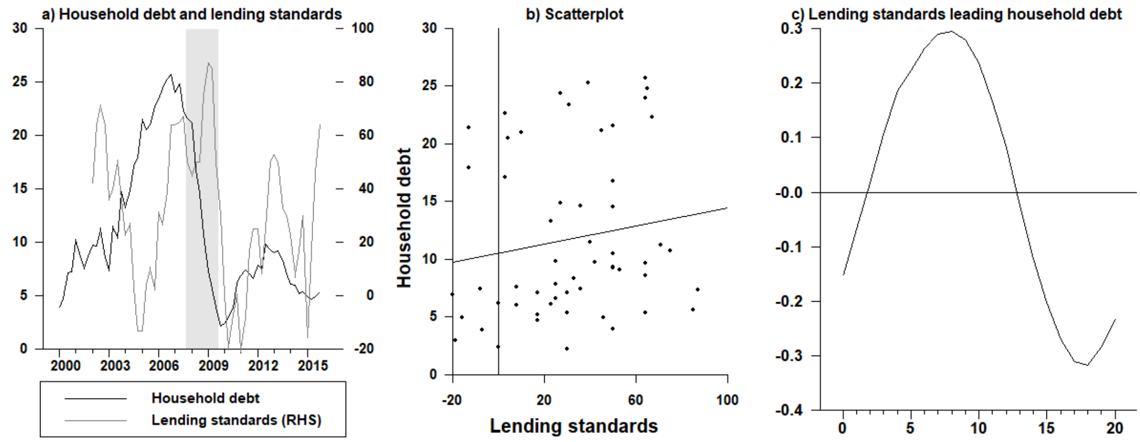


Source: South African Reserve Bank and author's calculations

Similarly, Figure 7.4 shows that there is a positive relationship between household debt and lending standards. This means that when lending standards loosen and banks supply more credit, household debt also increases. Therefore, the bilateral relationships presented so far imply that both hypotheses posited in literature are present in the South African data. But we do not know which hypothesis dominates the data and at the same we cannot rule out that the existence of non-linearities that are introduced by the thresholds.

[30] Figure A7.5 in the appendix shows that similar trends hold over the long-term period for 1990Q1 to 2015Q4.

Figure 7.4 Household debt and bank lending standards, 2000Q1 to 2015Q4



Source: South African Reserve Bank and author's calculations

It is against this background that this chapter tests for the household debt threshold and non-linear effects introduced by the threshold on GDP growth. In contrast with existing studies in literature, we test for the threshold on the level and growth rate in household debt and household-debt-to disposable income (income gearing or leverage) as opposed to the debt-to-GDP data.

This chapter contributes to existing literature in several ways. First, we use the penalty function approach to sign restriction to distinguish the role of loans supply and aggregate demand shocks on household debt. We use this approach to assess which hypothesis best explains dynamics in household debt in South Africa. In addition, the results and policy implications of such an analysis can be very informative for the design of macro-prudential and financial regulatory tools aimed at dealing with the macro-economic effects of the supply and demand for credit in pursuit of the financial stability objective.

Second, because the stylized facts presented earlier suggest the potential existence of non-linearities between household debt and GDP growth, the chapter establishes thresholds at which household debt exerts negative effects on GDP growth. As useful and informative the penalty function approach to sign restriction is by distinguishing the role of loans supply and aggregate demand shocks on household debt, it is very silent on the thresholds and the non-linearities they introduce. Hence, we apply the Tsay (1998), Hansen (1999) and the Balke (2000) approaches to determine the household debt threshold.

Furthermore, because the Tsay (1998), Hansen (1999) and the Balke (2000) approaches establish multiple thresholds but offer no information about the nature or characteristics of the non-linearity surrounding the threshold, we use the smooth transition (STAR) models. STAR models are better able to generate complex non-linear dynamics compared to those that can be captured by linear time series models. The STAR models allow us to test for the degree to which the thresholds in household debt exert non-linear persistent effects on GDP growth in the low and high household debt regimes. In addition, the STAR models deal with the endogeneity problems associated with other threshold approach and thus acts a robustness check.

Third, the nature of the error correction for household debt is equally important and informative. Having deviated from the long-run equilibrium level, what variables play an important role in the error correction process for household debt? At what rate does household debt adjust towards the equilibrium level? For this aspect of the chapter, we use the Johansen cointegration technique to test for the nature of the adjustment of household debt from deviations from the long run. Last, we estimate the regime dependent threshold VAR model. We use Tsay (1998), Hansen (1999) and the Balke (2000) estimated thresholds to test for the asymmetric responses of GDP growth. This aspect of the chapter also analyses whether the non-linear impulse responses indicate any signs of the asymmetric propagation of household debt shocks in different household debt regimes as identified by the point at which the household debt threshold occurs.

We find that adverse aggregate demand and loan supply shocks are mainly transmitted via the labor markets and are propagated by credit conditions. The simultaneous occurrence of positive employment, labor productivity and lower credit risk shocks loosens the credit constraints and allows banks to supply more credit to meet aggregate demand. Furthermore, employment creation results in immediate responses in household gearing as income shocks emanating from the labor market dynamics have an important relationship with credit growth (defaults) and the household debt burden in general. Second, the VECM error correction terms suggest that currently household debt is in shortfall by as much as 10 per cent. Furthermore, the rate at which household debt adjusts from disequilibrium position is terribly slow at less than one per cent per quarter. Third, we establish that the household debt threshold occurs between 8.8 per cent and 13.4 per cent. Empirical evidence shows that periods of high debt regimes, GDP and employment growth are persistently high compared to periods of low household debt regimes. The implications of the findings for price and financial stability are that household debt levels matter for GDP growth.

The channels of transmission are largely via the labor market and are amplified by credit conditions. Loan supply shocks act as amplifiers of aggregate demand shocks and induce asymmetric effects on the macro-economy.

The rest of the chapter is structured as follows: section two presents a summary of the literature review. Section three discusses the econometric approaches used in the chapter followed by the data and the empirical result. Section ten provides the summary of the findings, concludes the chapter, and offers policy recommendations.

7.2 The main channels through which household debt can amplify downturns and weaken recoveries

King (1994) discusses how differences in the marginal propensity to consume between borrowing (indebted) and lending (savers or surplus) households can generate aggregate output and demand downturns when household leverage (indebtedness) is excessively high. Theory and literature show that differences in the propensity to consume can arise for several reasons. The life-cycle motives have been emphasized as a source of differences in saving behavior by Modigliani (1986). Iacoviello, (2005); Eggertsson and Krugman (2010) focused on the role of time preferences which introduces a class of relatively impatient agents.

Furthermore, literature establishes that the accumulation of household debt amplifies slumps. Recent studies by Eggertsson and Krugman (2010); Guerrieri and Lorenzoni, (2011) and Hall (2011) establish that the distribution of debt within an economy matters. Models in these studies differentiate between borrowers and lenders and feature liquidity constraints and establish that the financial accelerator on household balance sheets primarily. The main channel of transmission is via changes in house prices which amplify fluctuations in consumer spending by tightening or relaxing collateral constraints on borrowing.

7.3 Identification of credit demand and supply shocks via the penalty function approach to sign restriction

We use the pure and penalty function approaches to sign restriction. The sign restriction approach requires imposing a set of economically plausible restrictions and the leaves the question of interest unrestricted. The penalty function heavily penalizes choices that violate the imposed signs and constraints (Uhlig, 2005). The approach minimizes a criterion function which penalizes impulse responses violating the sign restrictions, with respect to the identifying weights. This contrasts with the pure sign restriction approach where all the impulse responses that obey the imposed signs are considered equally likely. This means that the penalty function approach uses an additional criterion to select the best of all impulse vectors. In addition, the penalty function approach can be used to sharpen the impulse responses in cases where the error bands are relatively wide for some variables (Rafiq and Mallick, 2008).

The sign restriction approach starts with a reduced form VAR in Equation 7.1

$$Y_t = B_{(1)}\, Y_{t-1} + B_{(2)} Y_{t-2} + \cdots + B_{(l)} Y_{t-i} + u_t, t = 1, \ldots T \quad (7.1)$$

Where, Y_t is a $m \times 1$ vector of data at time $t = 1 - l, \ldots.,T, B_{(i)}$ are coefficient matrices of size $m \times m$ and u_t is a $(k\ x\ 1)$ vector of the one-step ahead prediction errors with $E\ [u_t\ ] = 0$ and $(k\ x\ k)$ symmetric covariance matrix $E[u_t u_t'] = \Sigma_u = [\sigma_{i\ j}]$. If there are m fundamental innovations which are mutually independent and normalized to be of variance 1 and written as a vector v of size $m \times$ 1with $E[vv'] = I_m$. We need a matrix A such that $u_t = Av_{t.}$ The $j - th$ column of A represents the immediate impact on all variables of the $j - th$ fundamental innovation, one standard error size. The identification problem translates the correlated prediction errors u_t into orthogonal structural shocks e_t. The assumption is that the structural shocks are zero-mean random variables with the covariance matrix $E\ [e_t e_t'] = I_k$. The relationship between prediction errors and structural shocks is given by $u_t\ Ae_t$, where the $(k\ x\ k)$ matrix A provides the factorization of the error covariance matrix $AA' = \Sigma_u$. The restrictions on A emerge from the covariance structure in Equation 7.2

$$\Sigma = E[u_t\ u_t']\ A'\ AA' \qquad (7.2)$$

There are $m\ (m-1)/2$ degrees of freedom in specifying A and restrictions are needed to achieve identification. In the case of identifying a single shock, this means that we need to find a single column $a \in \mathbb{R}^m$ of the matric A in Equation (7.2) which satisfies some restrictions that identify that particular shock. The vector $a\ \in \mathbb{R}^m$ is an impulse vector if there is some matrix A, so that $AA' = \Sigma$ and a is a column of A. If $x_i, i = 1, \ldots.,m$ be the eigenvectors of $\sum$ normalized to form an orthonomal basis of $\mathbb{R}^m$. Let $\lambda_i, i = 1, \ldots.,m$ be the corresponding eigenvalues. Then a is an impulse vector if and only if there are coefficients $\alpha_i, i = 1, \ldots, m$ with $\sum_{i=1}^{m} \alpha_i^2 = 1$ so that

$$a = \sum_{i=0}^{n} (\alpha_i \sqrt{\lambda_i})\ x_1 \qquad (7.3)$$

Where the $v_t^{(a)} = b' u_t$ is the scale of the shock at time t in the direction of the impulse vector $a$and $v_t^{(a)} a$ is the part of u_t which is attributable to that impulse vector. These tools can perform variance decompositions or counterfactual scenario. The identification of the impulse vector corresponding to shocks of interest can be done via the pure sign restriction approach and the penalty function approach.

7.3.1 Pure sign restriction approach

The pure sign restriction approach imposes the sign restrictions on the impulse responses. Unlike the recursive identification approach, the sign-restrictions approach does not require the number of shocks to be equal to the number of variables. Caldara (2010) show that the sign restriction approach does not impose any linear restrictions on the contemporaneous relation between reduced-form and structural disturbances. Rather, Mountford and Uhlig (2009) impose signs directly on the impulse responses.

The pure sign restriction approach chooses a horizon $K \geq 0$, takes a joint draw from both the posterior for the VAR parameters as well as a uniform distribution over the $(m-1)$ dimensional sphere $(\alpha_1, \ldots., \alpha_{m-1}), \sum \alpha_i^2 = 1$. The impulse vector in Equation 7.3 is constructed and the impulse responses $r_{k,j}$ at horizon $k = 0, \ldots., K$for the variables $j$in the VAR. In the sign restriction approach, if all the generated impulse responses satisfy the imposed sign restrictions, all the draws are kept. If not, they are discarded. This process is repeated sufficiently often based on the draws kept. The error bands are then calculated based on the draws that are kept. According to Fratzcher et al. (2010), the orderings of the variables do not alter the results as the results are independent of the chosen decomposition of $\sum$.

7.3.2 The penalty function approach to sign-restriction

The penalty function approach is an alternative to the pure sign restriction approach used to select one solution out of the set of pure sign restriction solutions. The penalty function approach is used in literature to numerically solve constrained nonlinear optimization problems for which closed form analytical solutions may be hard to obtain or may not exist at all. The difference is that the penalty function approach replaces the sign restrictions with a continuous penalty function that permits but (heavily) penalizes choices that violate the imposed signs. This means that the constrained problem is replaced with an unconstrained one. Caldara and Kamps (2010) show that in essence, the penalty function criterion solves a constrained optimization problem. The penalty function procedure finds the impulse vector that maximizes the forecast error variance of some variables in the VAR, subject to the imposed sign restrictions. In addition, Mountford and Uhlig (2009) indicate that that imposing sign restriction on the impulse responses does not produce sharp inference. Hence, it may be necessary to use the penalty function approach to sharpen the impulse responses.

The penalty function approach chooses a horizon $K \geq 0$ and the penalty function is defined as in Equation 7.4

$$f\,(x) = \begin{cases} x & if\ x \leq 0 \\ 100 * x & if\ x \geq 0 \end{cases}, \qquad (7.4)$$

The penalty function penalizes positive responses in linear proportion and rewards negative responses in linear proportion but at a slope 100 times smaller than the slope for penalties on the positive. This means that the penalty on the coefficients of the wrong sign is 100 times larger than that on the correct sign. Furthermore, Uhlig (2005) states that the penalty function approach leaves the reduced form VAR untouched and prefers large responses that are far away from the imposed sign restrictions.

We use the penalty function approach to sign restriction to identify adverse loan supply and aggregate demand shocks. The signs used to identify the structural hocks are shown in Table 7.1. We identify an adverse aggregate demand shock as that which elicits monetary policy loosening to support economic activity and lending.

Table 7.1 Identification of an adverse aggregate demand and loan supply shocks

	Aggregate demand	Loan supply
Policy rate	-	?
Lending rate	-	+
HH debt	?	?
HH income	?	?
GDP	+	-
Labour prod	?	-
NPLs	?	+
Employment	?	-
HH debt to YD	?	?

We compare the adverse aggregate demand shock to a tight loan supply shock. We identify a tight loan supply as that which tightens lending conditions via the increase in lending rate spreads. We leave the response of household debt to adverse aggregate demand and loan supply shocks open to the data to determine.

7.4 The thresholds models

This section discusses the TVAR and STAR models used in the chapter. We start by discussing the TVAR model followed by the STAR model.

7.4.1 Tests for a break in the series, delay parameter, and the threshold

The first step in the estimation of the threshold VAR model (TVAR) and the STAR models is to formally test for the presence of threshold-type non-linearity in the data. The Tsay (1989) approach uses a conventional F test based on an auxiliary regression to test for the threshold. The tests for the existence of the thresholds and non-linearity in the data are done for the null hypothesis of no threshold or breakpoint in the series. But the threshold needs to be identified first under the alternative hypothesis. As a result, we use the (i) Arranged Autoregression and Tsay (1998) F-test (ii) Hansen Threshold test and (v) STAR test, (iii) Andrews–Quandt test and Andrews-Ploberger test and (iv) Zivot and Andrews (1992) and Lumsdaine-Papell (1997).

The arranged autoregression and Tsay (1989) F-test avoid dealing with the thresholds directly and instead use the conventional F test based on an auxiliary regression. The Tsay (1998) approach uses arranged autoregression with recursive least squares (RLS) estimation in Equation 7.5

$$y_t = x_t \emptyset^{(j)} + \sigma^{(j)}\epsilon_t \ if \ r_{j-1} < z_t \leq r_j \qquad (7.5)$$

Where $X_t = (1, y_{t-1}, y_{t-2}, y_{t-p})$, $j = 1,2,3, k \ and -\infty = r_0 < r_1 < \cdots r_k - \infty$. The thresholds $r_0, r_1, \ldots r_{k-1}$divide the domain of the threshold z_t into k different regimes. In each different regime, the time series y_t follows a different $AR\ (p)$ model. When the threshold variable $z_t = y_{t-d}$ with the delay parameter d, the dynamics or regime ofy_t is determined by its own lagged values of y_{t-d}.Since the thresholds values r_i are unknown, the Tsay (1989) approach arranges Equation 7.5 for all $t = \max(d, p) + 1, \ldots n$ where n is the sample size such that the Equations are arranged according to the threshold variable y_{t-1} can take any value in the $Y_d = (y_n, \ldots, y_{n-1})$ with $h = \max(1, p + 1 - d)$ and

$$y_{\pi_i} = x_{\pi_i} \emptyset + \sigma \hat{\varepsilon}\pi_i \qquad (7.6)$$

For, $i = 1,2,3, \dots .n', n' = n - d - h + 1$ is the sample size for the arranged autoregression π_i is the index in the original sample such that $y_{\pi_{i-d}}$is the i_{th} smallest value in y_d. To test for threshold non-linearity the Tsay (1989) computes the RLS estimates for $\widehat{\emptyset}$ in Equation 7.6 such that if there is no threshold nonlinearity, the residuals $\hat{e}_{\pi_i}$ should be white noise asymptotically and orthogonal to x_{π_i}. But if y_t does not follow an $AR(1)$ process and $j > 1$ then the RLS estimates of $\widehat{\emptyset}$ are biased and $\widehat{\Psi}$ in the auxiliary regression in Equation 7.7 will be statistically significant and the conventional F statistic for testing $\Psi = 0$ can be used as a test for threshold nonlinearity.

$$\hat{e}_{\pi i} = X'_{\pi i} \Psi + \mu_{\pi i} \qquad (7.7)$$

Once the null hypothesis for of no-threshold is rejected the delay parameter d and the threshold $r_i \, for \, i = 1,2, \dots, k - 1$ can be estimated using least squares. As long as there are enough observations on each side of the threshold (each regime) the least squares estimates are consistent. The delay parameter $d$is chosen such that Equation 7.8

$$d = argmax_{v \in s} F\ (p, v) \qquad (7.8)$$

Where, $F\ (p, v)$is the F stat with an $AR(p)$ and the delay parameter equal to $s \ and \ v$ is a set value of d. On the other hand, the Hansen (1999) procedure estimates multiple regimes together with other model parameters and valid confidence intervals can be constructed for the estimated threshold. The Hansen (1999) approach facilitates for the estimation of exogenous thresholds and recommends 10 per cent of the total number of observations during the grid search for the threshold to ensure that each regime contains a minimum number of observations. The Hansen test trims the higher values of the variable of interest from influencing the threshold value by removing influence of outlying observations. This threshold method removes 15 per cent of large and small values at both ends of the time series of interest. The threshold is determined from the remaining 70 per cent of the observations.

The Andrews-Ploberger and Andrews-Quandt tests test for the structural break tests in a linear regression using Hansen's approximations for p-values. The tests test for a single structural break at an unknown point within the sample and a series of LM statistics are generated for breaks at each of the points of the data set. The Andrews-Quandt test uses maximum of the LM statistics, while Andrews-Ploberger uses the geometric mean as the test statistic. Both test statistics have highly non-standard distributions.

Literature has shown that the ADF test is unable to detect level shifts in the data generating process, hence it is necessary to use break pint tests. We use the Zivot and Andrews (1992), the Zivot and Andrews (1992) Lumsdaine-Papell (1997) tests propose a unit-root test that allow for an endogenous structural break. The Zivot-Andrews test tests for the presence of one break point whereas the Lumsdaine-Papell (1997) unit root test is a default test for the presence of 2 break points. The tests incorporate an endogenous break point into the specification of the unit root tests. The arranged autoregression test is based on Tsay (1989).

7.4.2 The threshold vector autoregression

We estimate a two-regime threshold VAR model specified in Equation 7.9

$$Y_t = [A_1 Y_t + B_1 (L) Y_{t-1}] I (y_{t-d} \leq \gamma_1) + [A_2 Y_t + (B_2 (L) Y_{t-1}] I (\gamma_1 < y_{t-d} \leq \gamma_2) \varepsilon_t \quad \dots\dots\dots (7.9)$$

Where Y_t is a vector of endogenous variables, $B_1 (L) B_2 (L) \, and \, B_3 (L)$ are lag polynomial matrices, ε_t is a vector of innovations to the non-structural TVAR, the threshold variable y_{t-d} determines the household debt regimes given by γ_1 and γ_2. I_t [.] is an indicator that partitions regimes such as $I (y_{t-d} \leq \gamma_1)$ equals 1 when $y_{t-d} \leq \gamma_1$ or 0 otherwise i.e. is the indicator that assumes the value of one when the d-lagged threshold variable y_t is lower than the threshold critical value $\gamma_1 \, or \, \gamma_2$ and 0 otherwise. The indicator I_t [.] is a transitional variable that identifies the two regimes based on the value of y_{t-d} relative to γ which is the endogenously estimated unknown parameter.

In Equation 7.9 is a function of household debt conditions as well as an element in Y_t. Because Y_t is a vector of endogenous variables, the TVAR allows household debt to switch within regimes also due to shocks to other variables in the model. Therefore, shocks to other endogenous variables can all determine whether the economy is in a tight household debt regime or not. This means that the shock to any element ε_t can induce a regime switch in the model hence the identification of the model matters.

7.4.3 Logistic and Exponential STAR Models

In the STR model, we use the same specification as in the TVAR and estimate Equation 7.9 and estimate

$$y_t = \pi' x_t + \theta' x_t F(z_{t-d}, \gamma, c) u_t \qquad (7.10)$$

Where y_t is a scalar, $x_t = \left(1, y_{t-1}, \ldots, y_{t-r}; w_{t-1}, \ldots, w_{t-q}\right)' = (1, \tilde{x}_t)'$ where w_t is a vector of exogenous variables; z_{t-d} is a scalar. When $z_{t-d} = y_{t-d}$ where d is the delay parameter which satisfies $1 \leq d \leq p$for p = max (r, q). When $z_{t-d} = y_{t-d}$ and $w_t = 0$ the model is estimated as a conventional STAR model. The transition function $F(z_{t-d}, \gamma, c)$is chosen to be either a logistic or an exponential distribution function. The exponential function is:

$$F(z_{t-d}, \gamma, c) = \left[\left[1 - exp\{-\gamma(z_{t-d}{}^{-c})^2\}\right]\right] \qquad (7.11)$$

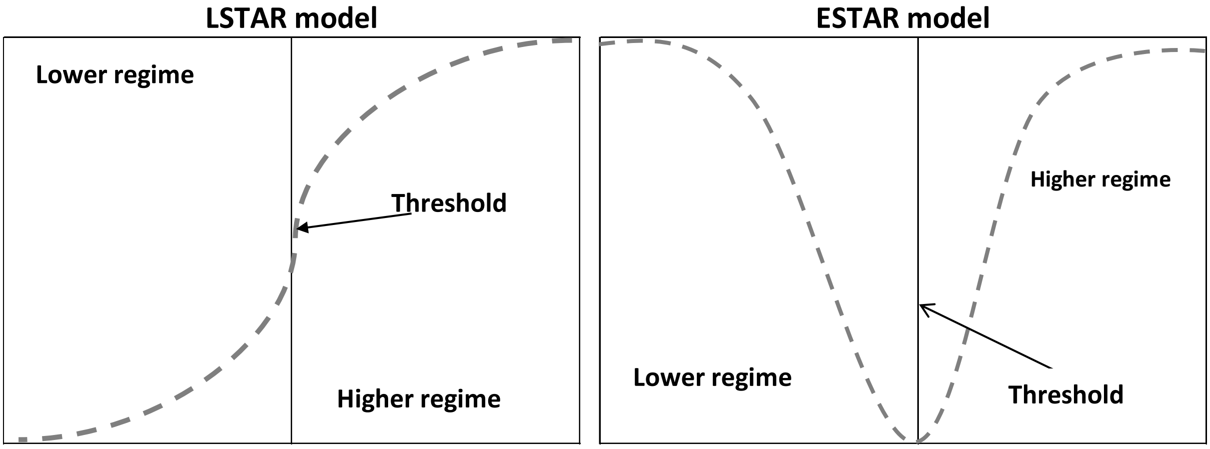
When $\theta_0 = c;\ w_t = 0\ \forall t\ and\ z_{t-d} = y_{t-d}$ the ESTR model is reduced to the exponential autoregressive model (EAR) in Equation 7.11

$$F(z_{t-d}, \gamma, c) = \left[\left\{1 + exp\left(-\gamma(z_{t-d}{}^{-}\,{}^{c})\right)\right\}^{-1} - \frac{1}{2}\right] \quad (7.12)$$

The different transition functions are depicted in Figure 7.5, where in the case of the ESTAR model the data is symmetrically distributed on each side of the threshold c. This means that when, $|y_{t-1}| \gg c, then\ F\ (y_{t-1}, \gamma, c) \cong 1$ the dynamic behavior of the data is characterized by the upper linear regime and when $|y_{t-1}|$ is close to c then $F\ (y_{t-1}, \gamma, c) \cong 0$ and the dynamic of the lower linear regime dominate. The speed with which the transition from on regime to the other occurs is set by γ.

In the case of the LSTAR model when $|y_{t-1}| \ll c, then\ F\ (y_{t-1}, \gamma, c) \cong 0$ then the data is characterized as the lower regime. On the other hand, $|y_{t-1}| \gg c, then\ F\ (y_{t-1}, \gamma, c) \cong 1$ the data is characterized as the upper regime. The speed with which the transition from on regime to the other occurs is set by γ and in cases where $\gamma \rightarrow \infty$ then the data is characterized by the threshold autoregressive (TAR) model.

Figure 7.5 Logistic and exponential transition functions



Source: Author's drawing

The asymmetric behavior of the data i.e. whether $\theta_0 \neq 0 \; and \; or \; c \neq 0$ will influence the ability to specify and test the STAR models. Furthermore, if γ is small, both transition functions switch between 0 and 1 very smoothly and slowly. But if γ is large, both transition functions switch between 0 and 1 more quickly.

The LSTAR is monotonic and the smoothness of the transition between two regimes smoothly depends on how much the transition variable z_t is smaller or greater than the threshold c. On the other hand, the ESTAR is symmetrical switches between two regimes smoothly depending on how far the transition variable z_t is from the threshold c. Therefore, for the LSTAR model both the distance between the transition variable z_t, the threshold c and its sign matter. But for the ESTAR model only the distance between $z_t$and c matters, but not the sign.

7.4.4 Test for STAR nonlinearity, choosing the delay parameter (function) d and the transition variable

Testing for the STAR-type nonlinearity is usually the first step is comparable to that of the threshold nonlinearity. The STAR test for linearity implies testing the null hypothesis $H_0: \theta' = 0$ in Equation 7.12. The tests have non-standard asymptotic distributions because parameters such as the AR coefficients $\phi^{(2)}, \gamma \; and \; c$, in the second regime are not identified. Tsay (1989) and Tersvita (1994) propose that $F(z_{t-d}, \gamma, c)$ is replaced with a Taylor series approximation in Equation 7.13

$$y_t = \pi' \, x_t + \left[\theta' \, x_t \left\{\gamma \, F_\gamma \, (z_{t-d}, \gamma = 0, c)\right\}\right] + \, v_{1t} \qquad (7.13)$$

Where F_γ $(.)$ indicates the first derivative of F with respect to $\gamma \; - \; \gamma F(.)$ is the first term of the Taylor approximation of F around $\gamma = 0$ and $F(.)$ for the logistic transition function yields the auxiliary regression in Equation 7.14

$$y_t = \delta_0 + \; \tilde{\delta}' \tilde{x}_t + \beta' \tilde{x}_t \, z_{t-d} + v_{1t} \qquad (7.14)$$

The null hypothesis of linearity becomes $H_0' = \beta_1' = 0$ which is the $LM_1 \; or \; NL_1$ test. Hence, linearity is the joint test of all the interaction terms between the regressors and the powers (1, 2 and 3) of the lags. The H_{01} is a test of the first order interaction terms. In cases where only the intercept is different between regimes, the $LM_1 \; or \; NL_1$ is unable to detect the shift in the mean the null hypothesis becomes $H_0'' = \beta_1' = \beta_2' = \; \beta_3' = 0$ i.e. H_{02} is a test of the second order interaction terms. The procedure to test for this hull hypothesis is to compute the sum of squared residuals (SSR_1) and the test statistic $(SSR_0 - \; SSR_1)/ \, SSR_0$ has asymptotically χ^2 distribution under the null hypothesis with $3 \; (p + 1)$ degrees of freedom. The approximation is given by the Fdistribution and is referred to as the $LM_3 \; or \; NL_3$ non-linearity test.

Thus, the H_{03} is a test of the third order interaction terms. For the ESTAR model the $LM_4 \; or \; NL_4$with the null hypothesis $H_0'' = \beta_1' = \beta_2' = \; \beta_3' = \; \beta_4' = 0$ has asymptotically χ^2 distribution under the null hypothesis with $4 \; (p + 1)$ degrees of freedom is used and the null hypothesis tested is H_{12} which is a test of the first and second order interactions terms.

As stated earlier, the transition function $F \; (y_{t-1}, \gamma, c)$ is continuous and bounded between 0 and 1, while γ is the speed of transition and c represents the threshold value of the transition variable. The thresholds c and the delay parameter (function) d are chosen as the estimates that maximize the lag determinant of the structural residuals ε_t in Equation 7.9. The p values of the test statistics can be used to help choose the appropriate transition variable as well. However, the selection of the transition variable can be based on economic theory and the lagged endogenous variable as it underlies the strengths of the dynamic relationship and the possible persistence effects. The transition variable is chosen as the variable with the lowest p-value amongst the variables i.e. the variable that rejects the null hypothesis of linearity using the $LM_3 \; or \; LM_4$ test. Once linearity has been rejected in the data, based on the $LM_3\ or\ LM_4$ sequence of tests below, the variable with the lowest p-value is chosen as the transition variable

$$H''_{03}: \beta_3 = 0$$
$$H''_{02}: \beta_2 = 0 |\ \beta_3 = 0$$
$$H''_{01}: \beta_1 = 0 |\ \beta_2 = 0 |\ \beta_3 = 0$$

The rejection of $H''_{03}: \beta_3 = 0$ implies the rejection of ESTAR specification since the cubic powers of z_{t-d} in a first order approximation of $F(z_{t-d}, \gamma, c) = 0$ but failure to reject $H''_{02}: \beta_2 = 0 |\ \beta_3 = 0$ means that the LSTR model is agreeable to the data. Similarly, failing to reject H_{01} after rejecting H_{02} means that the data accepts the ESTAR model whereas, rejecting H_{01} after failing to reject H_{02}means that the data accepts LSTAR model. Furthermore, the relative strength of the rejection of the model matters. If H_{01} and $H_{03}$are rejected more strongly by the data than H_{02} i.e. if the p-value of F_2 is the smallest of $F_1, F_2\ and\ F_3$ then the data accepts the ESTR model.

7.4.5 Non-linear impulse responses

The system estimated in the TVAR can change regimes by computing the generalized impulse response functions GIRF as in Equation 7.15

$$GIRF_k^{(i)} = E\left[Y_{t+k} | \epsilon_t^{(i)}, \Omega_{t-1}\right] - E\left[Y_{t+k} | \epsilon_t^{(i)}, |\Omega_{t-1}\right], for\ k =\ 0,1, \ldots, \quad (7.15)$$

Where the initial condition Ω_{t-1} determines the regime that the system is initially in. In Equation 7.9 $\epsilon_t^{(i)}$is the realized shock which can trigger a regime switch, different initial conditions, different sizes and signs of shocks which result in asymmetric impulse responses. To capture the potential asymmetry, each structural shock enters the model with a different sign (positive and negative) and different sizes (one and two standard deviations). The analysis of the collective non-linear impulse responses becomes what moves the economy from one stage of the business cycle to the next.

7.5 The Johansen cointegration approach

The Johansen cointegration approach starts with the VAR of order p in Equation 7.16

$$y_t = \mu + A_1 y_{t-1} + \cdots . + A_p y_{t-p} + \varepsilon_t \qquad (7.16)$$

Where y_t is an $n \times 1$vector of variables that are integrated of order one I (1); ε_t is an $n \times 1$vector of innovations. The VAR in Equation 7.10 can be expressed as Equation 7.17.

$$\Delta\, y_t = \mu + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i\ \Delta\, y_{t-1} + \ \varepsilon_t \qquad (7.17)$$

Where, $\prod = \sum_{i=1}^{p} A_i - \mathrm{I}$ and $\Gamma_i = - \ \sum_{i=1}^{p-1} A_j$. If the coefficient matrix $\prod$ has a reduced rank $r\ < n$then there exists $n \times r$matrices $\alpha\ and\ \beta$eachwith rank $r$such that $\prod = \alpha\, \beta'\ and\ \beta' y_t$ is stationary, r is the number of cointegration relationships. The elements of $\alpha$are the adjustment parameters in the vector error correction model. For a given r the maximum likelihood estimator of βdefines the combination of y_{t-1} that yields the largest $r$canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences.

The trace test and the maximum eigenvalue test are the two likelihood ratio tests for the significance of the canonical relations and the reduced rank of the Π matrix. The trace test tests for the null hypothesis of $r$cointegrating vectors against the alternative hypothesis of n cointegration vectors. On the other hand, the maximum eigenvalue test tests the null hypothesis of r conintergating vectors against the alternative hypothesis $r + 1$ cointegration vectors.

For example, in the VECM system $y_t = (y_{1,t} \quad y_{2,t})'$ where $y_{1,t}$ is an I (1) and $y_{2,t}$ is an I(1) at least one cointegrating vector given by $\beta = (0\ \ 1)'$ and the Π matrix has full rank then all n variables in the system are stationary. The result is a stationary process or cointegrating relation. The cointegration relation gives the only linear combination of both non-stationary processes which is stationary. Hence the Johansen procedure which allows for correction for serial correlation in the errors is preferred compared to the single equation procedures.

In the VAR in Equation 7.16, there always exists an error correction representation of the form $y_t = \ y_{t-1} + \ \Delta y_t$ and the long run relationship in Equation 7.18

$$\Delta y_t = \ \Pi\, y_{t-1} + \sum_{i=1}^{p-1} \Phi_i^{\,*}\, \Delta y_{t-1} + \varepsilon_t \qquad (7.18)$$

There is an adjustment to the 'equilibrium' y^*or long-term relation described by the cointegrating relation $\Delta y = 0$ and the long-run relation $\Pi_y{}^* = 0$ or $\Pi y^* = \alpha(\beta' y^*) = 0$. The long run relationship does not hold perfectly in $(t-1)$ and there is a deviation (error) given by $\beta' y_{t-1} = \xi_{t-1} \neq 0$ and the adjustment coefficients in α multiplied by the errors in $\beta' y_{t-1}$ induce an adjustment in Δy_t towards equilibrium. The adjustment in $y_{1,t}$ in t to ξ_{t-1} deviation from the long run in $t-1$ is given by Equation 7.19

$$\Delta y_{1,t} = (0.5)\, \xi_{t-1}\ and\ y_{1,t} = \Delta y_{1,t} + y_{1,t-1} \qquad (7.19)$$

If $\xi_{t-1} > 0$ then the error is positive term meaning that $y_{1,t-1}$ is too large which decreases the guarantee of convergence back to the long-run path. But if $\xi_{t-1} < 0$ then the error is negative term meaning that $y_{1,t-1}$ is small and not explosive and increases the guarantee of convergence back to the long-run path.

7.6 Data and stylized facts

We use the repo rate, lending rate, household debt, non-performing loans (NPLs), GDP growth, non-agricultural labor productivity and formal non-agricultural employment. The sample period spans 1990Q1 to 2015Q4. All the data is on quarterly basis (Q) and is sourced from the South African Reserve Bank database. We conduct the unit root tests because non-linearity tests assume of stationarity and ergodicity. The results based on the Augmented Dickey Fuller test and Phillips-Perron test are shown in Table 7.2 and the result confirm that all the variables are I (1).

Table 7.2 Unit root tests for global risk measures of global liquidity

Variable	PP	ADF
Repo rate	-3.453*	-3.446**
Lending rate	-3.453*	-3.531**
HH debt	-3.454**	-3.531**
GDP	-3.453*	-3.757**
HHYd	-5.537**	-3.440**
Lab productivity	-3.453*	-2.581**
Employment	-3.152*	-2.945 **
NPLs	-3.484**	-2.156**

Note: Significance at 5 per cent **, at 10 per cent*.

Source: Author's calculations

7.6.1 Identification of credit demand and supply shocks

We start the empirical analysis of testing for which hypothesis between aggregate demand and supply shocks explains the data by estimating a six variable VAR in Equation 7.20. The imposed sign restrictions are as shown in Table 7.1.

$$Y_t = \{repo, lend, hhdebt, GDP, YD, emply\} \ldots \ldots \ldots \ldots \ldots (7.20)$$

Where, $repo$ is the repo rate, lend is the lending rate, hhdebt is household debt, GDP is GDP growth, YD is disposable income and emply is formal non-agricultural employment. We start with the specification in Equation 7.20 where employment represents changes in the labor market and the impact on the demand and supply for credit. In the next two models we replace employment with non-performing loans to capture the impact of credit risk; labor productivity to capture aspects related labor market effects on the loan supply. The response of household credit in these three models are then compared to the eight-variable model in Equation 7.21

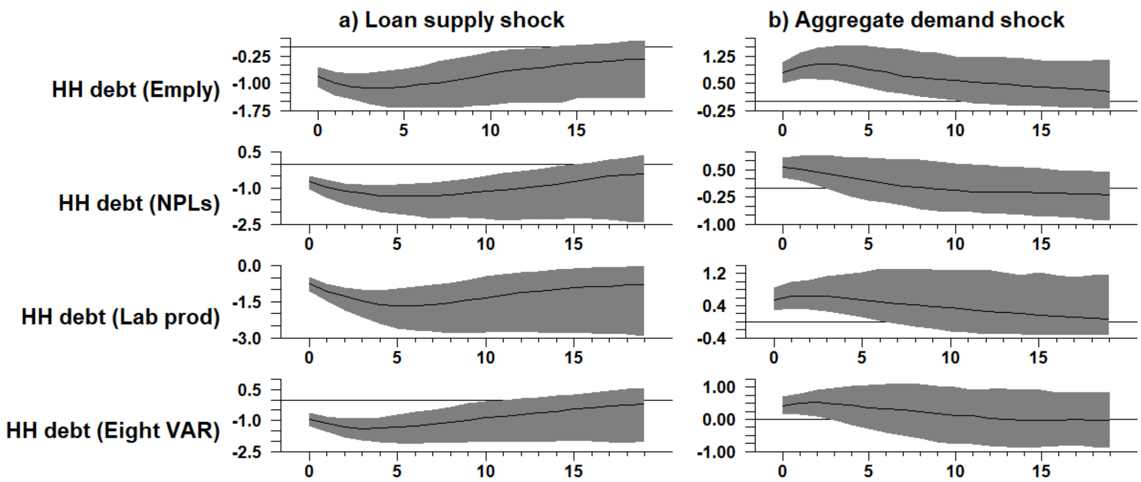
$$Y_t = \{repo, lend, hhdebt, GDP, YD, emply, NPLs, Labprod\} \ldots \ldots \ldots \ldots \ldots (7.21)$$

Where, $repo$ is the repo rate variable, lend is the lending rate variable, hhdebt is household debt variable, GDP is GDP growth variable, YD is disposable income variable, emply is formal non-agricultural employment variable, NPLs is non-performing loans variable and Labprod is formal non-agriculture labor productivity variable. Since the aim of the study is to assess the role of demand and supply shocks of household debt, all the variables are included in Equation 7.21 and the responses of household debt are compared to those of the six model variables. The intention is to assess the differential impact of the variables and under which shocks they tend to have potent effects.

All the VAR models are estimated for the period 2000Q1 to 2015Q4 and have two lags chosen by AIC/SBC/BIC and the impulse are generated from 10 000 Monte Carlo draws and are responses to a one standard deviation shock. The monetary policy shocks are a contractionary monetary policy shock, the loan supply, aggregate demand, and supply shock are adverse shocks. The model is estimated via penalty function approach to sign restriction. In the discussion we only present the results for household debt since it is the variable of interest and were left unrestricted in the estimation of all models.

Figure 7.6 present the responses of household debt to loan supply and aggregate demand shocks with the identification scheme based on signs imposed in Table 7.1. The impulse responses suggest that there are asymmetric responses involved in the responses of household debt to aggregate demand and loan supply shocks in various specifications. In Figure 7.6(a) it is evident that an adverse loan supply shock whether captured via the decline in employment or increase in NPLs or a decline in labor productivity has negative effects on household debt. However, adverse shocks to employment seem to have potent negative effects on household debt.

Figure 7.6 Comparison of household debt responses to various shocks in different models



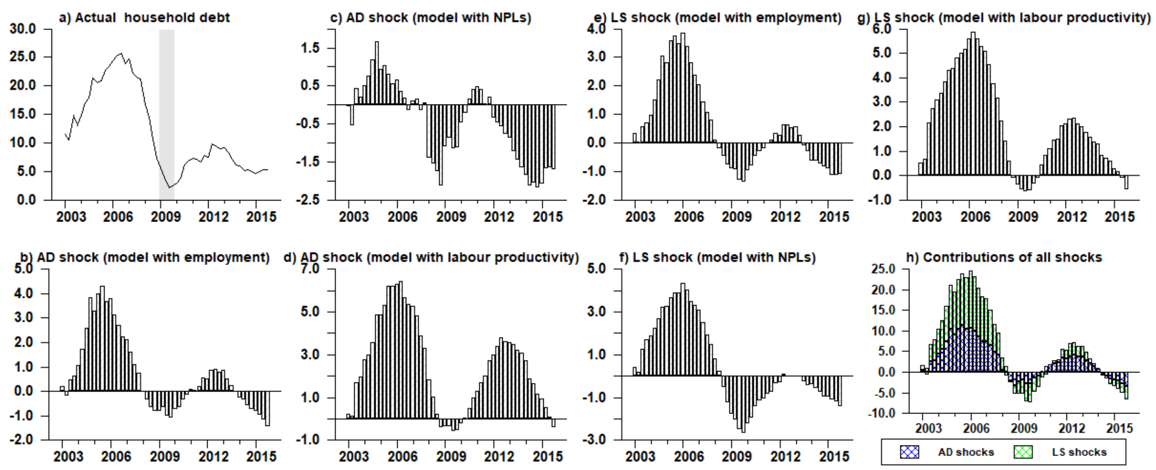
Note: Emply = employment, NPLs = non-performing loans, Lab prod = labor productivity, Eight VAR = impulse responses for household debt generated from the variable VAR model.

Source: Authors' calculations

On the other hand, because when faced with an adverse aggregate demand shock monetary policy is loosened, it seems that in Figure 7.6(b) the positive effects to household debt are largely transmitted via the increase in employment and labor productivity. In addition, the positive effects of employment and labor productivity growth seem to persist. Furthermore, the historical contributions of shocks based on the counterfactual scenarios in Figure 7.7 indicate that both aggregate demand and loan supply shocks reinforce each other over the cycle. Pre-2009 both shocks contributed to the increase in household debt but currently both shocks are contributing to the decline in household debt.

A comparison of the contribution of both shocks pre-2009 shows that loan supply shocks transmitted via the employment and labor productivity channels contributed more to household debt compared to aggregate demand shocks associated with these channels. At peak, loan supply shocks contribute 15 per cent to the 25 per cent growth in household debt compared with 10 per cent due to aggregate demand shocks.

Figure 7.7 Contribution of loan supply and aggregate demand shocks to household debt from various models



Note: NPLs = non-performing loans.

Source: Author's calculations

On the other hand, between 2011Q1 and 2013Q4 aggregate demand shocks contributed 4 per cent to the 5 percent increase in household debt compared to a mere 1 per cent contribution due to loan supply shocks. The implication of the results is that the simultaneous occurrence of positive employment, labor productivity and lower credit risk shocks loosens the credit constraints and allows banks to supply more credit to meet aggregate demand.

7.6.2 Does the household to debt income ratio corroborate these findings?

For the robustness test of the findings in the earlier section we change the specification and replace household debt and disposable income with the ratio of household debt to disposable income. Disposable income is one of the measures used to assess the financial standing of the household sector. It presents the degree to which households are leveraged or how geared the household income is and the risks this poses to financial stability. As such, the level of household debt and the degree to which they are geared complete each in the assessment of household debt on GDP growth.

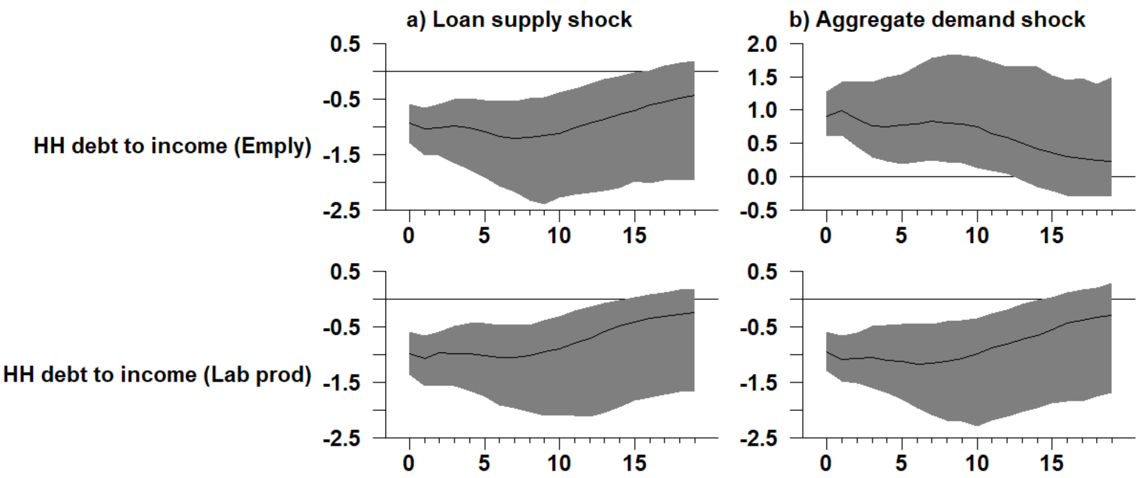
For the assessment of the role of loan supply and demand shocks on household debt to disposable income, we estimate a six variable VAR in Equation 7.22. The imposed sign restrictions are as shown in Table 7.1. Like the estimations using household debt, we leave household debt to disposable income unrestricted.

$$Y_t = \{repo, lend, hhdebtYD, GDP, npls, emply\} \ldots \ldots \ldots \ldots \ldots . (7.22)$$

Where, $repo$ is the repo rate, lend is the lending rate, hhdebtYD is household debt to disposable income, GDP is GDP growth, npls is non-performing loans and emply is formal non-agricultural employment. We start with the specification in Equation 7.22 and replace employment with productivity in the estimation of an alternative model. Figure 7.8 shows that the responses of household debt to disposable income to an adverse loan supply shock lead to a decline in the degree to which household are leveraged. This means that an increase in interest rate spreads discourages further accumulation of household debt.

On the other hand, because in an adverse aggregate demand shock monetary policy is loosened, Figure 7.8(b) shows that the positive effects to household debt are largely transmitted via the increase in employment compared to labor productivity. The positive effects of employment result in an increase in household debt to disposable income compared to positive shocks to labor productivity growth which take a considerable lag to turn positive. This indicates that employment creation results in immediate responses in household gearing compared to productivity. The responses are in line with Igan and Kang (2011) who show that positive (negative) income shocks largely emanating from the labor market dynamics have an important relationship with credit growth (defaults) and the household debt burden in general.

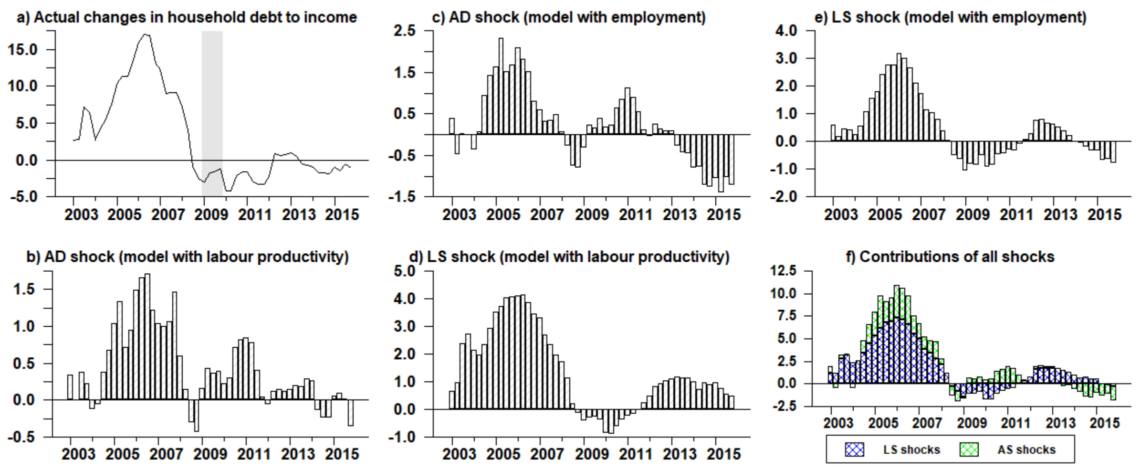
Figure 7.8 Comparison of household debt-to-income responses to various shocks in different models



Source: Author's calculations

Furthermore, the historical contributions of shocks based on the counterfactual scenarios in Figure 7.9 corroborate results in the earlier section. Loan supply shocks contributed more to the household increase in leverage pre-2009 mainly driven by labor productivity growth compared to employment growth. Aggregate demand shocks contribute positively to household leverage via increased employment.

Figure 7.9 Contribution of loan supply and aggregate demand shocks to household debt from various models



Source: Author's calculations

We conclude that the data confirms the existence of both credit demand and supply hypothesis but that the credit supply seems to have dominated the evolution of household debt pre-2009. However, post-2009 it is evident that the contributions changed significantly. Even though aggregate demand and loan supply shocks contributed positively to household debt between 2011Q1 and 2013Q4, loan supply shocks were constrained by credit risk as NPLs made negative contributions to household debt.

This means that despite the improvement in the aggregate demand conditions associated with the employment and labor productivity channels, heightened credit risk limited the ability of banks in supplying credit. In addition, the period post-2009 was associated with the implementation of stringent bank regulatory and macro-prudential tools which could have also contributed to tightening of credit supply shocks by banks. Nonetheless, it is evident that since 2014Q1 both aggregate demand and loan supply shocks are exerting downward pressure on household debt.

However, because the sign restriction approach is not geared towards answering questions related to thresholds or deviations from long-term trends, we are unable to relate the contributions of aggregate demand and loan supply shocks to overheating (or drag) in household debt. Hence, we use the thresholds and cointegration approaches to answer these policy relevant aspects of the contributions of shocks to overheating or drag in household debt.

7.7 How large was the overheating in household debt pre-2009?

We use the Johansen vector error correction model (VECM) to answer this question. In addition, which variables are instrumental in the error correction process for household debt? At what rate does household debt correct from long-term deviations. We estimate the VECM specified in the same way as the sign restricted VAR in the previous section. However, we use a recursive approach to the identification of shocks. We order household debt first, followed by household disposable income, GDP growth, employment or labor productivity or non-performing loans and the lending rate.

The ordering of output before the credit variables is conventional and in line with much of the monetary VAR literature. Furthermore, the credit view of the monetary policy transmission suggests that the decision on issuing bank loans is directly affected by the size of the external finance premium which depends on the creditworthiness of borrowers. Therefore, we order non-performing loans before the lending rate and the policy rate. The policy rate is placed last in line with literature and implicitly assumes that monetary policy responds contemporaneously to output, labor, and credit market conditions.

Like the sign restricted VAR, we estimated four VECMs and in all cases, we established one cointegrating vector for the sample period 2000Q1 to 2015Q4. The lags for the VECM were 2 chosen by AIC and SBC information criteria. We present the point estimates of the long-run relationship and the error correction term (ECT) in Table 7.3 and they indicate that the long run relationship is largely explained by GDP growth, labor productivity, employment and disposable income. The lending rate and the non-performing loans are negatively related with household debt.

Table 7.3 Cointegrating Equation: Dependent variable log of household debt

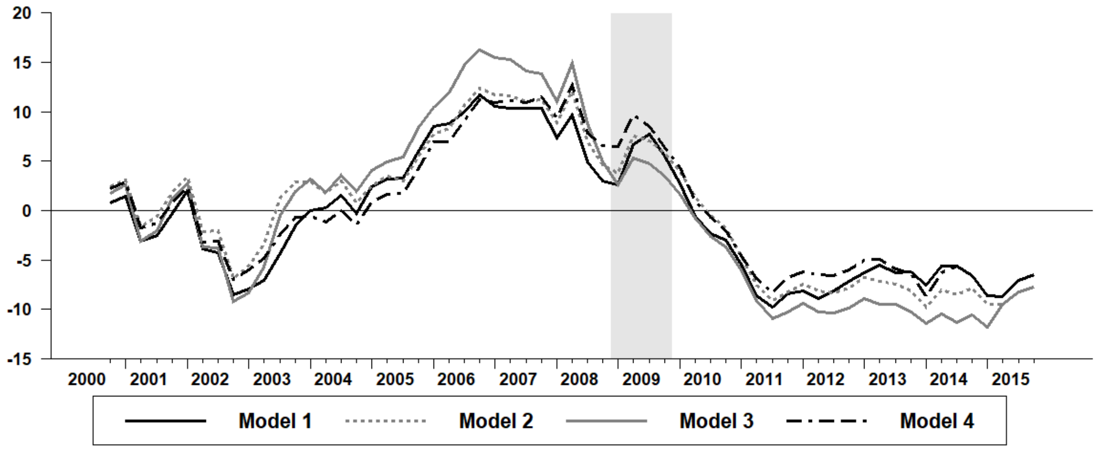
LHHYD (-1)	LGDP (-1)	LLABPROD (-1)	LNPLS (-1)	LEMPL (-1)	PRIME (-1)
0.971	1.47	1.85	-0.12	1.18	-0.05
(2.89) **	(1.99) **	(2.12) **	(-2.69) **	(2.59) **	(-2.00) **
			Error Correction		
			DLHHDEBT		
			-0.12		
			(-2.67) **		

Note: The numbers in (.) denote the p-value. * denotes significance at 1 per cent. ** denotes significance at 5 per cent.
Source: Author's calculations

The ECT in the error correction equation indicates that household debt adjusts by 1.2 per cent on a quarterly basis from the position of disequilibrium. The results of the other three models estimated are shown in Tables A7.1 to Table A7.3 in the appendix and corroborate the results in Table 7.3 that the adjustment of household debt from a dis-equilibrium is very slow at less than one per cent a quarter. Increases in labor productivity growth, GDP growth, employment growth and household debt are the key variables that assists in the adjustment of household debt from the dis-equilibrium positions. The decline in non-performing loans contributes more to the adjustment of household debt from the dis-equilibrium compared to the prime rate. This is consistent with results in the earlier sections showing that heightened credit risk limited the ability of banks to supplying credit and lending rate margins.

On the other hand, Figure 7.10 shows the evolution of the ECT or cointegrating vectors generated from the four estimated VECMs. All the models suggest that pre-crisis, household debt deviated by as much as 15 per cent above equilibrium. Post-2009, despite the financial crisis and the recession, household debt increased, and the disequilibrium continued until 2010Q2. However, all the measures indicate that household debt is currently in a short-fall position by as much as 10 per cent. The shortfall in household debt since 2010Q2 has persisted longer and is more severe than that during 2002Q1 to 2003Q4.

Figure 7.10 Estimates of the household debt overhang/shortfall based on the error correction term



Source: Author's calculations

Now that we have established the nature of the deviation of household debt relative to the long-run equation, it is important to establish whether the processes of deviation are characterized by want function. This means that it is highly informative to know that the overhang/short-fall positions are of a certain magnitude, but it matters more to know the transition process followed by household towards these positions. In addition, the knowledge of the thresholds and the asymmetries they introduce on other macroeconomic variables has important policy implications.

7.8 Does household debt growth follow a linear or non-linear process?

We start by establishing whether household debt growth has a breakpoint and whether it follows a linear or non-linear process. We use several tests that allow for structural breaks in the data to assess for convergence of the results. The objective of testing for the presence of the breakpoint is to establish the dates during which the breaks in the series occurred and show that the tests converge to the existence of the break points in the data.

Because the estimation the transition function requires long time series data, we conduct the tests for the sample period 1980Q1 to 2015Q4. We test for the existence of the break points in the log level and changes of the household debt series. The results of the break point test in Table 7.4 indicate that the household debt series does indeed have a break, both the log level data and the log changes in Table A7.4. This means that the household debt series follows a non-linear process and we can use non-linear approaches in the estimations.

Table 7.4 Tests for non-linearity in household debt (log level)

Test	Null Hypothesis	F-value	P value	Decision
Tsay arranged test	No break point	2.37973	(0.00) **	Break
Hansen Threshold test	No break point	-19.2465	(0.00) **	Break
STAR test	Linearity	4.6294	(0.00) **	Non-linearity
Zivot and Andrews (1992)	No break point	23.3183	(0.00) **	Break
Lumsdaine-Papell (1997)	No break point	6.74	(0.00) **	Break

Note: The numbers in (.) denote the p-value. * denote significance at 1 per cent. ** denotes significance at 10 per cent.
Source: Author's calculations

To establish which function best captures the non-linearity involved and the delay parameter in household debt we conduct the STAR tests. The results in Table 7.5 and Table A7.5 in the appendix indicate that the data is agreeable to the LSTAR and the ESTAR. Evidence in Table 7.5 suggests that the minimum p-value are equally stronger for the data for household debt to be estimated by the LSTAR and ESTR models. Jorda and Alvaro (1997) show that there are cases where the LSTR and ESTR model specifications are close substitutes. In addition, the ESTR model performs well when the threshold and the data are symmetrically distributed between the upper and lower regimes.

Table 7.5 LM and F test for linearity (p-values) household debt (log level)

Test	F-statistics	P-value	AR length	Delay parameter
Linearity	1.81	0.131	2	2
H01	3.08	0.001*	2	2
H02	2.05	0.079	2	2
H03	0.54	0.821	2	2
H12	2.99	0.004*	2	2
LSTAR	Yes			
ESTAR	Yes			

Note: The numbers in (.) denote the p-value. *implies significance at 1 per cent. Source: Author's calculations

We stated earlier that the intention of the chapter is assess threshold at which household debt exerts negative effects on growth and that we are more interested in the robustness of the threshold as well as the nature of the transition from the regimes demarcated by the threshold. We used several approaches to establish the thresholds and they are shown in Table 7.6 for the log level and log changes in household debt. The thresholds were derived from recursive VAR models as specified in equations estimated for the VECM models. The results indicate that there is convergence and the estimated thresholds for household debt are robust to changes in the specification and techniques used.

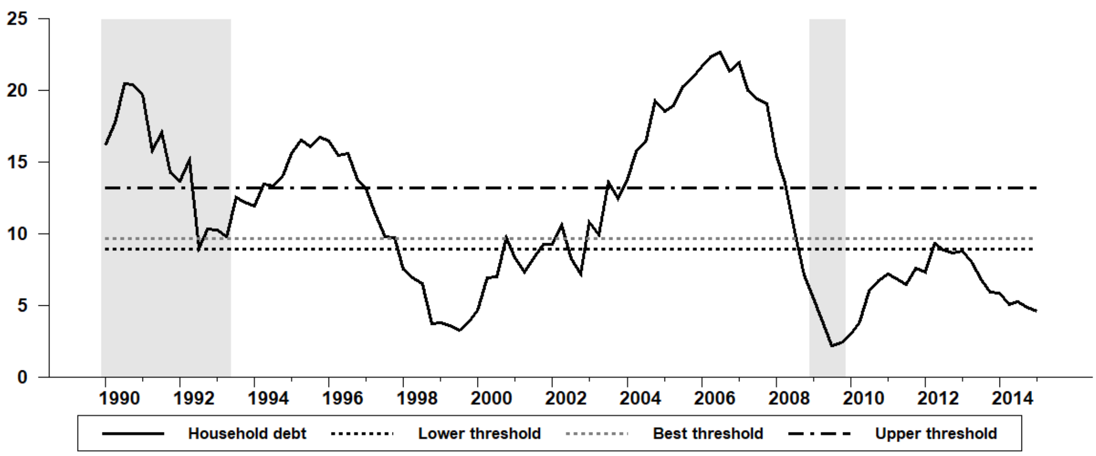
Table 7.6 Estimated household debt thresholds

Test	Lower threshold	Best point threshold	Upper threshold
Tsay (1998)	8.81	9.00	13.00
Hansen Threshold test	8.87	9.89	13.25
Balke (2000)	9.00	9.98	13.35

Source: Author's calculations

Furthermore, we show in Figure 7.11 household debt growth overtime in relation to the estimated lower, best point and upper thresholds. The relationship of household debt growth overtime with the thresholds confirms the trends that were implied by the ECT. Household debt is currently below all thresholds meaning that the thresholds corroborate the results derived from the VECM model and the HP and EKF.

Figure 7.11 Household debt growth and the estimated thresholds

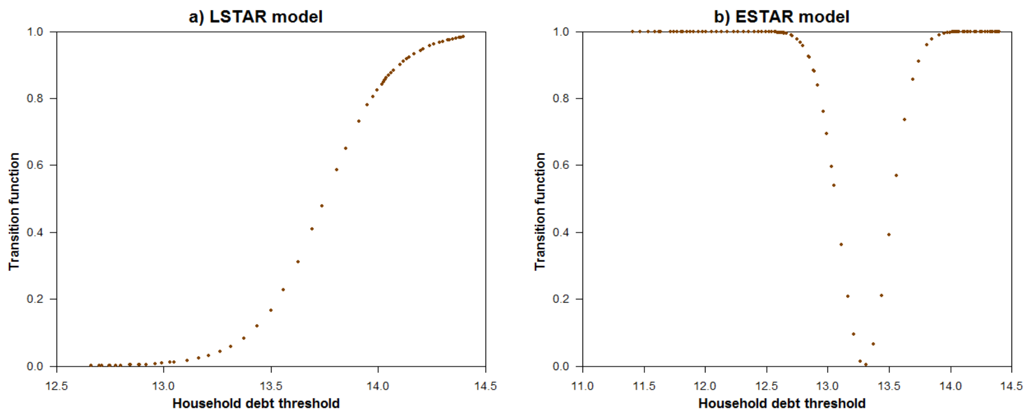


Source: Author's calculations

In addition, we stated earlier that the thresholds and the VECM estimates are informative, but they do not tell us the nature of the transition in household debt in relation to GDP growth. Hence, we present the results of the estimated transition functions in Figure 7.12. We stated earlier that the results for the nature of the transition function to estimate were rather undecided between the LSTAR and the ESTAR model hence we estimated both models.

The estimated transition functions suggest that household debt growth exhibits asymmetric behavior around the estimated transition functions. This means that household debt growth rates below (above) 13.5 per cent are synonymous with the low (high) household growth regime in which growth in household debt exerts different effects on GDP growth. Furthermore, the asymmetric behavior of household debt growth effects on GDP growth below and above the estimated threshold is not abrupt. The results of the estimated transition functions are presented in Table A7.5 in the appendix.

Figure 7.12 Estimated transition functions for household debt growth



Source: Author's calculations

The LSTAR function suggests that the effects of household debt growth on GDP start exerting positive and negative asymmetric effects around 13 per cent as it approaches the threshold. Similarly, the ESTAR model suggests that the distance between the household debt growth and the threshold matters as well. The negative and positive effects household debt exerts on GDP growth are also dependant on how far the growth rate is relative to the threshold. This is consistent with earlier evidence showing that GDP growth responds differently to positive and negative household deviations. However, we explore the threshold effects in the next section when we estimated the TVAR model.

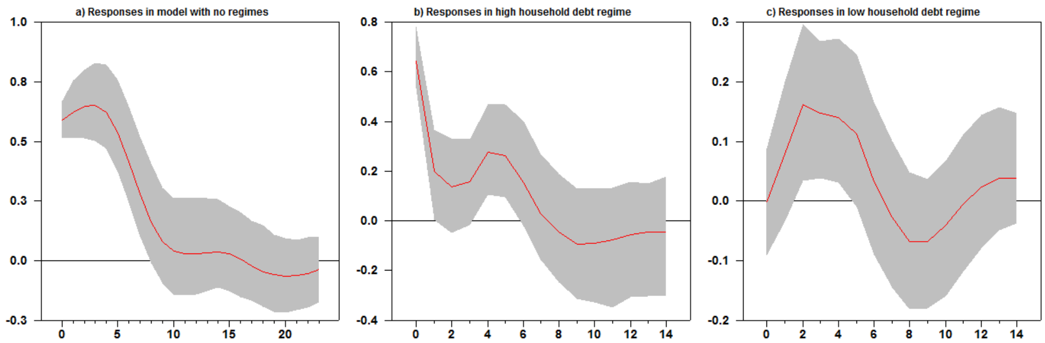
7.9 What does the TVAR model suggest are the asymmetric effects introduced by the household debt threshold?

To conclude the analysis of the asymmetric effects induced by household thresholds on GDP growth, we estimate A in Equation 7.5. In the equation, GDP growth is a function of household debt conditions as well as endogenous variables in Y_t, the TVAR allows GDP growth to switch within regimes also due to shocks to other variables in the model. Therefore, shocks to household debt, household disposable income, lending rate, employment, non-performing loans, and productivity can all determine whether the economy is in a tight household debt regime or not.

Similar to Balke (2000), Calza and Sousa (2005) and Avdjiev and Zeng (2014) we use a recursive structure and we order household debt first, followed by GDP growth, employment (or disposable income or labor productivity or non-performing loans), lending rate and inflation. We exclude bank credit in the specification because it constitutes almost 95 per cent of household debt and can thus bias the estimations. The ordering of output before the non-performing loans is in line with much of the monetary VAR literature. Furthermore, the broad credit view suggests that decisions on issuing bank loans are directly affected by the size of the external finance premium which depends on the creditworthiness of borrowers. Therefore, we order non-performing loans before the lending rate which also quantitatively measures the risk premium. Finally, following Balke and Zeng (2013), we order the repo rate last. The implicitly assumption is that monetary policy responds contemporaneously to output, labour, and credit market conditions.

To simplify the analysis, we use the average of the best threshold points estimated in Table 7.6 which amounts to 9.62 per cent to delineate between high and low household debt regimes. In the discussion we present the comparison of responses of GDP growth in models where (i) there is no household debt threshold (ii) household debt is below the threshold and (iii) household debt is above the threshold.

Figure 7.13 Responses of GDP growth below and above the household debt thresholds



Source: Author's calculations

Figure 7.13 and Figure 7.14 indicate that indeed household debt thresholds induce asymmetric responses in GDP and employment growth. The responses in models with no thresholds and during high debt regimes lead to high and persistent responses although employment tends to be volatile. Employment responses are much more volatile during regimes.

Figure 7. 14 Responses of employment growth below and above the household debt thresholds

Source: Author's calculations

7.10 Conclusion and policy implications

Does the level of household debt growth impact GDP? If so, is there a threshold of household debt that induces non-linear GDP growth responses depending on the household debt regimes? This chapter explored these questions via several econometric techniques. First, we use the penalty function approach to sign restriction to identify adverse aggregate demand and loan supply shocks. We establish that adverse aggregate demand and loan supply shocks are mainly transmitted via the labor markets and are propagated by credit conditions. The simultaneous occurrence of positive employment, labor productivity and lower credit risk shocks loosens the credit constraints and allows banks to supply more credit to meet aggregate demand. Furthermore, employment creation results in immediate responses in household gearing as income shocks emanating from the labor market dynamics have an important relationship with credit growth (defaults) and the household debt burden in general.

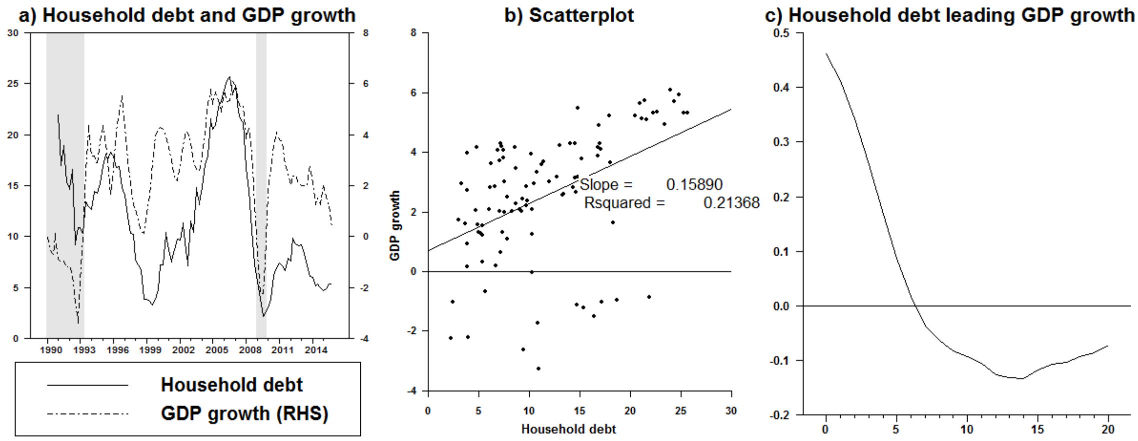
Second, we estimate the VECM and extract the error correction terms to assess what they imply about the nature of the deviation of household debt from for long-term equilibrium positions. We establish that the estimated error correction terms suggest that currently household debt is in shortfall by as much as 10 per cent. Furthermore, the rate at which household debt adjusts from disequilibrium position is terribly slow at less than one per cent per quarter.

Third, we use several threshold techniques and establish the household debt threshold occurs between 8.8 per cent and 13.4 per cent. The transition functions suggest that the distance from the threshold and the sign away from the threshold matter for the response of GDP and employment growth. In periods of high debt regimes, GDP and employment growth are persistently high compared to periods of low household debt regimes.

The implications of the findings for price and financial stability are that household debt levels matter for GDP growth. The channels of transmission are largely via the labor market and are amplified by credit conditions. Loan supply shocks act as amplifiers of aggregate demand shocks and induce asymmetric effects on the macro-economy.

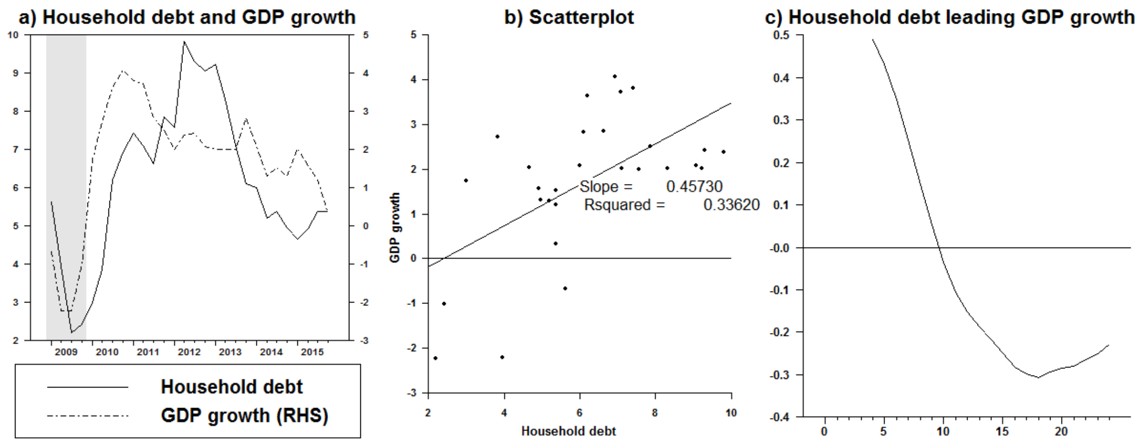
Appendix

Figure A7.1 Household debt and GDP growth 1990 to 2015



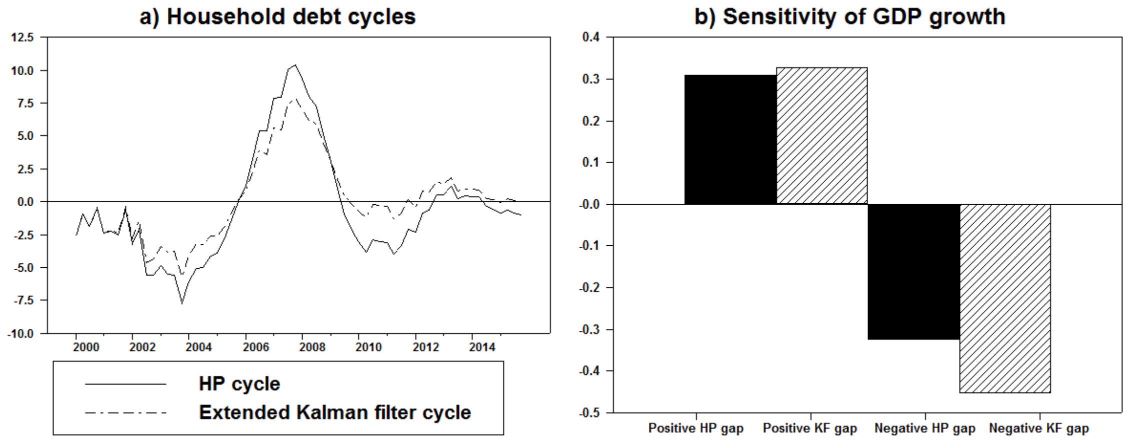
Source: South African Reserve Bank and author's calculations

Figure A7.2 Household debt and GDP growth 2009 to 2015



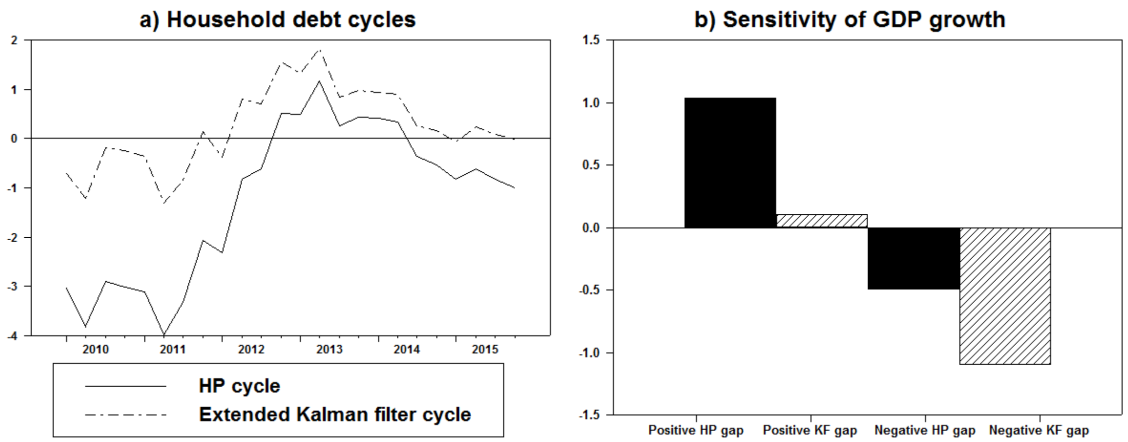
Source: South African Reserve Bank and author's calculations

Figure A7.3 Household debt and GDP growth sensitivity 2000Q1 to 2015Q4



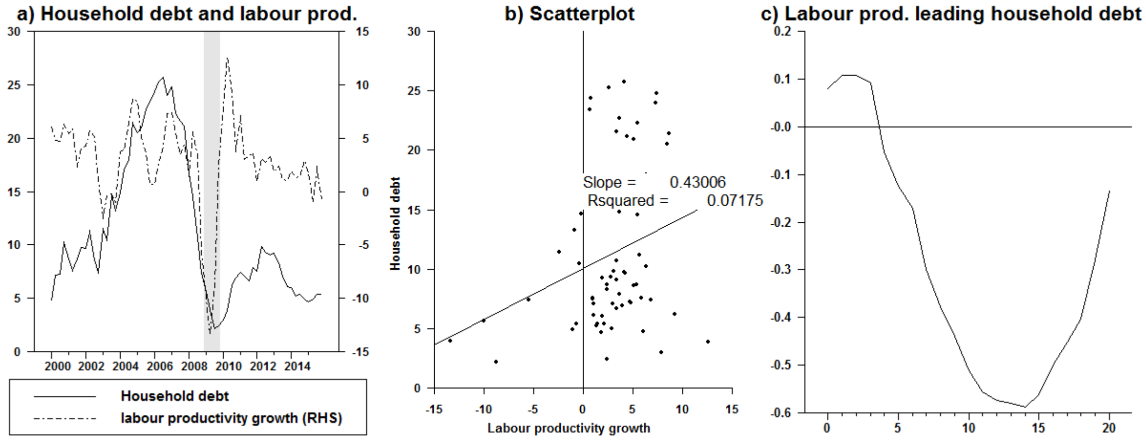
Source: Author's calculations

Figure A7. 4 Household debt and GDP growth sensitivity 2010Q1 to 2015Q4



Source: Author's calculations

Figure A7.5 Household debt and labour productivity growth 1990 to 2015



Source: South African Reserve Bank and author's calculations

Table A7. 1 Cointegrating Equation: Dependent variable log of household debt

	LHHYD (-1)	LGDP (-1)	LFRMLEMPL (-1)	Lend rate (-1)
	0.72	1.91	0.98	-0.02
	(2.05) **	(1.97) **	(1.98) **	(-1.97) **
		Error Correction		
		D(L_HHDEBT)		
		-0.03		
		(-1.98) **		

Note: The numbers in (.) denote the p-value. * denotes significance at 1 per cent. ** denotes significance at 5 per cent.
Source: Author's calculations

Table A7. 2 Cointegrating Equation: Dependent variable log of household debt

	LHHYD (-1)	LGDP (-1)	LLABPROD (-1)	Lend rate (-1)
	0.257	3.39	2.301	-0.03
	(1.94) **	(3.01) *	(3.89) *	(-1.99) **
		Error Correction:		
		D(LHHDEBT)		
		-0.02		
		(-2.12) **		

Note: The numbers in (.) denote the p-value. * denotes significance at 1 per cent. ** denotes significance at 5 per cent.
Source: Author's calculations

Table A7.3 Cointegrating Equation: Dependent variable log of household debt

	LHHYD (-1)	LGDP (-1)	LNPLS (-1)	Lend rate (-1)
	0.33	1.197	-0.12	-0.04
	(1.97) **	(6.32) *	(-3.12) *	(-1.98) **
		Error Correction		
		DLHHDEBT		
		-0.05		
		(-1.99) **		

Note: The numbers in (.) denote the p-value. * denotes significance at 1 per cent. ** denotes significance at 5 per cent.
Source: Author's calculations

Table A7.4 Tests for non-linearity in the household debt (growth series)

Test	Null Hypothesis	F-value	P value	Decision
Tsay arranged test	No break point	8.75397	(0.00) **	Break
Hansen Threshold test	No break point	13.5048	(0.00) **	Break
STAR test	Linearity	17.97	(0.00) *	Non-linearity
Zivot and Andrews (1992)	No break point	11.0709	(0.00) *	Break
Lumsdaine-Papell (1997)	No break point	7.19	(0.00) **	Break

Note: The numbers in (.) denote the p-value. * denote significance at 1 per cent. ** denotes significance at 10 per cent.
Source: Author's calculations

Table A7.5 LM and F test for linearity (p-values) household debt (log changes)

Test	F-statistics	P-value	AR length	Delay parameter
Linearity	3.87	0.467	2	2
H01	3.08	0.006*	2	2
H02	2.05	0.045	2	2
H03	0.54	0.79	2	2
H12	2.99	0.002*	2	2
LSTR	Yes			
ESTR	Yes			

Note: The numbers in (.) denote the p-value. .*implies significance at 1 per cent

Source: Author's calculations

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