

Essays on international capital flows and macroeconomic stability

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Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
at the University of Pretoria
June 2015

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Abstract

Global monetary policy, financial risk and risk aversion are important determinants of international capital flows. Capital flows may in turn cause expansion of credit and leverage in the recipient economy. This PhD thesis contributes to our understanding of the transmission channel from global risk factors to domestic credit and saving. We estimate the time varying effects of risk on portfolio flows to South Africa, we estimate the transmission of portfolio flows to credit, and lastly we incorporate our empirical findings in a two-country DSGE model with portfolio flows and risk constrained financial intermediaries.

Risk and risk aversion are found to affect bond and share flows to South Africa differently. Risk consistently affects bond flows more than share flows. The relationship between risk and portfolio flows is also found to be continuously evolving and highly dependent on the macroeconomic environment.

We further study the transmission channel linking portfolio flows to credit extension in South Africa. We posit that the transmission works by increasing banks' supply of credit and we find empirical support for this hypothesis. Parts the proceeds from portfolio flows are deposited in local banks. This cash injection increases banks' supply of credit and the effect is pro-cyclical. If the cash is injected during a credit expansion it will have a stronger effect on credit extended. We find that share flows tend to cause more cash injections than bond flows and are therefore more prone to cause credit expansions.

The empirical findings guide our construction of a two-country DSGE model with financial intermediaries and macroprudential policy. The model shows that portfolio flows arise from changes in asset demand from foreigners relative to demand from residents. Simulations show that risk shocks affecting both emerging market and foreign investors will cause demand for emerging market bonds to shift from the foreign to the local investor, causing an outflow in the emerging bond market. Both the foreign and domestic investors will cut demand for shares, and therefore the direction of share flows is unpredictable. Shocks to risks that are only carried by foreign investors cause stronger portfolio flows out of emerging market shares. The global policy environment has a great impact on the transmission of global shocks to portfolio flows. Bond supply can absorb risk shocks, while interest rates can absorb income shocks. Tighter macroprudential policy in the recipient economy has very limited, if any, effect on the relationship between portfolio flows and domestic credit extension.

For Eleyce and Anders Bo.

Acknowledgments

My sincerest gratitude goes to my wonderful wife, Eleyce. Thank you for all your support and patience. Thank you for believing in me, encouraging me, and patiently listening to my lengthy complaints of unsolvable models. Thank you for taking care of our newborn son (and myself) while I was absorbed in this research. You and Anders are the inspiration that drives all my work.

I wish to thank Nicola Viegi, for your excellent mentorship and seemingly limitless excitement and optimism. Thank you for making this process an exciting journey focused on curiosity, learning and discovery.

I wish to thank my former professors, Brian Kantor and Shakill Hassan, for first opening my eyes to the surprisingly exciting world of economics and finance. I would not be working in this field today had I not taken your courses five years ago.

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Chapter 1

Introduction

Global monetary policy, financial risk and risk aversion are important determinants of international capital flows. Capital flows may in turn cause expansion of credit and leverage in the recipient economy. This PhD thesis aims to contribute to our understanding of the transmission channel from global risk factors to domestic credit and saving.^{1 2}

The focus of the thesis is on gross portfolio inflows as measured by non-resident net purchases of domestic shares and bonds. *Figures 1-1* and *1-2* illustrate the dramatic growth in non-resident ownership of shares and bonds in several emerging markets. The figures show each country's debt and equity liabilities to non-residents and reveal a common trend in most emerging economies. Equity liabilities to foreigners expanded prior to the global financial crisis in 2008 and the growth has since slowed down. Debt liabilities to foreigners were more stable prior to the global financial crisis but have expanded rapidly in more recent years.

¹Throughout this text risk is generally understood as the uncertainty (measured by standard deviation) of expected asset returns. In empirical parts of the text this is measured by the standard deviation priced into options on US equities. In certain instances we distinguish between risk on specific asset classes or specific regions. In those cases, risk is understood as uncertainty of expected returns on the respective asset class in the respective region.

²Risk *factors* refer to the sources of risk. In theoretical models presented in the text, the risk factors simply refer to the geographical origin of the source. That is, uncertainty (standard deviation) of expected asset returns can be caused by shocks arising in advanced economies (named *global*) or in emerging economies (named *local*). The total risk of a given asset classes in a given region depends on its exposure to the risk factors, that is its exposure to different sources of uncertainty. A risk *shock* constitutes an unexpected increase in the uncertainty (standard deviation) of an asset's expected return.

The large changes in foreign liabilities are either caused by portfolio flows or changes in the valuation of existing liabilities. Gross portfolio flows to emerging markets arise from changes asset demand from foreigners relative to the asset demand from local investors. If foreigners increase demand for local assets, there will be a gross portfolio inflow, *ceteris paribus*. But if local investors also increase demand for local assets, the direction of the portfolio flow is uncertain and depends on whom increases demand more. The distinction between absolute and relative demand is central in this thesis.

In Chapter 2 we show that a vast empirical and theoretical literature has found global risk and monetary policy to be important drivers of portfolio flows. There is further strong evidence that capital flows have expansionary effects on credit in the recipient economies. Careful analysis has been done on the transmission channel that links global risk to global demand for emerging market assets (Adrian and Shin, 2009; Bruno and Shin, 2012). In Chapter 3 we estimate the impact of global risk on portfolio flows to South Africa over the last 20 years. We find that the response of portfolio flows to risk shocks is highly time dependent. During times of financial stress, the risk shocks have a greater impact on portfolio flows than during times of financial stability. We also note that bond flows to emerging markets are more sensitive to risk than share flows. The latter finding may be surprising given the fact that shares carry more risk than bonds. In Chapter 5 we show that one potential explanation of this finding lies in the *relative* demand for emerging market bonds from global investors compared to local investors. When general risk or risk aversion increases, emerging market investors will increase demand for their local bonds while foreign investors reduce demand for emerging market bonds. Thus, the foreign (global) investors will sell emerging market bonds to the local investors, reflecting a portfolio outflow. The share flow is less predictable because both the foreign and the emerging market investor will reduce demand for emerging market shares.

There is further uncertainty around the transmission channel linking portfolio flows to local credit extension. In this thesis we posit that the transmission mechanism goes through the banking sector. Portfolio flows generally involve a transaction

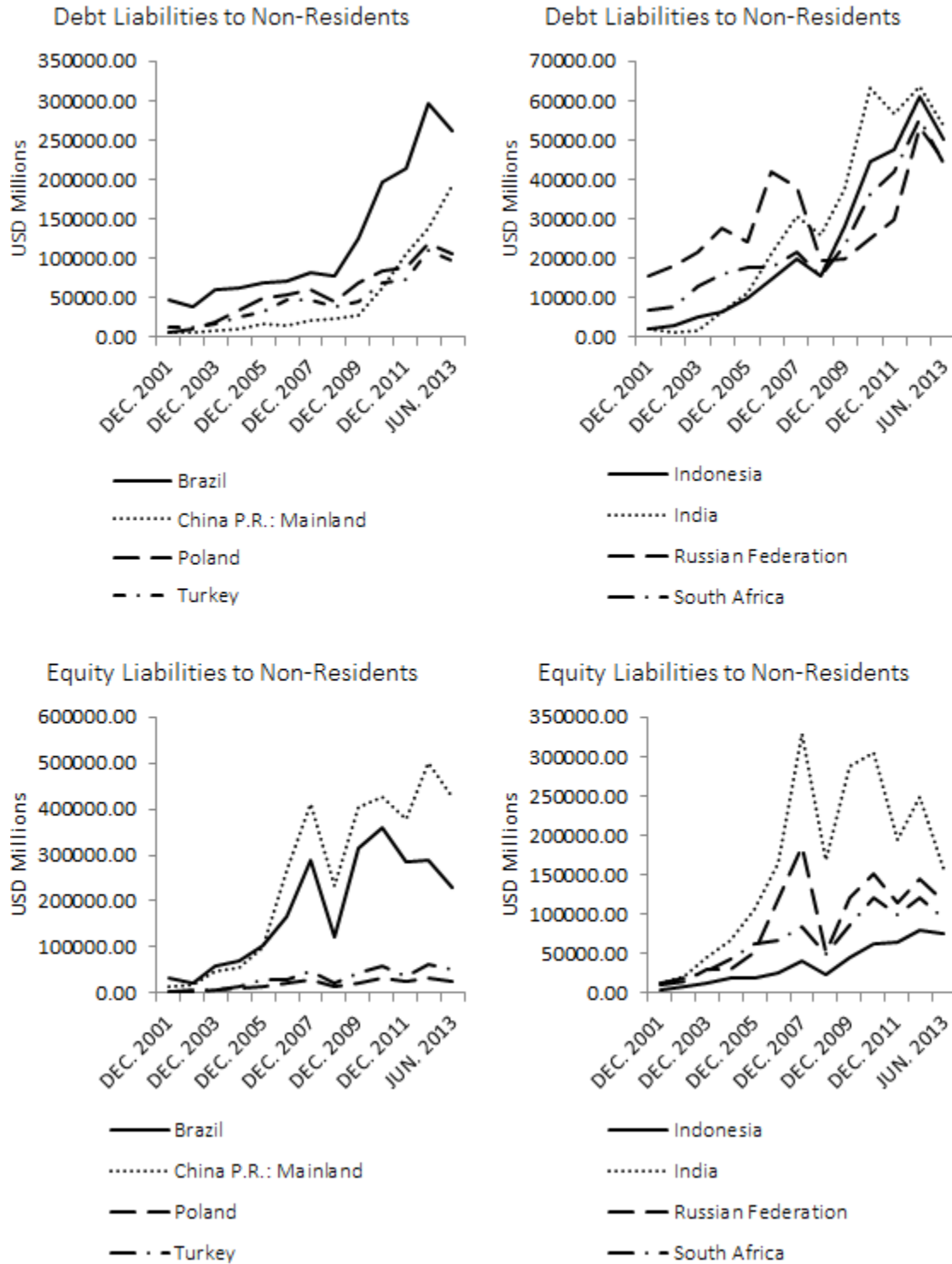


Figure 1-1: Emerging economies' debt and equity liabilities to foreigners. Source: IMF (2014a,b)

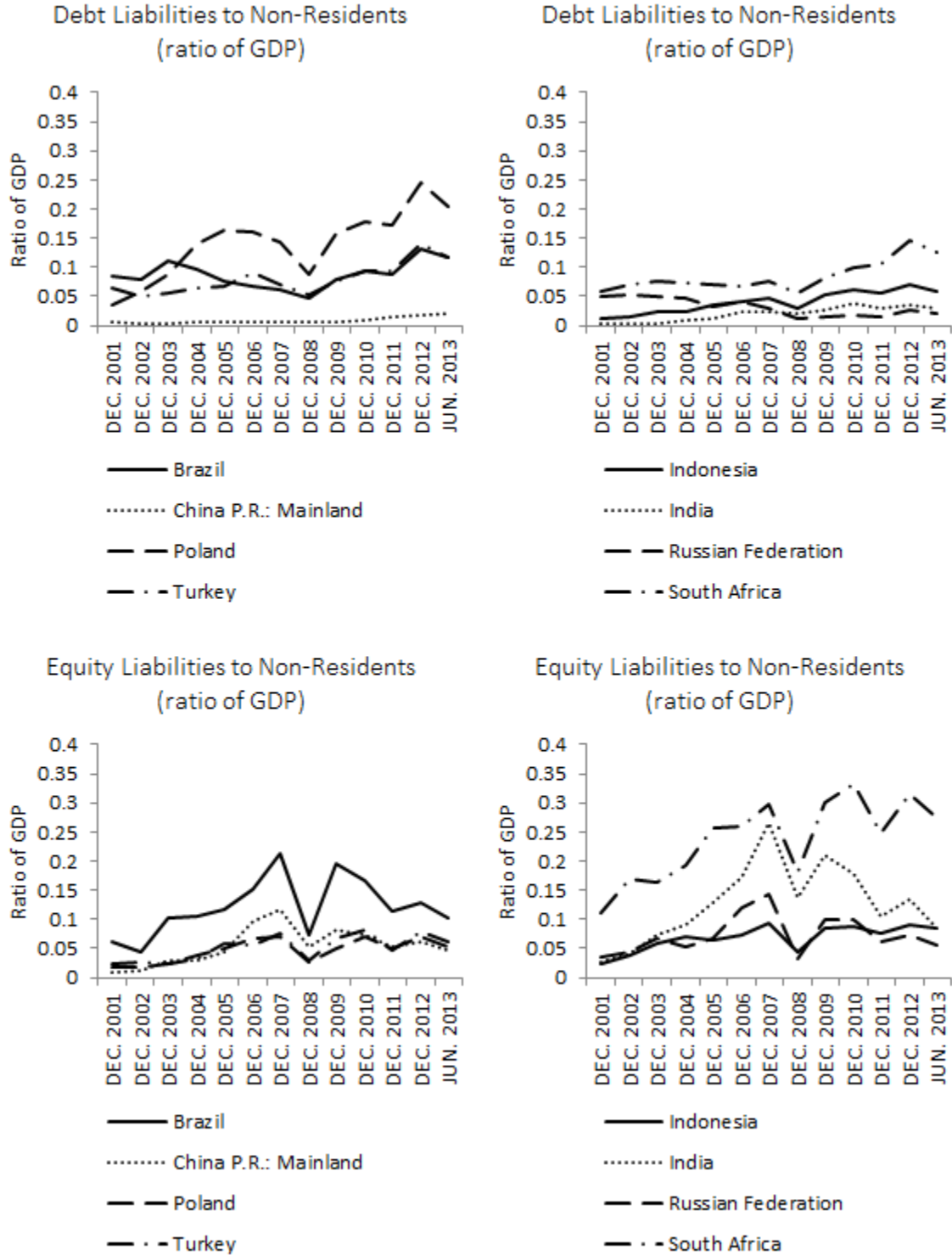


Figure 1-2: Emerging economies' debt and equity liabilities to foreigners as share of GDP. Source: IMF (2014a,b)

between foreign and local fund managers. The local fund manager must decide what to do with the proceeds from the sale of domestic assets. Parts of the proceeds may be deposited in a local bank. This injection of cash on the bank's balance sheet is in effect an increase in the supply of credit to the bank. The bank may choose to invest the cash in new assets, thereby expanding the balance sheet, or the bank can use the deposit liabilities from fund managers to pay off other borrowed funds and thereby keep the total size of the balance sheet constant.

We find empirical evidence that portfolio inflows do cause an increase in bank deposits from fund managers³. We also find evidence that part of the cash injection on bank balance sheets is invested in new assets, specifically mortgages to households and corporations. We find that the timing of this cash injection matters for its impact on credit. If the injection happens at a time when banks have little spare cash, the injection will have a strong impact on credit extension. If instead the cash injection happens at a time when banks have larger holdings of cash, the injection has less impact. If one assumes that banks have less spare cash during a credit expansion, the implication is that portfolio flows have pro-cyclical effects on credit. Our empirical results suggest share flows are more likely than bond flows to cause an increase in cash deposits from fund managers, and therefore share flows are more likely to have pro-cyclical effects on credit. That does not mean that the size of the share flow itself is pro-cyclical. If the majority of share flows happen during credit contractions, share flows will have little effect on credit. If the majority of share flows happen during a credit expansion, it will have a greater impact on credit. Rey (2013) finds that share flows are the least correlated to the global financial cycle. Lane and McQuade (2013) find that share flows have less impact on credit than other kinds of capital flow. It is possible that Lane and McQuade (2013) would find a stronger effect of share flows on credit if the share flows had been more correlated to the financial cycle. A non-linear model of portfolio flows and credit can capture these regime dependent relationships. We estimate this relationship in Chapter 4.

³As measured in the line item *fund manager deposits* on the banks' BA900 form reported to the South African Reserve Bank each month.

We find evidence that parts of the transmission channel from portfolio flows to credit extension works by affecting banks' supply of credit rather than households' demand for credit. Since supply and demand are equal, there is an identification challenge when estimating this empirical relationship. We distinguish the supply channel from the demand channel by studying the impact of portfolio flows under different regimes. We find that when banks have less cash on their balance sheet, a cash injection caused by portfolio flows will be more likely to expand credit. This is not consistent with a transmission channel affecting credit demand.⁴ If banks have plenty of cash, it indicates that their cost of raising funds is low and the demand for bank credit is low. If demand for credit increases, this demand can immediately be satisfied by lending out the excess cash. Thus, if portfolio flows increase demand, we should see stronger responses of credit when the cash ratio is high. Instead we see that the response is greater when the cash ratio is low.

The fact that cash injections affect credit more when the cash ratio is low, indicates that the supply channel is dominant. When the cash ratio is low, banks have already lent out as much as they can. There is likely to be more credit demand in the economy, but satisfying this demand would require raising more funds from deposit liabilities. And raising deposits requires higher deposit rates. However, a portfolio inflow in this environment may provide a welcome injection of deposits from fund managers. This cash injection will quickly be lent out to satisfy the existing credit demand. If instead the portfolio flow and the associated deposit from fund managers arrives at a time when credit demand is low and banks already have sufficient cash holdings, the effect on credit is less likely to be important. Arrival of more cash from fund managers will not necessarily be met by demand for credit and may instead be used to pay off other liabilities. In this environment, the portfolio flow does not affect the aggregate size of bank balance sheets.

The empirical evidence is supportive of a transmission channel from portfolio flows to credit that goes through banks' credit supply. We incorporate this finding in a

⁴Such a demand channel could be that portfolio flows increases household wealth, making households more credible borrowers and possibly also more eager borrowers. However, our results show that this channel is not dominant.

dynamic stochastic general equilibrium (DSGE) model with two countries and risk constrained financial intermediaries. We see in Chapter 3 that a model of portfolio flows should be able to explain the different response of share flows and bond flows to risk shocks. It should also explain the time variation in the impact of risk shocks on portfolio flows. We hypothesised that parts of the explanation may lie in changes in *relative* demand for assets from local agents compared to foreign agents. Thus, an important feature in the two-country DSGE model is that we model both foreign and domestic asset demand and portfolio flows arise as their relative demand changes. The asset demand functions incorporate findings from the current literature reviewed in Chapter 2. One important finding is that banks tend to target risk (Adrian and Shin, 2009). In the model we achieve this by imposing a macroprudential policy restricting the risk adjusted leverage of bank balance sheets. Profit maximizing behavior implies that banks will always operate at the binding risk constraint. This creates bank behavior similar to Adrian and Shin (2009). In the model, the transmission channel from portfolio flows to credit goes through the financial sector. Purchases of domestic assets by foreigners cause an injection of cash in the domestic financial sector. The cash injection reduces demand for savings, and thus reduces interest rates on deposits. Household savings decrease. Since the aggregate household savings can not be negative in the model, a credit expansion is reflected in declining savings. The model simulations are in line with the empirical observations.

Simulations show that risk shocks generally cause portfolio outflows from the emerging economy. If the emerging agents are exposed to the risk, the majority of portfolio flows will take place in the bond market. This is because local investors increase demand for local emerging market bonds, while global investors reduce demand for these bonds. Both local investors and global investors reduce demand for emerging market shares and therefore there is a strong price effect but an undetermined direction of the share flow. The direction of the share flow will go towards the agent that reduces demand the least.

Shocks to global risk that does not directly affect the emerging market investor will cause strong portfolio flows out of emerging market bonds. Local investors are

not directly exposed to this risk and will therefore not change their demand. Global investors are exposed to the risk and will reduce demand for all risky assets. Therefore the global investor sells emerging market shares and bonds to the local emerging market agents.

The model presented in Chapter 5 incorporates findings from the preceding three chapters. The simulations of the model match the observed empirical data and provide new insights into the transmission channel from global risk to portfolio flows and local credit extension. We simulate the model responses to risk shocks and income shocks under different policy regimes and find that global policy can have a significant impact on the transmission of risk to portfolio flows. We find that the supply of global risk free bonds can reduce the impact of risk shocks on emerging markets. In contrast, a fixed supply of bonds with variable interest rates will best absorb shocks to global income. Lastly, we find little, if any, significant effect of tighter macroprudential policy on the transmission of portfolio flows to credit extension.

Chapter 2

Literature Review

Decades of academic research has come to the conclusion that global monetary policy, financial risk and risk aversion affect international capital flows by affecting global demand for emerging market assets. In the 1990's we saw empirical evidence that monetary policy has a direct impact on portfolio flows to emerging markets by affecting the yield spread between emerging market assets and US assets (Calvo, Leiderman, and Reinhart, 1996). More recent research argues that monetary policy also affects cross-border capital flows through a “risk-taking channel” (Bruno and Shin, 2013). This channel implies that monetary policy affects risk itself. And when global assets are less risky, risk targeting financial intermediaries will demand more risky emerging market assets. Once the capital flows arrive in the emerging economy, they are thought to cause an expansion of credit (Rey, 2013). The outcome is that credit and monetary policy in emerging markets is to a large extent driven by monetary policy and financial conditions in major global economies, particularly the USA, the Eurozone and the UK (Rey, 2013; Taylor, 2013).

The current relevance of global capital flows has been highlighted by several high-profile conferences and publications on this topic in recent years. For example, the International Monetary Fund (*henceforth* IMF) published in November 2012 their revised institutional view on capital flows, in which they take a more positive stance towards capital control measures under certain circumstances (IMF, 2012). In September 2012, the Brookings Institution held a gathering of its Committee on Inter-

national Economic Policy and Reform, consisting of eighteen distinguished academics and business representatives, with the title *Banks and cross-border capital flows: Policy challenges and regulatory responses* (Brookings Institution, 2012). The Centre for Economic Policy Research (CEPR) recently published a comprehensive report on the issue of cross border banking in Europe (Allen, Beck, Carletti, Lane, Schoenmaker, and Wagner, 2011). Other institutions currently publishing frequently on the topic include the Bank for International Settlements and the US Federal Reserve.

This survey will focus on the parts of the literature addressing the determinants of portfolio flows and the effects portfolio flows may have on the recipient economy.

2.1 Understanding portfolio flows

Portfolio inflows are here defined as non-resident purchases of domestic shares and bonds. The transaction will be reflected in an increase in the foreign liabilities of the recipient economy, and an equivalent increase in the foreign assets of the originating economy. Importantly, portfolio flows only explain part of the change in foreign asset and liability positions. We may see large changes in assets or liabilities as the price of the asset changes. Lane and Milesi-Ferretti (2007b) provide a seminal overview of the evolution of international balance sheets and their relation to capital flows. They show that a large part of the evolution in the external position of many countries is explained by valuation effects. For example, the United States has seen a great increase in its aggregate foreign assets due to the high capital gains earned on these investment. This increase comes despite a widening current account deficit over the same period (Lane and Milesi-Ferretti, 2007b). The link between stocks and flows may even be negative, that is, rising foreign assets may be associated with portfolio inflows. Hau and Rey (2006) use a general equilibrium model as well as empirical data to demonstrate that high equity returns in a country is likely to cause capital outflows from this country as foreign investors rebalance their international portfolio. The high equity returns will cause the foreigner's investment in the country to increase as a share of her total portfolio. The portfolio outflow occurs as the foreign investor

sells assets in order to return the position to its benchmark weight.¹ Since changes in the stock of assets may be significantly different from the portfolio flows, studies tend to focus on one of the two. In the following we review the literature of flows, leaving out several important papers on external positions, such as Lane and Milesi-Ferretti (2007a); Lane and Shambaugh (2010); Gourinchas and Rey (2007); Herrero and Peria (2007).

The text book argument in favor of free capital flows suggests that international financial markets are used to hedge risk to future consumption. Through *intertemporal* trade a country trades current consumption for future consumption by purchasing foreign financial assets, reflected in a current account surplus (see for example Obstfeld and Rogoff (2005)). And through *intratemporal* trade a country trades its own risky assets for foreign risky assets. Intertemporal trade is used to smooth consumption across time by *trading goods for assets*, and intratemporal trade is used to smooth consumption across stochastic states of nature by *trading assets for other assets* with different risk profiles. This should raise welfare of risk averse agents and indeed be a Pareto improvement if markets are complete (Obstfeld and Rogoff, 2005).

The CEPR's report on cross border banking in Europe found evidence of benefits from intratemporal trade that reduces volatility of credit supply across stochastic states of nature Allen et al. (2011). They conclude that cross-border banking do have significant benefits and that these benefits are two-fold: banks benefit from diversification which reduces their exposure to idiosyncratic country risks. At the same time, the supply of credit to consumers will be more stable, as banks are less likely to be forced to cut lending due to country specific shocks. The presence of foreign banks will also reduce the risk to firms relying on credit as they are even less exposed to local shocks. A nation that on aggregate is a net saver may also benefit from cross-border banking. There is ample evidence of home-country bias amongst investors (see for example French and Poterba (1991)). Cross border banking may therefore reap some of the gains that are foregone by investors bias towards domestic

¹ It may be noted that the only paper to have tested for rebalancing flows in South Africa found higher equity returns on the Johannesburg Stock Exchange to cause further equity inflows to the country (French, 2011). This is in contrast to the prediction of Hau and Rey (2006).

securities (Allen et al., 2011).

The gross capital flows (trade in assets for assets) will not show up on the current account. This point has recently been drawn into the spotlight, most notably by Borio and Disyatat (2011) who argue heavily against the narrow focus on current account imbalances. Borio and Disyatat suggests that the financial crisis is too often explained as the consequence of current account imbalances and the net capital flows this entails. Examples of such reasoning include Eichengreen (2009) and Bernanke (2009). The central hypothesis of this “excess savings” story is that consistent savings above investments in emerging markets caused a flow of capital from these economies into advanced economies with current account deficits. This flow of excess savings pushed down interest rates and incentivized increased credit and risk taking.

This “excess savings” story focuses on the intertemporal trade of goods for services. The US trades assets (future consumption) for current consumption, while emerging markets save by trading goods for assets that can purchase future consumption. By purchasing these assets, China and other savers push up their prices and push down their yields. This reduces the cost of borrowing in the US. However, according to Borio and Disyatat (2011), this focus on excess savings "diverts attention away from the global financing patterns that are at the core of financial fragility" (Borio and Disyatat, 2011). In other words, they suggest that focus should be shifted towards *intratemporal* trades of assets for assets.

The current account balance equals to the *net* flow of capital into the country. This net flow equals to the change in residents’ foreign assets (gross outflows) minus the change in residents’ liabilities to non-residents (gross inflows). Generally, the net numbers may be largely disconnected from the volume of gross flows. Global gross capital flows have increased from approximately 10% of world GDP in 1998 to over 30% in 2007 (Borio and Disyatat, 2011). The volume and composition of these gross flows have not been closely related to the current account deficit (the net flow) of the respective countries. Contrary to the “excess savings” story, the majority of gross inflows into the US prior to the financial crisis did not come from emerging markets, but from Europe. And most of these flows went onto US banks’ balance

sheets as foreign liabilities (Borio and Disyatat, 2011). The gross inflows are offset by similar gross outflows onto European private bank balance sheets. The large increase in cross-border bank lending did consequently not show up on the current account. Neither does the current account reflect the massive collapse in such cross border bank lending at the height of the crisis (Borio and Disyatat, 2011).² Forbes (2012) emphasizes the volatility of gross flows and find that both inflows and outflows have been “extremely volatile” in most countries around the world, and that this volatility has sharply increased since the mid-2000s. Again, this volatility is often not visible in net flows, as “gross capital inflows and outflows tend to move simultaneously in opposite directions and be roughly the same magnitude” (Forbes, 2012). Forbes and Warnock (2012) find evidence that while net flows show no significant reaction to global risk, there is a highly significant response in gross capital flows.³

In the words of Obstfeld (2012b) :“While the general scale and persistence of current account imbalances certainly has increased over the past two decades, even more strikingly - and potentially more threatening to financial and economic stability - is the rapid expansion of *gross* international asset and liability positions [...] [I]t is the gross positions that better reflect the impact on national balance sheets of various economic shocks, including counterparty failure" (emphasis in original).

Obstfeld (2012b) uses an example described by Acharya and Schnabl (2010) of how bank-sponsored conduits raising capital through asset-backed commercial paper (ABCP) generated huge gross positions prior to the financial crisis of 2007-09. A german bank may issue its ABCP in American money markets and invest the proceeds in other higher yield US assets. In this transaction, the amount raised in the US money market will add to both Germany’s and the US’ gross foreign positions, but no net transfer has taken place. Hence, huge and potentially destabilizing gross flows will be overlooked by the net positions (Obstfeld, 2012b). These flows may very well be completely independent of the so-called savings glut in emerging markets, their

²Other research argues along the same lines. For example, Lane and McQuade (2013) find that “the current account balance is a misleading indicator in understanding the inter-relation between international capital flows and domestic credit growth”(Lane and McQuade, 2013).

³Another important finding of their paper is that gross flow volatility is not sensitive to capital controls (Forbes, 2012).

corresponding current account surplus and the US' current account deficit.

The fact that the current account does not tell the full story, does not, however, mean that it has become irrelevant. Obstfeld (2012a) refers to evidence that links current account imbalances to credit booms and financial crises (for example Ostry, Ghosh, Habermeier, Laeven, Chamon, Qureshi, and Kokenyne (2011) and Jorda, Schularick, and Taylor (2011)). He further argues that the net balance has implications, such as the ability of a country to service its net external debts (Obstfeld, 2012a). In order to better understand the role played by net and gross capital flows, we must understand what drives the flows and how they affect the recipient economy. The following sections will survey the literature addressing these two questions.

2.2 Drivers of portfolio flows

2.2.1 Capital flows are driven by risk and monetary policy

In theory, agents should hold portfolios that reduce the uncertainty of their future consumption. The optimal global portfolio is the one that gives the highest expected future consumption with the least uncertainty attached to its outcome. This optimal portfolio may need frequent rebalancing due to continuously changing expectations of risk and return. The revised expectations will establish a new demand for domestic and foreign assets. Consequently, portfolio flows arise as assets are reallocated between domestic and foreign investors until markets reach their new equilibrium. Most of the literature is focused on portfolio flows that arise in response to changes in global demand for emerging market assets. That is, a rising global demand for emerging market assets will cause a portfolio flow to emerging markets. But as we will see in later chapters, the local demand for emerging market assets can be equally important. For example, a portfolio flow to emerging markets can occur despite an unchanged global demand for emerging market assets. This could happen if the local investors reduce demand for emerging markets assets and are therefore willing to sell the assets to global investors at a reduced price.

The demand function for financial assets can generally be expressed as the present value of the expected future payoff. That is, the price we are willing to pay equals the expected fundamental value of the asset. This demand can change due to revised expectations of the payoff or due to changes in the discount factor. Both the expected payoff and the discount factor may have complicated interdependencies with the macroeconomic environment surrounding the issuer of the asset and the agents purchasing the asset. In the literature, the term “push factors” tend to refer to global factors affecting demand for emerging market assets, and “pull factors” refer to domestic conditions in the recipient economy.⁴ While the literature does not explicitly make the distinction, the push factors will be related to the discount factor of the global investor, while the pull factor is related to the expected payoff on the asset. This distinction may be useful to keep in mind when we later review theoretical models where portfolio flows are the product of changes in these demand functions.

Taylor and Sarno (1997) find empirical evidence that bond flows to Latin America and Asia between 1988 and 1992 were predominantly caused by global factors, whilst both global and local factors were equally important in determining long-term equity flows. Similar findings were made by Calvo et al. (1996) who showed that external factors were important determinants of capital flows to Latin America in the 1990s. Both papers find US interest rates to be one of the most dominant determinants. In other words, lower US interest rates will reduce the discount rate applied to all assets, including assets issued in emerging economies. (See Calvo (2013) for a more recent discussion of this and other related papers).^{5 6}

Empirical research from the 1990s indicates differing views on whether portfolio

⁴To our knowledge, the terms “push” and “pull” factors were first introduced by Calvo et al. (1996)

⁵Chuhan, Claessens, and Mamingi (1998) conduct a panel study of both bond and equity flows to Latin America and Asia for the same period as Taylor and Sarno (1997), 1988-1992. Their findings indicate that local factors are “at least as important” determinants of capital inflows. In addition they find equity flows to be more sensitive to global factors than bond flows, a finding that goes directly against the evidence found by both Taylor and Sarno (1997) and Calvo et al. (1996).

⁶Chai-Anant and Ho (2008) make the interesting finding that equity inflows in Asia tend to be driven by common regional (Asian) factors, whilst equity outflows tend to be driven by idiosyncratic local factors. Their results also support the argument of Hau and Rey (2006) that positive asset returns cause a capital outflow from the respective economy as foreign investors rebalance their portfolio.

flows to emerging markets are driven by local or external factors. More recent research, however, is largely in agreement that different external forces are the most important determinants of global portfolio flows (Rey, 2013; Bruno and Shin, 2013; McCauley, 2012). Of particular importance is monetary policy (interest rates) and risk. For example, Taylor (2013) argue that monetary policy in the US tends to force other economies to follow suit with similar policy to avoid the large capital flows caused by the initial change in the US. The link between monetary policy and risk can be very tight, and it is not always straight forward to distinguish the effects of one from the other. For example, Rey (2013) demonstrates forcefully that monetary policy drives capital flows by affecting leverage of global banks and risk / risk aversion. This story is supported by Bekaert, Hoerova, and Duca (2010) who decomposes the VIX ⁷ into a risk aversion and uncertainty component. They find that both risk and risk aversion are reduced with monetary stimulus. It may not be immediately obvious how asset risk should affect capital flows. Risk aversion, on the other hand, affects investors' willingness to purchase risky emerging market assets and thereby affects portfolio flows directly.

McCauley (2012) argues that the risk-on / risk-off capital flows can themselves be reinforced by a different type monetary policy behaviour. His focus is on emerging market economies because these tend to be the destination for risk-on flows.⁸ Since emerging economies tend to grow faster than global economies during expansion, and shrink at a faster rate during recessions, they attract foreign investor when risk appetite is high (McCauley, 2012). Such inflows will have strong effects on the emerging market currencies, and their central banks will often attempt to dampen this by purchasing foreign assets, typically foreign government bonds. This has two consequences. Firstly, by increasing demand for advanced economies' government bonds, they push down the yield on these and indirectly reduce the risk premium in global markets (McCauley, 2012). This may induce more flows to the emerging

⁷Implied volatility in put and call options on the S&P 500 (Carr and Wu, 2004)

⁸Risk-on refers to a state in which investors have high risk appetite, or as in Adrian and Shin's models where risk is low and demand for risky assets therefore is high. Risk-off refers to the opposite state.

economies, as shown in the Adrian and Shin models above. Secondly, the local central banks tend to fund (sterilise) their purchases of foreign assets by issuing their own local currency bonds, and by doing so providing new safe assets to the local market (McCauley, 2012). This action provides both local and foreign investors a safe asset in the local currency, thereby making the capital inflow more attractive.⁹

The role of monetary policy as a re-enforcing factor in these capital flow dynamics may potentially explain the increased volatility of such flows. Forbes (2012) and Forbes and Warnock (2012) find that gross capital flow volatility has increased sharply since the mid-2000s. Forbes and Warnock (2012) conclude that sudden surges and sudden stops in gross capital flows are driven by global risk, while they find global liquidity and interest rates to be less significant. Adrian and Shin (2010) and Bruno and Shin (2012) find a link between monetary policy rates in the US and global risk premia (measured by the VIX, the same risk measure used by Forbes and Warnock (2012)). They further predict that lower risk leads to increased appetite for risky assets including emerging markets, thus increased gross inflows to these economies. One may therefore speculate that the findings of Forbes and Warnock (2012) capture the direct effect of risk on capital flows, but not the effect of monetary policy on risk itself (risk is treated as an exogenous variable, which conflicts with Adrian and Shin (2010)).

Takats (2010) find that “supply factors” were the main drivers of the fall in cross-border bank lending to emerging market economies during the financial crisis.¹⁰ This contrasts to a much more balanced impact of both supply and demand factors prior

⁹In a paper not discussed here, Plantin and Shin (2011) demonstrate another channel through which monetary policy may exaggerate cross-border capital flows. They assume that the monetary policy rule responds to inflows by raising interest rates. This would be a response to the assumed expansionary effects of capital inflows. In such a scenario, the policy rule may work against its purpose by attracting further expansionary flows in anticipation of continued appreciation due to expected future carry trade activity (Plantin and Shin, 2011). This creates an unstable environment by pushing the exchange rate further from its fundamental value until a stochastic shock may suddenly trigger a sharp depreciation that brings the exchange rate back to its fundamentals (Plantin and Shin, 2011).

¹⁰These findings are the results of a panel regression analysis on 21 emerging market economies between 1995 and 2009; Argentina, Brazil, Chile, China, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Thailand and Turkey (Takats, 2010).

to the crisis (Takats, 2010). The supply factor is in their paper proxied by measured volatility on the S&P 500, which will be highly correlated to the volatility risk premium. The demand factor is measured by GDP growth in the emerging market economies. Together, these two factors explain approximately two thirds of cross-border lending to emerging markets prior to the global financial crisis. Interestingly, during the crisis the supply factor explains almost 100% of the change in cross border bank lending (Takats, 2010). One should perhaps add to their discussion that the unusually high explanatory power of supply factors during the crisis can possibly be attributed to the fact that this was a *drop* in cross-border lending. This point is important because a bank may easily choose to cut its lending independently of demand for such loans. They can however not choose to increase lending without a sufficient increase in (or unfulfilled) demand. This relates back to the point made by Brown and De Haas (2012) that foreign currency lending will depend on the nature of the clients, particularly the foreign currency exposure of the client's income and expenditure.

Another substantial finding of Takats (2010) is that countries with a larger share of foreign ownership in the banking sector received more bank lending during the crisis, thus softening its impact on the exchange rate and credit supply. This finding supports the argument of Allen et al. (2011) that foreign banks are less likely to cut lending and withdraw funds during a crisis “[...] if they have established their presence in the form of a subsidiary (due to the presence of significant fixed costs)” (Allen et al., 2011). Similarly, Schnabl (2011) finds evidence that banks in Peru with foreign ownership received more foreign funding than locally owned banks during the crisis that followed Russia's default in 1998. McCauley, McGuire, and Von Peter (2010) show that in emerging markets (as opposed to other economies), foreign banks' lending in the local currency (funded by local deposits) through local branches was more stable than their cross-border lending, and particularly so in Latin America and Asia. These results are again confirmed by Herrero and Peria (2007) who also find evidence that regulatory barriers and lack of scale opportunities are associated with less local branch claims of foreign banks (that is, a larger fraction of liabilities to

foreigners are through cross-border loans).

We see that recent research tends to explain portfolio flows by global factors such as risk and monetary policy, while earlier research lacked a similar consensus. One possible explanation of the varying results could be that the importance of drivers change over time. Fratzscher (2011), for example, estimates a constant parameter model, but includes dummy variables to control for changes in the relationships during and after the global financial crisis of 2008. He finds that global risk and macro factors (“push factors”) became the dominant driver of cross-border capital flows during the financial crisis. During the recovery after the crises he finds that domestic “pull factors” have come to dominate in many emerging economies in Asia and Latin America. The finding that push factors become dominant during times of financial stress can potentially explain the strong empirical finding that global asset markets become highly correlated when global volatility is high (Forbes and Rigobon, 2002). Related results are found by Duca (2012) who estimates the time variation of the determinants of daily portfolio flows between 2007 and 2012. The results indicate that local factors are more important when market tension increases, but they lose importance when volatility turns into panic and changes in risk becomes the dominating factor.

There is unfortunately a lack of research using modern time varying parameter models over a longer sample period. Furthermore, any literature at all on portfolio flows to African economies is scarce. In Chapter 3 we address this gap in the current literature by extending the research to the African continent and importantly by estimating a time varying parameter model (TVP-VAR) with stochastic volatility on a sample of monthly data from 1988 to 2013. This allows us to estimate gradual changes that cannot be captured by a dummy variable as well as the sudden structural breaks that may come with financial crises. Such empirical results should give important insights that may support or reject models discussed above.

2.2.2 Theoretical models of monetary policy, risk and capital flows

The empirical literature suggests portfolio flows in recent times have been driven by risk and monetary policy. The two factors are not independent of each other. Borio and Zhu (2008) argue that the traditional view of the monetary policy transmission mechanism has ignored the price of risk and capital regulation. The “risk-taking channel” refers to the effect of interest rates on the perception of risk and risk tolerance. For example, lower interest rates will raise asset prices as well as income and profits. The higher profits may induce higher risk tolerance and / or reduce the perception of market risk (Borio and Zhu, 2008). A more rigorous investigation of this relationship was conducted by Bekaert et al. (2010) who finds strong evidence that expansionary US monetary policy reduces both risk and risk aversion. Borio and Zhu (2008) emphasise the lack of theoretical models that incorporate this potentially important transmission mechanism.¹¹ Since then, a series of papers by Hyun Song Shin and co-authors have made a significant contribution in modelling the risk-taking channel of monetary policy. In addition they demonstrate how this risk taking channel links monetary policy to gross cross-border capital flows¹².

Financial intermediaries target risk

Banks have traditionally been dominant in supplying credit, but in the US they are now supplemented by market based institutions (financial intermediaries that raise funds in the money market to invest in longer term debt securities). In the 1980’s, banks were dominant holders of mortgages, but in 1990 they were surpassed by market based institutions that have since grown faster in absolute terms (largely thanks to

¹¹Support for the economic importance of the risk premium can for example be drawn from the findings that a sustained phase of declining risk premia is typically followed by a financial crisis (Brunnermeier and Oehmke, 2012). Accordingly, H.S. Shin has recently proposed a Tibou type tax on non-core liabilities on bank balance sheets as a means to reduce risk of such crisis. The rationale for such a tax is based on the research reviewed in this paper which demonstrates how an expansion of such non-deposit liabilities is the cause (and effect) of lower risk premia (Adrian and Shin, 2009).

¹²See for example Adrian and Shin (2010), Adrian, Moench, and Shin (2010), Danielsson, Shin, and Zigrand (2011), Bruno and Shin (2013) and Bruno and Shin (2012).

government sponsored enterprises such as Fannie Mae and Freddy Mac) (Adrian and Shin, 2009). Adrian and Shin (2009) develop a model that demonstrates how these market based institutions may provide a transmission mechanism for monetary policy through the risk taking channel suggested by Borio and Zhu (2008). This behavior is shown to cause pro-cyclical leverage that will spill over to foreign countries through the banking system (Bruno and Shin, 2013).¹³

Commercial banks fund the majority of their loans through deposits, but because deposits are relatively stable, the bank must borrow in capital markets to fund loans at the margin when credit is growing. This borrowing is typically small compared to the value of deposits on the commercial bank's balance sheet. Market based institutions, such as broker-dealers and issuers of asset backed securities (ABS), will on the other hand fund all their lending by borrowing in capital markets. In the US, these so-called "shadow banks" have a growing role as providers of credit by purchasing securitized debt.

Adrian and Shin (2009) show graphically that the market based institutions tend to increase leverage when total assets increase.¹⁴ In a subsequent paper, they point out that this must be caused by active leverage management, as an increase in asset prices would otherwise reduce leverage (Adrian and Shin, 2010). For example, as the price of a home increases the home owner will be less leveraged because her assets (the house value) increases while the debt stays constant. The positive correlation between assets and leverage of market based banks suggests that an increase in the valuation of assets induces the bank to expand its balance sheet even further by taking up debt to purchase more assets. They do this to such an extent that leverage becomes pro cyclical. Adrian and Shin (2009) explains this behaviour as a consequence of bank's aiming to keep their *Value at Risk* (henceforth VaR) at a constant level. *VaR* is defined for a given confidence interval (c) and time period such that during this period the probability of a random variable (A), e.g. total assets, falling below a certain level ($A_0 - VaR$) is less than $1 - c$:

¹³A very different model, but with the same implication of procyclical leverage and therefore wide fluctuations in the leverage cycle were presented by Geanakoplos (2009).

¹⁴Leverage is defined as total assets over equity

$$\text{Prob}(A < A_0 - VaR) \leq 1 - c \quad (2.1)$$

If A represents assets marked-to-market, then VaR may be viewed as the minimum equity capital necessary to keep the probability of staying solvent at c . A more volatile portfolio of assets will increase the VaR , and thus increase the amount of equity required to keep the insolvency risk constant. Since the bank's equity capital does not always perfectly match its Value at Risk, Adrian and Shin (2010) introduce a time varying coefficient, λ , that indicates the proportion of equity to VaR . We denote as Adrian and Shin (2010) equity capital by K , total assets by A , Value at Risk by VaR and leverage by L . The Adrian and Shin model is derived:

$$K = \lambda * VaR \quad (2.2)$$

$$L = \frac{A}{K} \quad (2.3)$$

$$L = \frac{A}{\lambda * VaR} \quad (2.4)$$

$$L = \frac{1}{\lambda} * \frac{1}{V} \quad (2.5)$$

$$V \equiv \frac{VaR}{A} \quad (2.6)$$

where V is the *Unit Value at Risk*: VaR per dollar of assets. Equations 2.4 to 2.6 show that an increased valuation of assets will reduce the *Unit Value at Risk* and must be compensated for by greater leverage if VaR is to remain constant (Adrian and Shin, 2010). Thus, this simple model explains the strong positive correlation between assets and leverage observed for American market based institutions that target VaR .

Commercial banks on the other hand, are found to have a weak (if any) correlation between asset growth and leverage growth. This can be explained by the fact that the deposit base of commercial banks is rather sticky and thus their liabilities cannot be adjusted as quickly. Therefore, changes in asset valuation will often lead to changes

in equity that reduces leverage.¹⁵ The liabilities of an investment bank, on the other hand, can be expanded or reduced at the will of the bank, typically through repurchase or reverse-repurchase agreements (*henceforth* repo transactions).

If the investment bank funds asset purchases by repo borrowing, the size of the haircut (capital ratio) will greatly affect their ability to take on leverage. If the haircut is 2% the bank's maximum leverage is 50.¹⁶ An increase in the haircut by 1 percentage point will reduce the maximum leverage to 33. To comply to the new haircut the bank must drastically reduce its leverage, either by raising equity or selling assets. But selling assets will not only reduce the size of their balance sheet, it will also put downwards price pressure on the respective asset being sold. These effects strengthen the pro-cyclical tendencies of asset and leverage growth, as rapid de-levering will push down asset prices and *vice versa*. Many of these now unpopular assets may be securitised debt, and thus, "when haircuts rise, all balance sheets shrink in unison, resulting in a generalized decline in willingness to lend" (Adrian and Shin, 2009). This is similar to the argument clearly laid out by Brunnermeier and Oehmke (2012) and Brunnermeier (2009) as one of the accelerators of the drop in asset valuations during the recent global financial crisis.

This notion is supported by data from the US. Adrian and Shin (2009) find that lagged dealer asset growth (increase in leverage) explains current housing investment, while commercial bank asset growth shows no such predictive power (due to the relative large size of deposit funding compared to market funding). A related important finding of Adrian and Shin (2010) is that changes in investment banks' balance sheets predict changes in the volatility risk premium. Based on the model above, the rationale for such predictive power can be laid out as follows. Increased leverage leads to an expansion of balance sheets (and thus liquidity) which implies higher demand for

¹⁵Because deposits are sticky, a credit expansion by commercial banks is typically characterized by increased non-core (non deposit) liabilities. In other words, when banks need to expand its balance sheet quickly, they may turn to wholesale markets to fund this expansion. Hahn, Shin, and Shin (2011) show that a large increase in non-core liabilities do indicate a lending boom and increased vulnerability to financial crises.

¹⁶Leverage is here defined as assets divided by equity. In the case of a repurchase agreement, the leverage is the dollar amount borrowed divided by the haircut dollar amount (or just the inverse of the haircut rate, e.g.: $0.02^{-1} = 50$).

assets and positive price pressure. Higher asset prices and greater liquidity leads to increased risk appetite, as the *Unit Value at Risk* (from equation 2.6) drops. Investment banks are now willing to pay more for risky assets, reducing the risk premium. There is some self enforcing feedback here, as higher asset prices will by themselves increase the balance sheet and reduce leverage which again induces more borrowing and asset purchases to keep *VaR* constant. This has important implications for monetary policy as the policy rate can influence the profitability and thus the balance sheet of these investment banks.

The transmission mechanism of monetary policy works not only through risk and asset prices in their model. Adrian and Shin (2010) argue and show empirically that the slope of the yield curve directly affects the profitability of market based lenders and consequently real credit supply. The reason is that these institutions fund purchases of long term debt securities by rolling over short term debt through repo agreements. The institution profits from the term spread¹⁷ gained through this maturity mismatch. The steeper the yield curve is, the more profitable this business model is. Based on the simple model derived above, the higher profitability will increase the expected equity capital of the institution (Adrian and Shin, 2010), which again induces it to increase leverage in order to keep *VaR* constant. In accordance to the argument above, this will lead to increased risk appetite. This has real effects; the potential borrower who was previously marginally too risky to receive a loan may now be profitable as the spread between her borrowing rate and the bank's wholesale funding rate is greater. The price of debt securities backed by these loans will therefore increase as the risk premium declines.

This has the important implication that the short term rates are directly instrumental in the transmission mechanism by affecting the profitability and risk taking ability of market based banks. This is an important addition to the conventional view of the transmission mechanism. Taylor (1995) discusses the relative importance of short term versus long term interest rates in the transmission mechanism:

¹⁷The term spread refers to the difference in yield on long term government bonds compared to money market rates

"It is difficult to determine on theoretical grounds whether the short-term interest rate or the long-term interest rate has a greater effect on consumption and investment; changes in the form of debt instrument - for example, the introduction of variable rate mortgages - are likely to change the relative importance of long versus short rates. However, there is surely some a priori reason to believe that for long-term decisions like buying a house or investing in plant and equipment, the long-term interest rate should be the variable of greater interest. To the extent that it is the long-term interest rate that is important for consumption and investment demand, the monetary transmission mechanism depends on how monetary policy affects the long-term interest rate" (Taylor, 1995).

Compared to this view, what is special about the transmission mechanism demonstrated by Adrian and Shin (2009) is that the less responsive long term rates are to changes in short term rates, the more powerful is this transmission. Adrian and Shin (2009) link this finding to Bernanke (2009) who were amongst the first to thoroughly argue for the banks' role in the transmission mechanism. Bernanke and Blinder (1992) found evidence that a higher federal funds rate leads to an immediate reduction in securities held by banks and that these only start returning to the previous level once the bank is able to reduce the slower moving loan portfolio. Unemployment rate only responds once actual loans are being reduced (Bernanke and Blinder, 1992). If this rise in unemployment is caused by the reduced credit supply for banks, the bank is clearly a part of the transmission mechanism. As such the Adrian and Shin model has many similarities to the Bernanke and Blinder model. The main difference is that Adrian and Shin focus on the now extensive shadow banking sector and the role of risk in their credit supply decision. Bernanke and Blinder focused on commercial banks and how liquidity constraints imposed by the required reserve forced these banks to cut loans in response to higher deposit cost when rates are high. More recent evidence by Ashcraft (2006) indicate that this transmission mechanism through commercial banks is weak.

This behavior by financial intermediaries not only bear consequences for the domestic economy, it can also be demonstrated to affect the volume of gross cross-border

capital flows. Bruno and Shin (2013) and Bruno and Shin (2012) demonstrate this in a model of US demand for emerging market equities. The findings that the financial sector targets risk and leverage are at the core motivation for the general equilibrium two-country model presented in Chapter 5 of this thesis.

2.2.3 Risk affects global demand for emerging market assets

Monetary policy affects risk and asset demand. Bruno and Shin (2013) construct a model that demonstrates the role of risk and monetary policy in determining global demand for emerging market assets. In their model, the assets in question are debt liabilities of firms in emerging economies. The model consists of three stages, starting with the wholesale funding (money) market where global banks borrow funds. In stage two, the regional branches (in other countries) draw on these funds, and in doing so create a cross-border capital flow. This flow is recorded as a liability in the regional bank and an asset with the global bank. The global bank has an equivalent liability to the lender in the wholesale money market. In stage three, the regional bank lends these funds out to local borrowers (business and households). This study is focused is on stage 2, where the capital flows cross borders.

In a separate paper, Bruno and Shin (2012) utilize this model in a study of the relationship between monetary policy in advanced economies (the USA) and capital flows across borders, particularly into emerging markets. It is a popular notion that low interest rates in the US and EU drives capital into EMs¹⁸, but the exact economic reasoning behind this idea has been weak. Bruno and Shin argue and demonstrate formally how financial intermediary behaviour may affect these capital flows. The focus is on the banks' balance sheet management. They posit that banks keep *VaR* constant at its limit to maximize profits. This means that they must increase leverage as soon as markets are less volatile (risky), as argued by Adrian and Shin.

In their model, emerging market financial intermediaries behave like the US intermediary, that is they target a certain level of *Value at Risk*. But instead of funding

¹⁸See for example The South African Reserve Bank's governor Gill Marcus' letter to the Financial Times (Marcus, 2012), discussing this issue.

their credit expansion by issuing local money market liabilities, they instead borrow from market based banks in the US. The local emerging market intermediaries lend to local households and firms in dollars. The loan will fund a project with local currency income. If the value of the project is less than the face value of the debt at maturity, the borrower will default. The dollar value of the debt is normally distributed and will increase with local currency appreciation. That is, a stronger domestic currency relative to the dollar will increase the dollar value of the project and therefore make default less likely.

They solve for total cross-border credit extension in equilibrium and find that higher interest rate spread, leverage and bank capital will increase lending.

$$\text{Total Cross-Border Lending} = \frac{\text{Bank Capital}}{1 - \text{Spread} \times \text{Regional Leverage} \times \text{Global Leverage}} \quad (2.7)$$

Bruno and Shin classify the effect of capital and leverage in global banks as “push factors” on cross border lending, while the capital and leverage of regional banks as “pull factors”. The results suggests that the credit cycle (and leverage cycle) in emerging markets can be tightly linked to the credit cycle in the US.

From equation 2.7, we see that a lower funding rate in the US will increase local credit supply in emerging economies by widening the interest rate spread. This increase in credit is fully funded by raising new debt liabilities in the US wholesale money market. By assumption, the flow of credit to the emerging market will lead to appreciation of the exchange rate due to the higher demand for the currency. This appreciation will make the local project (borrower) more valuable in dollar terms, assuming that the borrowers income is in local currency. The more valuable project reduces the probability of default (Bruno and Shin, 2012, 2013). The reduced risk of default will lead to more lending to households by the local intermediary because the local intermediary needs to increase leverage to push VaR back to the target. The lending is funded by more cross-border funding from the US bank. This leads to further appreciation, even lower probability of default, and so on.

To test their model, Bruno and Shin (2012) examine the effect of dollar funding

cost on cross border flows by estimating a four variable structural Vector Autoregressive model on the VIX, forward term premium between 10 year and 3 month US Treasury yields, the Fed Funds target rate, and aggregate cross border banking sector flows. The impulse responses indicate that tighter monetary policy causes a higher VIX after two quarters and a decrease in cross-border bank flows after six quarters. A shock to the VIX leads to expansionary monetary policy which causes a greater term spread. Importantly, a shock to the term spread leads to a significant increase in cross-border loans. And as important, a shock to cross-border loans lead to a reduced VIX. Both results are in line with the model's predictions.

Bruno and Shin (2013) estimate the effect of the respective “push” and “pull” factors on cross border lending. In particular they focus on regional bank capital (equity) which indicates the bank's capacity to borrow (pull factor) and global banks' leverage which increases loan supply (push factor). According to the model, cross border flows should increase with global leverage and change in global leverage as well change in regional equity. Since leverage is inversely related to the VIX, we should have a negative effect of VIX on cross border lending.

They first estimate the determinants of growth in inter-office assets of foreign banks in the US. As expected they find a negative significant effect of the VIX.¹⁹ The interest rate spread has no significant effect on interoffice assets, and they blame this on central banks' policy rules. Next, they estimate the determinants of cross-border capital flows: Interoffice assets are significant with a positive sign. The VIX is again highly significant with a negative coefficient, in line with the predictions of the model. Banks' return on equity is included as a measure of growth in the banking sector and has a positive significant sign. Their model indicates that growth in the banking sector multiplied by bank leverage (proxied by the VIX) should also explain capital flows. They do indeed find a positive significant coefficient for this interaction term between ROE and the VIX.

¹⁹The negative sign on the VIX suggests that cross-border banking declines during financial turmoil. This finding is not uncontested in the literature. For example, Kleimeier, Sander, and Heuchemer (2013) find evidence that financial crises lead to “sustained increases” in cross-border deposits and loans. This is explained by consumers in the crisis-struck economy shifting from local banks to less risky foreign banks (Kleimeier et al., 2013).

Lastly, they estimate a model explaining credit growth in the respective countries. Again they find a positive and significant effect of interoffice assets, and a negative and significant effect of the VIX. Bruno and Shin (2013) then argue that the VIX indicates the degree of global liquidity (due to its inverse relation to global leverage), which means that its significant coefficient supports the notion that global liquidity does have an impact on local credit supply. They conclude that “the evidence in our paper suggests that the driving force behind banking sector capital flows is the leverage cycle of the global banks. Furthermore, credit growth in the recipient economy is explained, in part, by the fluctuations in global liquidity that follow the leverage cycle of global banks”.

It is important to bear in mind that the Bruno and Shin model assumes a certain demand for foreign currency loans from local clients. Brown and De Haas (2012) point out that banks’ propensity to extend local loans in foreign currency will reflect the local demand for such loans. This implies that the characteristics of the client base will affect the bank’s share of foreign currency denominated assets and liabilities. Thus, their conclusion is that recent increases in foreign currency lending (in Eastern Europe) cannot be fully explained by foreign banks optimal supply of these loans. In related papers, Cowan (2006) and Brown, Ongena, and Yesin (2011) show that such client demand for foreign currency depends on factors that are included in the Bruno and Shin model derived above (interest rate spread and exchange rate volatility), but also on the extent to which the client earns its income in foreign currency. This is natural, as a foreign currency loan will hedge the exchange rate risk implicit in the foreign currency income.

The research by Adrian, Bruno and Shin provides evidence that global financial institutions target risk and that this behavior cause their cross-border lending to be pro-cyclical and self-reinforcing. They do not explicitly study whether similar behavior might affect cross border portfolio flows. Furthermore, they do not explicitly model the monetary policy in the recipient economies. However, Taylor (2013) argues that the model by Bruno and Shin (2013) illustrates how central bank *policy* may spill over across countries. The argument is quite simple: lower rates in the US (and

thus lower price of risk) will induce emerging market central banks to cut their own interest rates to avoid having domestic firms borrowing money overseas (and thereby avoiding capital inflows that strengthens their currency) (Taylor, 2013). Taylor's argument focuses on how monetary policy itself may be self re-enforcing in the US and globally. That is, expansionary US monetary policy causes other countries to implement similar expansionary policy. The US policy will then respond to the other countries by implementing a further monetary expansion. And the circle continues.

A related argument was presented by Rey (2013), suggesting that monetary policy institutions cannot conduct independent monetary policy if they choose to allow free capital flows in and out of their economy. She recommends to implement partial capital controls and cyclical macroprudential regulation that limits the overall leverage of the financial sector. By making the leverage constraint tighter in response to capital inflows, one may avoid the pro-cyclical leverage that market based financial intermediaries would cause in the Bruno and Shin model.

Cetorelli and Goldberg (2011) and Cetorelli and Goldberg (2012) show that global banks actively use internal cross-border funding to manage liquidity in the face of local monetary policy shocks. This has two consequences, one is that a liquidity shock caused by monetary policy will have less impact on the domestic economy when global banks are present. That is because these banks may use their internal funding channels (sourced in global wholesale markets) to lend locally when local liquidity is low. This concurs with the prediction of Bruno and Shin (2013) that higher domestic policy rates attract cross-border bank flows from the "global" bank. The second implication is that local policy shocks may spread to other countries where these global banks operate as liquidity is moved from these countries to the country where a contractionary policy shock originated. Such a propagation mechanism has for example been found to be present in Europe. Popov and Udell (2012) investigate the bank credit supply to small and medium sized enterprises (SMEs) in central and eastern Europe. Due to the lack of developed markets for corporate debt in these economies, SMEs rely on bank lending for external funds. A large share of these banks are foreign owned global banks. Using an extensive set of survey data, they

find that local branches or subsidiaries of global banks are less likely to extend credit to SMEs if the parent bank either has low capital ratios or recent loss of assets (Popov and Udell, 2012). The riskier the client firm is, the more affected it is by the capital shock to its bank. These findings support the notion that the internal capital market of a global bank does indeed transfer risk shocks across borders, and has real economic impacts.

2.3 Transmission channel flow and saving

2.3.1 Portfolio flows transmit to saving through financial intermediaries

Gross capital flows have been found to cause credit expansion in the recipient economies (Rodrik and Velasco, 1999; Lane and McQuade, 2013; Rey, 2013). Rey (2013) presents evidence from regressions on a large panel data set that higher global risk as measured by the VIX causes a fall in European bank leverage, reduced cross border credit extension, reduced domestic credit extension in most countries.

The fluctuations in credit caused by capital flows are of serious concern. Part of the danger caused by these credit booms is the risk of a sudden reversal of the capital flows (Calvo, 1998). However, as Calvo (1998) shows in a theoretical model, this fragility is most severe if the credit expansion was caused by short term debt investments by foreigners. If the capital flow consisted mainly of equity or long term bonds, the risk of a sudden stop is sharply reduced (Calvo, 1998). Unfortunately a sudden stop is not necessary for credit expansion to cause a financial crisis. Using data from 12 developed countries over a large sample from 1870-2008, Schularick and Taylor (2012) find strong evidence that credit expansion should be carefully watched by policy makers due to its tendency to be followed by financial crises, also when they were not caused by capital flows. Similar results have been found by Rodrik and Velasco (1999); Bordo, Eichengreen, Klingebiel, and Soledad (2001); Reinhart and Rogoff (2009); Gourinchas and Obstfeld (2012); Mendoza and Terrones (2012). This

evidence is remarkably consistent over several years of research and places a great burden on policy makers in an economy where credit growth may be driven by global factors as shown by Rey (2013). As Rey (2013) argues, if countries wish to allow free capital flows, their monetary policy will be tied to the global financial cycle.

But the question still remains of what is the optimal policy response to capital flows and the associated credit. The answer will lie in the transmission channel that links the capital flow to the demand and supply of domestic savings. In Chapter 4 we investigate this question in more depth in a case study of South African banks' balance sheets and their responses to global portfolio flows. We choose to look at portfolio flows partly because the evidence here is more mixed than in the direct credit flows. This is not surprising, a credit flow will by definition cause an immediate increase in credit (there is still a question of whether this credit is used to pay off other liabilities or goes to fund investments or consumption). The transmission channel with respect to credit flows is also more obvious, as the flow will either go directly to firms or directly to banks. In the case of portfolio flows, the transactions are mainly in the secondary market where the payment for assets will generally go to fund managers and institutional investors. The transaction does not necessarily imply an increase in credit.

The risk channel proposed by Borio and Zhu (2008); Adrian and Shin (2009) can offer one explanation of how portfolio flows affect credit. If the portfolio inflow is caused by higher foreign demand for local assets, the asset prices will increase and possibly induce the pro-cyclical leverage adjustment argued by Adrian and Shin (2009); Bruno and Shin (2013). This would explain the high correlation in global leverage and risk premia observed by Rey (2013). Another explanation may be that higher asset prices create a wealth effect or affect credit extension through the "balance sheet channel" suggested by Bernanke, Gertler, and Gilchrist (1999). Households with investments in domestic assets become more wealthy as asset prices rise, and therefore become less risky borrowers. The lower risk improves their access to credit (Bernanke and Gertler, 1995; Bernanke et al., 1999). "[...] A decline in asset values (for example, a fall in the home equity values) reduces available collateral, leads to an unplanned

increase in leverage on the part of borrowers, and impedes potential borrowers access to credit” (Bernanke and Gertler, 1999). The risk story is a supply channel, while the wealth (or balance sheet) story is partly demand driven and partly supply driven.

Lane and McQuade (2013) finds evidence from 54 emerging and advanced economies that bond flows have a significant impact on credit extension, while equity flows do not:

“We investigate whether domestic credit growth have similar covariation patterns with net international debt flow and net international equity flow [...] The difference is quite striking - net debt flows are highly significant but net equity flows are not significant. This suggests that it is not the overall current account balance that intrinsically matters in understanding the relation between international capital flow and domestic credit growth. Rather, the significant connection is between international net debt flows and credit growth. ” (Lane and McQuade,2013; p14) .

Their comment reflects our lack of understanding of the transmission mechanism. We simply accept the empirical result that debt flows matter more than equity flows without knowing the reason behind. A clue to the explanation may lie in observations made by Kaminsky, Reinhart, and Vegh (2005) and Rey (2013). Kaminsky et al. (2005) show that capital flows are not only correlated to the local business cycle of the recipient economy, most developing countries also tend to have procyclical fiscal policy *and* procyclical monetary policy that both correlate to the the capital flows. Rey (2013) observes that “[...] cross sectionally, just like in the time series, credit flows seem more strongly related to the global [credit] cycle than other flows and in particular than equity flows.” (Rey,2013; pp: 301-302). We will later introduce a hypothesis that can potentially explain Lane and McQuade’s result in light of Rey’s observation: By our hypothesis, portfolio flows have a greater impact in an already expanding credit market. Debt flows are more correlated to the credit cycle implying that the majority of debt inflows arrive in an already expanding credit market. The debt flows arrive at a time when, by our hypothesis, flows have a greater impact on

credit. Equity flows, on the other hand, arrive at all stages of the cycle and will therefore have a smaller impact on average. This non-linear relationship will not be captured by standard linear regressions as in Lane and McQuade (2013).

In Chapter 4 we use various non-linear models to investigate the validity of such partial pro-cyclicality. In chapter 5 we then introduce a structural general equilibrium model of asset demand and the business cycle in two countries linked by portfolio flows. The model incorporates a transmission channel similar to the one explained in Chapter 4, though it does not capture the non-linearity of this relationship. But first, in Chapter 3, we study the global factors that may drive portfolio flows to emerging markets in the first place.

2.3.2 Two-country models of portfolio flows

The model by Bruno and Shin is one of the few that can link cross-border capital flows to monetary policy and the risk targeting behaviour of financial intermediaries. However, there are still several elements of international capital flows that need to be explained. Bruno and Shin model US demand for foreign assets, where the asset in question is a dollar denominated debt liability of firms or households. As we show in Chapter 3, these bank flows constitute approximately a third of flows to South Africa, the subject country of our empirical research. In chapter 1 we saw that the debt and equity liabilities of most emerging markets have grown significantly over the last decades.²⁰

Portfolio flows are the product of changes in demand for financial assets from foreign agents relative to domestic agents. A model that only explains foreign demand will be able to explain parts of the flows we observe, but they ignore important dynamics. As we show in section 5.1.1, the size and direction of portfolio flows is dependent on the elasticity of both foreign and domestic asset demand with respect to the asset price. Thus, a model of portfolio flows should ideally include a demand function for both the local and foreign investor. Furthermore, if the objective of the

²⁰Portfolio flows consisting of another third of total capital flows to South Africa, the third component being the less volatile direct investments

study is to understand not only the drivers of portfolio flows, but also the economic impact of the flow, it will be advantageous to specify a fully fledged general equilibrium model of both the originating and recipient economy. Here we review some of the more recent developments in this regard. Unfortunately we have not found a two-country general equilibrium model of portfolio flows that includes a risk targeting financial intermediary.

The immediate challenge in modelling portfolio flows is to model the portfolio allocation problem in a general equilibrium setting. In a frictionless model, a first order approximation of the steady state solution implies that asset demand is fully based on expected returns. If two assets yield the same return, the investor is indifferent between the two. If one returns more than the other, the investor will invest the entire portfolio in the higher returning asset. The variance and covariance properties of the assets fall away in the first order approximation. Thus, there are two possible approaches to solve the portfolio problem. Either introduce frictions or solve the model using second order approximations.

Devereux and Sutherland (2011) and Tille and van Wincoop (2010) independently develop highly related approaches to solving the problem using second order approximations. And both approaches are then applied to models of portfolio flows. Devereux and Sutherland (2009) apply the approach to a standard two-country neoclassical model in which one economy is viewed as ‘developed’ and the other as ‘developing’. The model includes households who supply labour to the domestic firm and save or consume the income. Savings can be invested in ‘developing’ country shares or ‘developed’ country shares or bonds. There is no friction in the financial market (other than the assumption that there is no ‘developing’ country bond available). To ensure a steady state solution, the discount factor of the household is endogenous, following the approach of Schmitt-Grohe and Uribe (2003). This makes the discount factor dependent on expected future consumption, implying it depends on the number of assets held. This creates a downward sloping asset demand function in steady state where consumption is constant.

Other than the households there is a firm in each economy, which is owned by

shareholders who earn dividend and capital gains. Money in the economy follows the quantity theory of money where the velocity of money is fixed and inflation is equal to the rate of money growth. In the stochastic steady state, the home country holds 234% of foreign capital stock while the foreign country holds 350% of the home capital stock. This means that households in both countries have large short positions in the domestic firm. These significant short positions are optimal due to the high correlation between labour income and share returns on the home firm. The firm in the other economy therefore provides a great diversification benefit. Since there are no financial frictions there is perfect risk sharing between the two countries. Consequently, a positive shock to home productivity causes a loss on the home portfolio due to the large short position in home firms. The foreign liability of the home firm increases with the share price. In the process there is a portfolio outflow in which the home household purchases home equities from the foreigner. The purchases are funded by selling foreign shares. In total, the productivity shock causes a net portfolio outflow. There is little impact on consumption due to the risk sharing. The income lost on the portfolio is gained in the improved labour productivity which gives higher wages.

Tille and van Wincoop (2010) presents a model similar to Devereux and Sutherland (2009). The only assets are equities in each of the two countries. Equities are claims on a fraction of output. A relevant difference from Devereux and Sutherland (2009) is the households that only work in one period and invest for consumption in future periods. This eliminates the need to diversify the portfolio away from assets with correlations to labour income. They also add a friction to financial markets in the form of a cost on investing abroad. The solution yields optimal portfolio consisting of domestic and foreign shares. The weights depend on expected returns and variance of returns and goods prices. Returns depend on saving, changes in relative asset prices and the variance of returns and goods prices (Tille and van Wincoop, 2010). Capital flows are then the result of portfolio growth due to savings greater than investment, rebalancing due revised expected returns or risk. The simulations of the model show that a positive shock to home productivity causes the residents to purchase more foreign assets and the foreigners sell home assets. In total, the

higher productivity at home caused a net outflow, improving the net international investment position of the economy. This is the same result produced by Devereux and Sutherland (2009).

The models by Devereux and Sutherland (2011) and Tille and van Wincoop (2010) provide important insights in the risk sharing that takes place across countries through international portfolios. Their models provide a starting point for a two-country DSGE model with more elements and frictions. In particular there is scope for including a financial sector that behaves in a manner similar to those observed by Shin and his co-authors. In Chapter 5 we present a model that incorporates the lessons learned from the range of models reviewed above.

2.4 Conclusion

Recent research suggests that push factors such as global interest rates, risk and risk appetite are the main determinants of cross-border capital flows. The risk factors may be directly affected by monetary policy via the policy rates' impact on bank profitability and asset prices. There are a variety of potential feedback loops that can re-enforce such a policy shock. For example, if market-based banks target their *Value at Risk* they may behave in a pro-cyclical manner by increasing leverage when asset prices are rising, and thereby put further price pressure on these assets. This process will increase risk appetite and push down the risk premium. Part of this appetite for risk will be directed to foreigners by extending loans across borders and purchasing foreign securities. This will push up asset prices in the recipient (local) economy and further reduce the local risk premium and actual riskiness (by strengthening the local currency). The monetary authorities in the local economy may in some cases intervene to dampen the appreciation by cutting policy rates or by purchasing global safe assets. This will push up asset prices, and thus re-enforce the first step of this cycle by raising the value of the global banks' balance sheet.

Bank flows, or credit flows, are the product of global supply of credit and local demand for credit. Portfolio flows, on the other hand, is the product of changes in

demand for local assets from foreigners relative to domestic investors. Portfolio flows and credit flows tend to be driven by the same push factors that will be investigated further in Chapter 3. However, evidence suggest that credit flows and to some extent bond flows are more correlated to the global financial cycle, while equity flows are not. We further saw that equity flows have been found to have a lesser impact on credit supply in the recipient economy. We hypothesise that an explanation may lie in the transmission channel which potentially could be non-linear. Portfolio flows have a greater impact on credit extension when banks themselves are credit constrained in the sense that they must rely on wholesale money markets for funding as opposed to their core deposit liabilities. In such times, the potential increase in bank deposits caused by portfolio flows may quickly be extended as credit to households or investors. During other phases of the credit cycle, the added deposits may instead be held as cash or used to pay off other non-deposit liabilities. We will explore this potential transmission channel in Chapter 4.

The theoretical models of capital flows tend to focus on global demand for emerging market (foreign) assets. Adrian and Shin (2009); Bruno and Shin (2013) demonstrate that financial intermediaries tend to be risk targeting and that this behaviour has a direct impact on cross border bank flows. Devereux and Sutherland (2009) and Tille and van Wincoop (2010) construct two-country DSGE models that can simulate portfolio flows that arise from changes in relative asset demand. In their models households invest directly in local and foreign shares. We will supplement this literature with a new model that introduces risk targeting financial intermediaries in models of similar structure to Devereux and Sutherland (2009). The model introduced will simulate both the drivers of portfolio flows and their impact on saving in the recipient economy. The transmission channel from portfolio flows to savings in the model goes via the financial sector as proposed in Chapter 4.

Chapter 3

Time varying determinants of portfolio flows

Abstract

The empirical literature on determinants of cross-border capital flows has consistently assumed the determinants of such flows to be constant throughout the sample. In this chapter we investigate this notion by estimating the time varying relationship between portfolio flows to South Africa and two widely accepted determinants of such flows: the sovereign spread and global risk. The results show that the time variation is significant. Bond flows (non-resident net purchases of South African bonds) are consistently more sensitive to risk than shares flows. The effect of risk on portfolio flows is stronger during times of financial stress, particularly in the case of bond flows. The determinants of portfolio flows are estimated using a time varying parameter vector autoregressive (TVP VAR) model with stochastic volatility.

3.1 Introduction

Recent literature has come to the conclusion that the main drivers of capital flows are global risk and interest rates. A recurring assumption of the empirical literature is that the effect of global factors on portfolio flows is stable over time and one can estimate unbiased constant parameters. Here we reestimate the effect of global risk and bond yields on portfolio flows to South Africa without imposing the assumption of constant parameters. The results show that bond flows are more sensitive to risk

shocks than share flows, especially during times of financial stress. We show that bond flows were three times as sensitive to risk shocks during major financial crises than it has been on average over the rest of the sample period. The two major crises in the sample are the Asian crisis in 1998 and the global financial crisis in 2008. The response of share flows has been less significant and less variable. We do see signs of stronger sensitivity of share flows to global risk during the global financial crisis of 2008, but not nearly to the same extent as in bond flows.

This chapter does not aim to *explain* the different responses of shares and bonds, nor to explain the different responses at different times. Here we merely observe and describe the relationships present in the data. In chapter 5 we present a model that may provide some explanations of the observations made here. In chapter 5 we will for example show that the stronger sensitivity of bond flows to risk shocks does not necessarily imply that global bond demand is more sensitive to risk than share demand. Instead, the *relative* demand of foreign investors *compared to* local investors is more sensitive. An increase in risk may induce higher demand for local emerging market bonds from local emerging market investors, as they view their domestic government bonds as a relative safe haven in times of financial stress. Thus, the risk shock causes a significant bond outflow from emerging markets, as local investors respond by demanding more emerging market bonds and global investors respond by demanding less emerging market bonds. The emerging market shares, on the other hand, become more risky in the eyes of both global and local investors. All investors reduce demand for emerging market shares, implying an undetermined direction of portfolio flows. The net effect is that the share flow goes in the direction of whomever reduces demand the least.

In chapter 2 we saw that share flows are less correlated to the global financial cycle than other types of flows, including bond flows. This matches the findings we make here. Not only do bond flows respond to risk more than shares, bond flows also become more sensitive to risk when risk is high. In chapter 4 we study whether the timing of portfolio flows in the credit cycle matters for the effect of portfolio flows on credit. We will see that the timing does matter.

To our knowledge, the literature does not include a model of portfolio flows in which the coefficients and covariance matrix are allowed to vary over time. Here we estimate a Time Varying Parameter Vector Auto Regression (TVP-VAR) with stochastic volatility (time varying covariance matrix). This enables us to estimate the impulse response of capital flows to shocks in the determinants at different points in time, providing a dynamic picture of these relationships. If the relationship was constant, this would be a pointless complication of the estimation procedure, but our results confirm that the time variation is indeed a significant feature in these relationships.

The findings of this chapter are significant on several levels. First, we observe a changing composition of portfolio flows to South Africa, and the results indicate a significantly different effect of global factors on share flows compared to bond flows. This makes it important to separately estimate the effect of each type of flow on local credit extension.

Second, there is substantial time variation in the effect of both bond yields and global risk on the portfolio flows to South Africa. This time variation will induce a bias to coefficients estimated on a sample where the relationship is assumed to be constant.

Third, it is possible that risk has a non-linear impact on portfolio flows. This should be taken into account when estimating constant parameter models (as we do in chapter 4).

Fourth, we do not find a development in the time varying responses of portfolio flows to risk or bond yields that can explain the observed shift in the composition of portfolio flows to South Africa. Since neither the coefficients nor the covariance matrix can explain this shift it may instead be explained by changes in the determinants themselves. Risk has remained very low after the global financial crisis, and the yield spread has remained relatively constant at a higher level than the years prior to the financial crisis. Given the stronger response of bond flows to risk and the yield spread, this development alone can potentially explain the shift in composition from share flows to bond flows after 2009. The relevant development in both these factors is

possibly related to the extraordinary monetary policy of the US Federal Reserve over this time period.

3.1.1 Capital Flows to South Africa

South Africa and several other emerging markets including Mexico, Poland, Hong Kong, Turkey and Chile have received average annual net bond inflows amounting to more than 2% of their respective GDP since 2009. Equity inflows to these economies have remained significantly lower in the same period (International Monetary Fund, 2013). Here we study the evolution of portfolio flows to South Africa over the past 20 years by estimating the time varying effect of the two factors that have been widely recognised as important drivers of cross-border portfolio flows: long term bond yields and global risk (as measured by the CBOE Volatility Index, *henceforth* VIX) ^{1 2}.

Foreign capital that enters South Africa is recorded on the Financial Account in the balance of payments under direct investments, portfolio investments, other investments or as a change in the Reserve Bank's net foreign reserves. Net portfolio flows (purchases of bonds and shares by non-residents less South African residents purchases of foreign bonds and shares) are the most volatile of the different categories, both relative to the its own volume and in rand terms. Quarterly net portfolio flows have a standard deviation of 21 billion rand compared to 16 billion rand for the current account deficit as a whole.

The net portfolio flows as reported on the Balance of Payments consists of changes to South Africa's foreign liabilities (that is foreigners' assets in South Africa) and South Africa's foreign assets. The lower panel of figure 3-1 illustrates the importance of portfolio flows in funding South Africa's current account deficit prior to the global financial crisis in 2008. Such portfolio inflows can either be sourced from the disposal of foreign assets, or from foreigners purchasing domestic assets. The latter of the two

¹The VIX calculates the volatility that is priced into options on the S&P 100 index according to the Black Scholes formula (Black and Scholes, 1973). For an excellent introduction and discussion of the VIX index and the older VXO index, see Carr and Wu (2004).

²See for example Calvo et al. (1996); McCauley (2012); Bruno and Shin (2013); Bekaert et al. (2010) and others; all discussed further in Chapter 2.

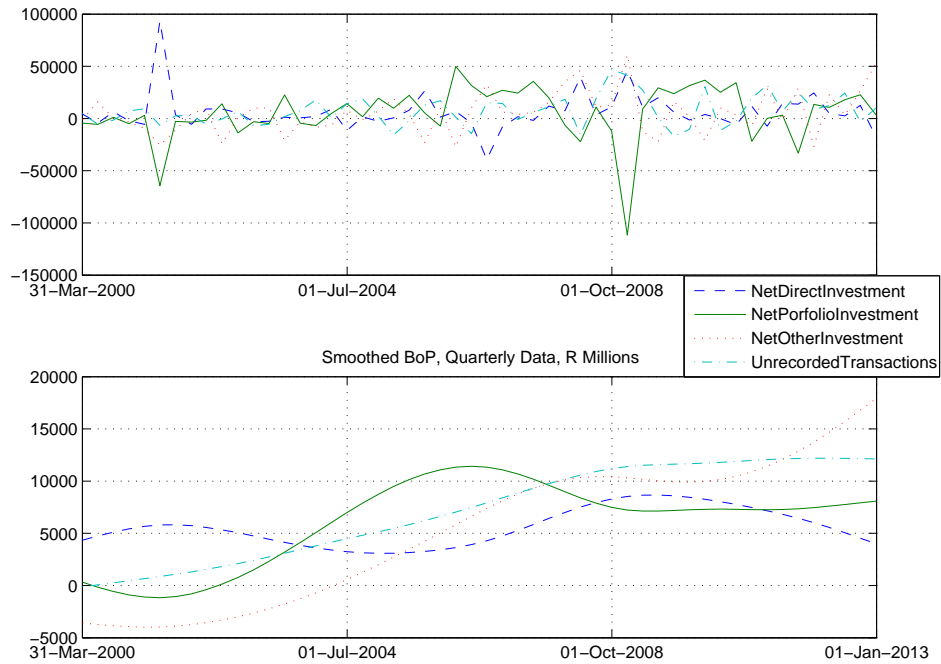


Figure 3-1: Quarterly Balance of Payment Figures - Actual (top) and Smoothed (bottom). The Y-axis is denominated in Rand Thousands.

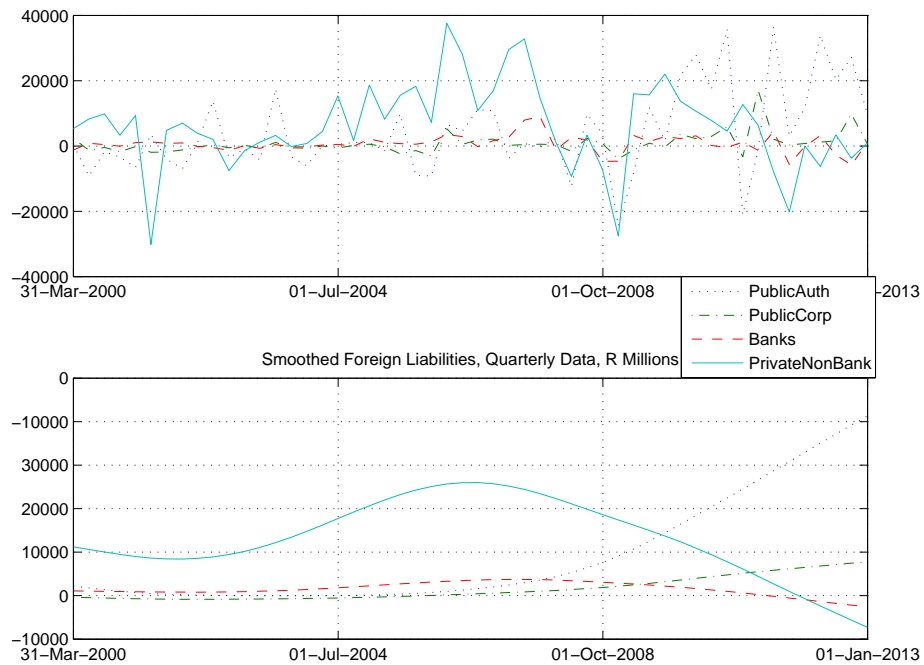


Figure 3-2: Quarterly Portfolio Inflows - Actual (top) and Smoothed (bottom). The Y-axis is denominated in Rand Thousands.

is the only sustainable option in the medium to long run ³. Thus, of particular interest is the gross portfolio inflows, that is non-resident purchases of South African assets or equivalently changes in South Africa's foreign liabilities. The Reserve Bank reports these portfolio flows broken down to five different categories; the foreign liabilities of monetary authorities, public authorities, public corporations, the banking sector and the private non-banking sector.

Figure 3-2 plots the different components of portfolio investments. It is clear from Table A.2 (in the appendix) that the volatility in portfolio flows is caused by the volatility of investments in *Public Authorities* and *Private Non-Bank corporates*. The former is likely to consist of non-resident purchases of South African government bonds, whilst the latter is likely investments in corporate bonds and shares. Portfolio flows into South African private sector non-bank corporations was the dominant source of portfolio inflows in the expansionary years prior to the global financial crisis. During and after the crisis these flows declined and were replaced by flows into the public authorities.

We have singled out portfolio inflows to South African public authorities (mainly government bond flows) and to the private sector (mainly share flows) as the important components in total foreign currency inflows and volatility. We may study these flows in more detail by looking at data on non-resident purchases of South African shares and bonds on the Johannesburg Stock Exchange (JSE). The JSE reports such transactions to the Reserve Bank on a daily basis. The cumulated non-resident net purchases of South African shares and government bonds are plotted in Figure 3-3. Notably there has been a pronounced shift from equities to bonds beginning in late 2009.

Non-resident net purchases between January 2000 and July 2013 added to a total of 184 billion rands in bonds and 300 billion rands in shares. In the period from January 2009 to July 2013, the purchases added to R227 billion in bonds and only R92 billion in shares. The standard deviation of monthly bond purchases was 6.7 billion

³Clearly, sustained portfolio inflows also come with certain risks, for example sudden stops as argued by Calvo (1998)

rands, whilst the standard deviation of monthly share purchases was 5.3 billion rands. In comparison, the current account deficit for 2011 was approximately 100 billion rand, thus approximately 8 billion per month. There seems to be good reasons to suspect that the volatile portfolio flows have the potential to contribute significantly to volatility in the South African economy and particularly in the exchange rate. South Africa has a constant demand for foreign currency to fund its imports, but foreigners have a highly volatile demand for South African shares and bonds. The country's dependence on gross portfolio inflows makes the determinants of such flows a relevant research topic for local policy makers.

Figures 3-3 and 3-4 plot the cumulative net purchases of South African bonds and shares by non-residents with the yield spread and the VIX. There is no obvious relationship that can be discerned from these graphs, other than the negative correlation between the VIX and portfolio flows at the onset of the global financial crisis in 2008.

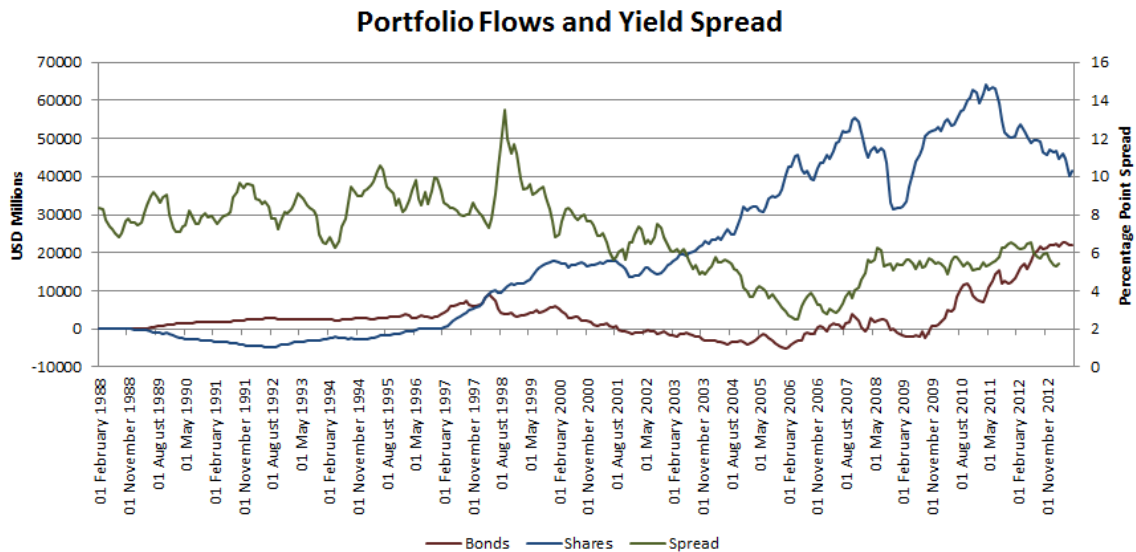


Figure 3-3: Cumulative portfolio flows (left axis) and the yield spread between 10 year South African and 10 year US Treasury bonds (right hand axis)

It is more clear that there exists an important relationship between the two explanatory variables. *Figure 3-5* shows that the yield spread has moved very much in line with VIX during most of the sample period. Interestingly, the yield spread has remained rather stable since the onset of the crisis, whilst the VIX has been highly

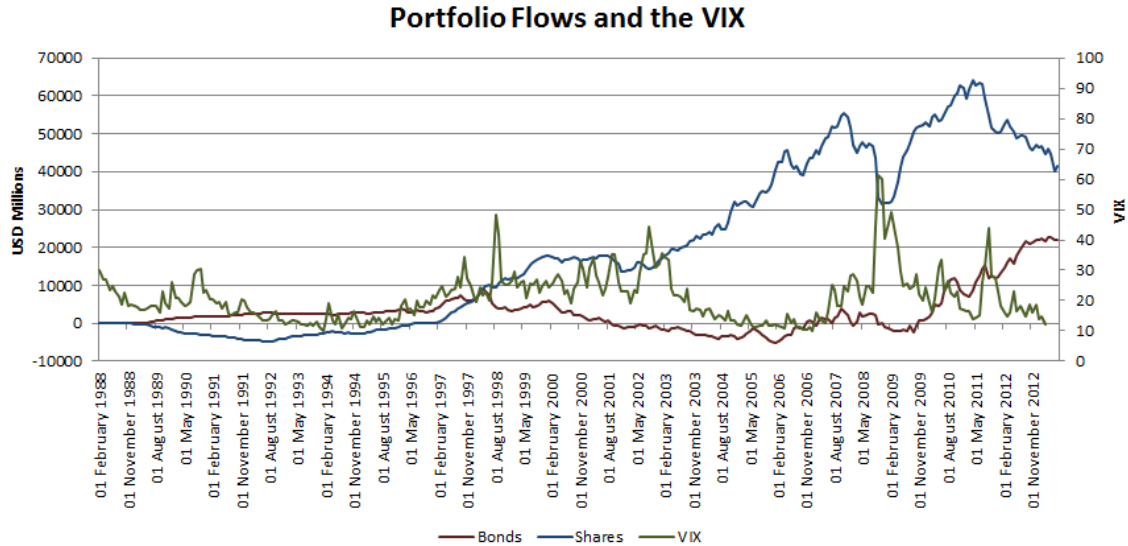


Figure 3-4: Cumulative portfolio flows (left axis) and VIX (right hand axis)

volatile before falling to levels well below average.

It was argued by Adrian and Shin (2009); Borio and Zhu (2008) that monetary policy can affect both risk and bond yields. In figure 3-6 we explore this by pointing out the dates where the US Federal Open Market Committee announced significant changes to their monetary policy. The graph does not prove any causal links, but certain patterns are interesting. In short, the figure suggests that the so-called Quantitative Easing responds to high risk and causes risk to fall. The threat of reducing such asset purchases appear to cause an increase in risk. The coincident timing of monetary policy announcements and sharp movements in the VIX suggests that the two are highly interrelated.

Figure 3-7 plots the cumulative portfolio flows in this period post 2008 and indicates the dates of important monetary policy announcements. It is not obvious that there is a relationship between these dates and the actual flows. However, results from our TVP-VAR estimates suggest that these monetary policy interventions can possibly explain the significant shift in composition in portfolio flows, from shares to bonds, after 2009. That is, quantitative easing and “operation twist” will have strong positive effects on bond flows and modest, possibly even negative effects on share flows.

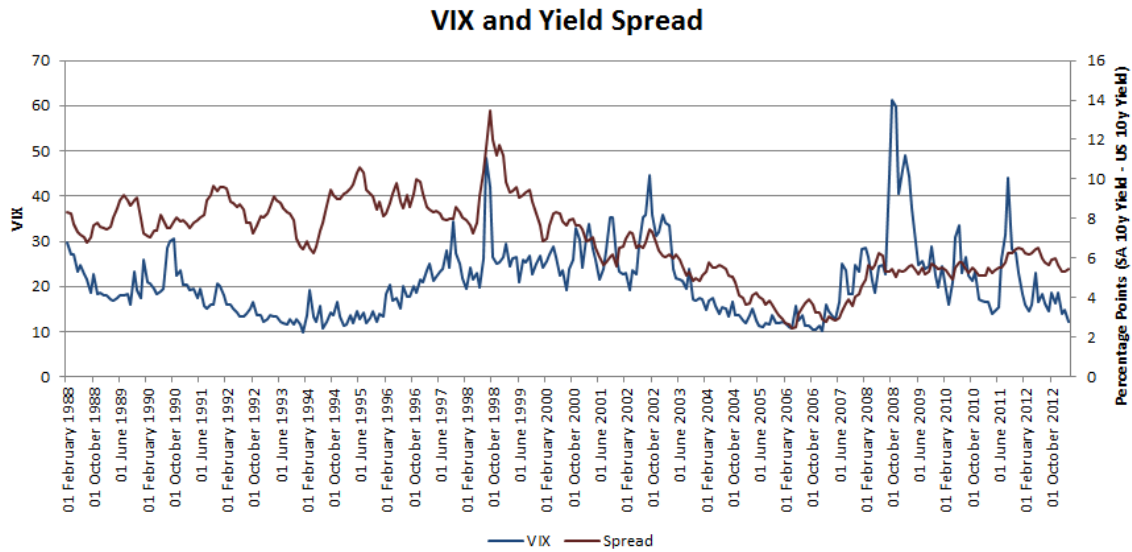


Figure 3-5: The VIX (left) and the yield spread between South African and US 10 year government bonds (right)

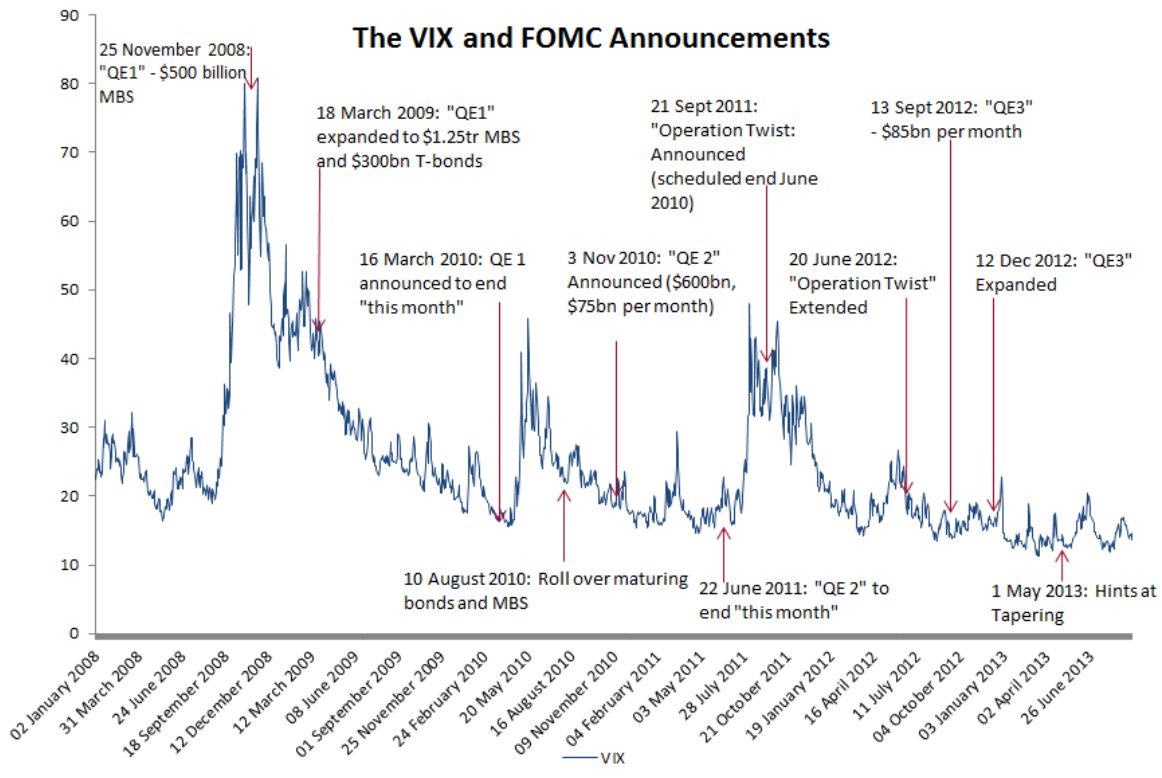


Figure 3-6: The VIX and the timing of monetary policy announcements by the Federal Reserve's Open Market Committee

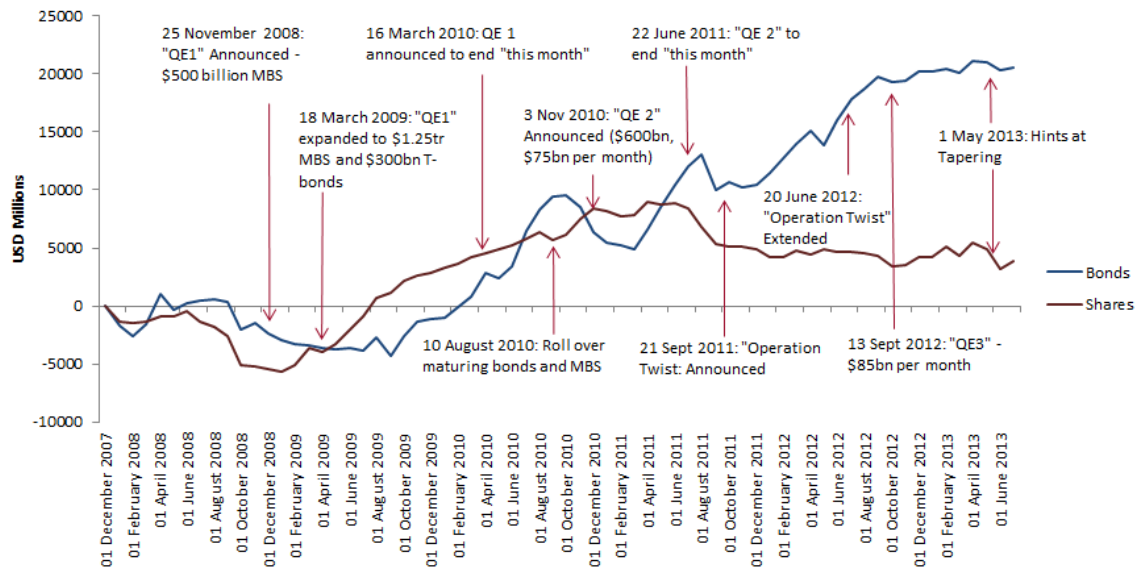


Figure 3-7: Cumulative portfolio flows since January 2008 and the timing of monetary policy announcements by the Federal Reserve's Open Market Committee

Time varying parameters are important

An important feature of our approach that was not present in the above mentioned literature is the time-varying parameters of our model. This enables us to capture both gradual and sudden changes in the importance of different determinants of bond and share flows. Past empirical literature has found such time variation to be highly significant. Fratzscher (2011), for example, estimates a constant parameter model, but includes dummy variables to control for changes in the relationships during and after the global financial crisis of 2008. He finds that global risk and macro factors (“push factors”) became the dominant driver of cross-border capital flows during the financial crisis. During the recovery after the crises he finds that domestic “pull factors” have come to dominate in many emerging economies in Asia and Latin America. The finding that push factors become dominant during times of financial stress can potentially explain the strong empirical finding that global asset markets become highly correlated when global volatility is high (Forbes and Rigobon, 2002). The only empirical results from a time varying parameter model were done by Duca (2012). He finds significant time variation in the determinants of daily portfolio flows to emerging markets between 2007 and 2012. The results indicate that local factors are more important when market tension increases, but they lose importance when volatility turns into panic and changes in risk becomes the dominating factor.

If one assumes a constant covariance matrix (homoskedasticity) and constant parameters and normal distribution of the residuals, one may efficiently estimate this model and derive the impulse responses using Ordinary Least Squares (OLS). Unfortunately, neither the parameters nor the covariance matrix between the variables are likely to be constant over the entire sample (1988 to 2013). South Africa has gone through significant changes over this time period. Most important for this study is the gradual liberalization of cross-border capital flows and the financial integration with global markets. We also suspect that the global investor may have different behavior during financial crises compared to calm times. Such time variation implies that a VAR with constant parameters may be inaccurate and ignore important

changes to the relationship between the respective variables. We therefore choose to use a TVP-VAR framework.

The literature on portfolio flows to African economies is practically non-existent. The same goes for any literature on time varying parameters to explain cross-border portfolio flows. This paper thus places itself in the current literature by extending the research to the African continent and importantly by estimating a time varying parameter model with stochastic volatility (to avoid the unrealistic homoskedasticity assumption) on a sample of monthly data from February 1988 to January 2015. This allows us to estimate gradual changes that cannot be captured by a dummy variable as well as the sudden structural breaks that may come with financial crises. Such empirical results should give important insights that may support or reject models discussed above.

3.2 Data and the Empirical Estimation Procedure

3.2.1 Data

We aim to estimate the response of portfolio flows to South Africa to changes in global volatility and bond yields. To measure global risk we use the CBOE S& P 100 Volatility Index (VIX) (CBOE, 2015). Data on flows and yield on South African government bonds come from the South African Reserve Bank's Quarterly Bulletin (South African Reserve Bank, 2015c)⁴. US government bond yields are accessed from the US Federal Reserve Economic Data (Board of Governors of the Federal Reserve System (US), 2015a,b). The sample period is from February 1988 to January 2015.

⁵ Portfolio flows are adjusted for inflation by inflating past values to January 2015 rands using the linked historical headline CPI index provided by StatsSA (Statistics South Africa, 2015). ⁶

⁴We use the following data series: KPB2003M (Yield on South African government bonds with maturity of ten years and over), KBP2050 (Net purchases of shares by non-residents), KBP2051 (Net purchases of bonds by non-residents).

⁵The variables are later referred to with the names: *BondFlow*, *ShareFlow*, *VIX*, *Spread*.

⁶Portfolio flows are originally reported in nominal rand amounts. We divide the time series of nominal portfolio flows by the CPI index normalised to 1 in January 2015. The inflation adjusted

3.2.2 Estimation

The empirical analysis is conducted using a Bayesian Time Varying Parameter Vector Autoregression (TVP-VAR) model with stochastic volatility. There are several reasons for this approach. First, we choose a structural VAR framework in order to capture the dynamic interrelations between the different macroeconomic variables at play. This allows us to calculate the estimated impulse responses of each variable where all the dynamics are taken into account. As such we avoid the many endogeneity issues that plague macroeconomic variables (Sims, 1980). In our case, it is for example important that we allow the yield spread to be endogenously determined by the VIX. We will discuss other remaining endogeneity concerns in section 3.2.2.

Several algorithms have been developed to estimate a TVP-VAR with constant covariance matrix (for example, Sims (1993), Canova (1993), Stock and Watson (1996) and Cogley and Sargent (2001)). This would give time varying estimates of the coefficients in a reduced form model. A structural model on the other hand will derive the parameters from the reduced form coefficients and the covariance matrix. The simultaneous relationships are purely derived from the covariance matrix. Thus, for this to be time varying, one must allow the covariance matrix to be time varying. The time varying covariance matrix will also capture any heteroskedasticity in the data and thus we avoid mistakenly attributing volatility changes to changes in coefficients (Cogley and Sargent, 2005).

Koop and Korobilis (2010) give an overview of algorithms that allow for both time varying coefficients and covariance matrix. The algorithms are widely used in economics to estimate monetary policy models. Important contributions include Primiceri (2005) and Cogley and Sargent (2005) and examples of more recent extensions include Koop, Leon-Gonzalez, and Strachan (2009) and Canova and Ciccarelli (2009). One could use switching models rather than TVP models to capture sudden structural changes. These models have the advantage of estimating fewer parameters, and they would be likely to successfully capture changes caused by sudden events such as the global financial crisis. However, they are too rigid to capture longer transitions

portfolio flows are now denominated in January 2015 South African rand.

such as the gradual liberalization of capital flows in and out of South Africa. For the purposes of this paper, the framework of Primiceri (2005) will be sufficient. This methodology allows us to estimate a TVP structural VAR with stochastic volatility by using an efficient Markov Chain Monte Carlo (MCMC) algorithm. One should note that this is a smoothing algorithm which means that we find the posterior distribution of the parameters at each point, conditional on the entire dataset⁷. As such, the technique is not suitable for forecasting, but the smoothed estimates are more efficient when the goal is to estimate the true time varying parameters (Primiceri, 2005).

The Model

The paper uses the model specification from Primiceri (2005). We have a state space model where the observation equation (3.1) is the reduced form VAR where the last term is the reduced form residual ($u_t = A_t \Sigma_t \epsilon_t$). Note we express the reduced form residual (u_t) in its decomposed form, where ϵ holds the residuals from the corresponding structural VAR⁸. B_t includes all coefficient estimates for time t , α_t refers to the non-zero elements of the lower diagonal A_t . Lastly, σ_t contains the diagonal elements of the diagonal matrix Σ , where $\sigma_{i,t}$ represents the standard deviation of variable i .

$$y_t = c_t + B_{1,t}y_{t-1} + \dots + B_{k,t}y_{t-k} + A_t^{-1}\Sigma_t\epsilon_t \quad (3.1)$$

$$B_{i,t} = B_{i,t-1} + v_t \quad (3.2)$$

$$\alpha_t = \alpha_{t-1} + \xi_t \quad (3.3)$$

$$\log \sigma_t = \log \sigma_{t-1} + \eta_t \quad (3.4)$$

We impose the assumption that the error terms are independent (this is necessary

⁷This is in contrast to particle filters which find the posterior distribution conditional on past observations only

⁸The A_t matrix solves the equation $A_t \Omega_t A_t^\top = \Sigma_t \Sigma_t^\top$, where Ω_t is the time varying covariance matrix of the reduced form residuals: $u_t = A_t \Sigma_t \epsilon_t$

in order to interpret the estimates as a structural model):

$$V = Var \begin{pmatrix} \epsilon_t \\ v_t \\ \xi_t \\ \eta_t \end{pmatrix} = \begin{pmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix} \quad (3.5)$$

Equation 3.2 imposes a random walk process on the coefficients in the reduced form VAR model. This allows the coefficients to drift over time, and by making prior assumptions about the variance of this random walk we affect the probability distribution of the process. For example, a larger variance implies that the coefficients are more likely make larger moves from observation to observation. If the variance is set to be too large, the estimated the coefficients will move enough to explain all variation in the data, resulting in overfitting. A very small variance may be too restrictive and thus cause the estimates to miss structural changes in the relations.

Equation 3.3 defines a random walk for the non-zero elements of A_t . This is allows the covariance matrix to be time varying, which again gives us time varying simultaneous relations. The prior assumption of the variance of ξ_t has the same implications as discussed for equation 3.2. Equation 3.4 makes the variance of y_t a stochastic process, which implies that the true underlying variance (σ^2) is unobserved.

The goal is to estimate the parameters B, A, Σ and the hyper parameters in V . To do this we utilize a Gibbs sampler in an MCMC algorithm based on Carter and Kohn (1994)⁹. We impose the same set of priors as Primiceri (2005): We assume independent inverse-Wishart distributions of the blocks of V (that is Q, W and S) which implies normal conditional distributions of B, α and $\log \sigma$. The prior values of the coefficient are set to the OLS estimate of these coefficient from a regression on the first 70 observations. The time-varying parameters are then estimated over the remaining sample from 1995 to 2015. We follow the same rule of thumb as Primiceri (2005) in setting priors for the variance of parameter processes. Each block of these

⁹The model is estimated using Mathworks Matlab ®. Our code is based on code written by Koop and Borilis which is available on his website in the file TVP VAR CK: http://personal.strath.ac.uk/gary.Koop20/bayes_matlab_code_by_Koop20_and_korobilis.html

hyper parameters in V are set such that the degrees of freedom equals one plus the dimension of the block (see Primiceri (2005) for a discussion).

We can now list all our priors:

$$\begin{aligned}
 B_0 &\sim N(\hat{B}_{OLS}, (k+1) * Var(\hat{B}_{OLS})) \\
 A_0 &\sim N(\hat{A}_{OLS}, (k+1) * Var(\hat{A}_{OLS})) \\
 \log \sigma_0 &\sim N(\log \hat{\sigma}_{OLS}, I_n) \\
 Q &\sim IW(k_Q^2 * 90 * Var(\hat{B}_{OLS}), 90) \\
 W &\sim IW(k_W^2 * (k+1) * Var(\hat{B}_{OLS}), (k+1)) \\
 S_{i=1:k} &\sim IW(k_S^2 * (i+1) * Var(\hat{B}_{OLS}), (i+1))
 \end{aligned}$$

where $(k_Q, k_W, k_S) = (0.01, 0.1, 0.10)$ as in Primiceri (2005). One can see here that smaller values for these constants (k) imply lower variance of the random walks, α_t and B_t , and thus less time variation in the estimated parameter series.

After imposing these priors, we estimate two models, both with a lag order of two:

$$\begin{aligned}
 \text{Model 1 : } y_t &= \begin{pmatrix} V XO_t & BondFlow_t & Spread_t \end{pmatrix} \\
 \text{Model 2 : } y_t &= \begin{pmatrix} V XO_t & ShareFlow_t & Spread_t \end{pmatrix}
 \end{aligned}$$

Since the entire covariance matrix is estimated at each data point in the sample, the number of parameters to estimate grows rapidly as we add more variables. We therefore restrict the number of variables to three, as in (Primiceri, 2005). We do this by separately estimating the model explaining shares and bonds. We derive the structural errors and coefficients by using a Cholesky decomposition on the covariance matrix of the reduced form equations. The variables are ordered such that the VIX

has a contemporaneous impact on the yield spread and portfolio flows. The portfolio flows have a contemporaneous impact on the yield spread. All variables can affect all other variables at lags. In practice, bond flows and bond yields will simultaneously affect each other. Thus, the order of portfolio flows and yields is not obvious. We plot the results from the alternative ordering in *Appendix B.1*. Comparing the results from the two orderings reveal that the ordering does matter for the estimated relationship between portfolio flows and the yield spread. The relationships between the VIX and portfolio flows, and the VIX and the yield spread are robust to changes in the order. We select the above listed order because it is unavoidable that prices (yields) will be immediately affected by demand, and the results show that this ordering yields a positive response of bond flows to a wider yield spread, while bond flows cause the yield spread to narrow. This is exactly the relationship one would expect.¹⁰

In *Figure 3-3* we saw that the composition of portfolio flows to South Africa has changed over time. These long term effects will be removed if we difference the data. However, estimating the responses of data with unit roots may potentially give rise to other issues. A time varying parameter VAR model with stochastic volatility is well behaved independently of the time series properties of each variable (Canova, 2007). The unit roots in the endogenous variables will not cause autocorrelation in the residuals as the parameters instead will change over time. This property of time varying parameter models allows us to capture the long run changes in the relationships present in the model. In the following, we estimate the model both on cumulative flows (non-stationary) and on net monthly flows (stationary). The spread and the VIX are both stationary in their levels.

¹⁰The alternative ordering yields impulse responses suggesting that a wider yield spread causes portfolio outflows. This is hard to reconcile with our understanding of carry trades and portfolio rebalancing (Hau and Rey, 2006). The sign of this response suggests the causation goes the opposite way, that is, the causation is correctly estimated using the order listed above.

3.3 Results

In *Figure 3-8* we plot the time varying impulse responses in the same month as the shock, after 3 months and after 6 months. On the left hand side we plot the responses from the model explaining share flows, on the right hand side we plot responses from the model explaining bond flows. In *Figure 3-9* we plot the same one-month impulse responses as in *Figure 3-8*, but with the simulated 15th and 85th percentiles (out of 50 000 simulations).

We find a consistent statistically significant negative effect of global risk on cumulative bond flows to South Africa. We find a consistent negative sign on the response of cumulative share flows to global risk, but this response is statistically insignificant. At the peak of the global financial crisis in 2008-09, both share and bond flows appear to respond more strongly to global risk. Bond flows also became more sensitive during the Asian crisis in 1998. The impulse response of bond flows vary more than the impulse response of share flows over time. A wider yield spread consistently causes bond inflows and share outflows. Both bond flows and share flows generally cause the spread to narrow, but the magnitude of the impact is time varying.

Since cumulative bond flows are non-stationary, any shock will have a permanent impact on the process. This is illustrated in *Figure 3-11* and *Figure 3-12* where we plot the full 24 month impulse responses at six different points in time. We see that the VIX has a permanent negative impact on cumulative share and bond flows. The VIX has a temporary positive impact on the spread, mainly caused by the bond outflows.

We plot all the remaining results on net flows, as well as results on the alternative ordering of the variables, in *Appendix B.1*.

3.3.1 The time varying effect of risk on portfolio flows

An increase in global risk is expected to cause portfolio flows away from “risky” emerging markets. The reason is reduced global demand for risky assets. We find empirical evidence that bond flows consistently respond in this manner: more global

risk or risk aversion causes foreigners to sell South African bonds to South African investors. We do not find the same effect in the share market. While the sign of our estimated impulse responses on cumulative share flows is consistently negative, we fail to reject the null hypothesis that the effect of risk is zero.

We posit here that the reason lies in local South African demand for South African shares and bonds. We are not aware of any model or theory suggesting that global demand for emerging market bonds should be more sensitive to risk than global demand for emerging market shares. But portfolio flows are not only driven by global demand. If the risk shock causes demand from South African investors to fall to the same extent as global demand, the direction of the portfolio flow is undetermined. The shock will cause a sharp fall in asset prices since demand from all agents is lower, but it is not clear whether any transactions will take place. The portfolio flow will go in the direction of the investor with the least negative elasticity of demand with respect to risk.

The consistent significant response of bond flows to risk implies that South African demand for South African bonds is less sensitive to risk than is global demand for South African bonds. These findings may reflect a different perception of the risk associated with South African bonds. South African investors may view South African government bonds as a low-risk asset. They may indeed demand more of this asset as risk and risk aversion increases. Foreign investors view South African bonds as a relatively risky asset and will reduce demand for this asset as risk and risk aversion increases. In friction free complete markets, different perception of the riskiness of South African bonds is hard to justify. The *inherent* risk of the asset is not in the eye of the beholder. The currency risk depends on the consumption currency of the investor, but in complete markets this risk can be hedged. In a world with no capital controls, the relative riskiness of South African assets compared to other global assets does not depend on the location of the investor. But these assumptions do not hold in South Africa. South Africa has significant capital controls on foreign investments by South African residents (South African Reserve Bank, 2015b; National Treasury, 2001). Hedging currency risk is possible, but can be costly (de Roon, Eiling, Gerard,

and Hillion, 2012). Due to these frictions, South African bonds may be the lowest risk asset available to South African investors. Hence, the perceived risk of South African bonds does lie in the eyes of the beholder. And therefore, South Africans may demand more South African bonds when risk and risk aversion is high, while foreigners demand less South African bonds when risk and risk aversion is high. The implications is large portfolio outflows from the bond market when risk and risk aversion is high. South African shares, on the other hand, are risky both in the eyes of South Africans and foreigners. Thus, both parties reduce demand for South African shares when risk and risk aversion is high and there is therefore no significant portfolio flows.

The insights and questions raised here are central in the development of the structural general equilibrium model in Chapter 5. There we impose capital controls on the emerging market country, restricting the investors from the global financial market. We further impose currency risk that cannot be fully hedged. The simulated responses are in line with our findings here. A risk shock that affects both global and local investors will cause significant portfolio flows out of the bond market, and less flows in the share market.

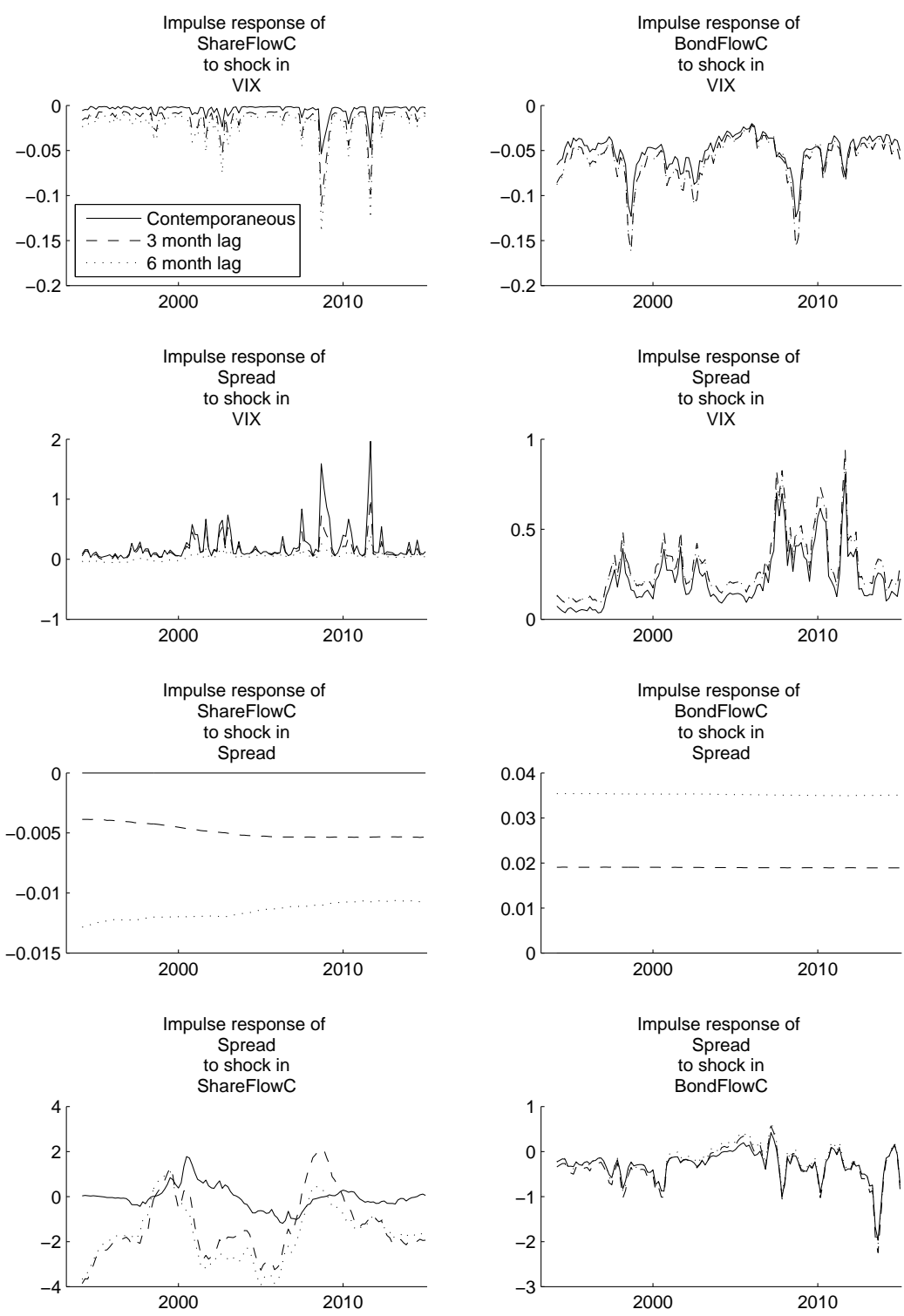


Figure 3-8: Time varying impulse responses of *cumulative* flows in the same month, after 3 months and after 6 months.

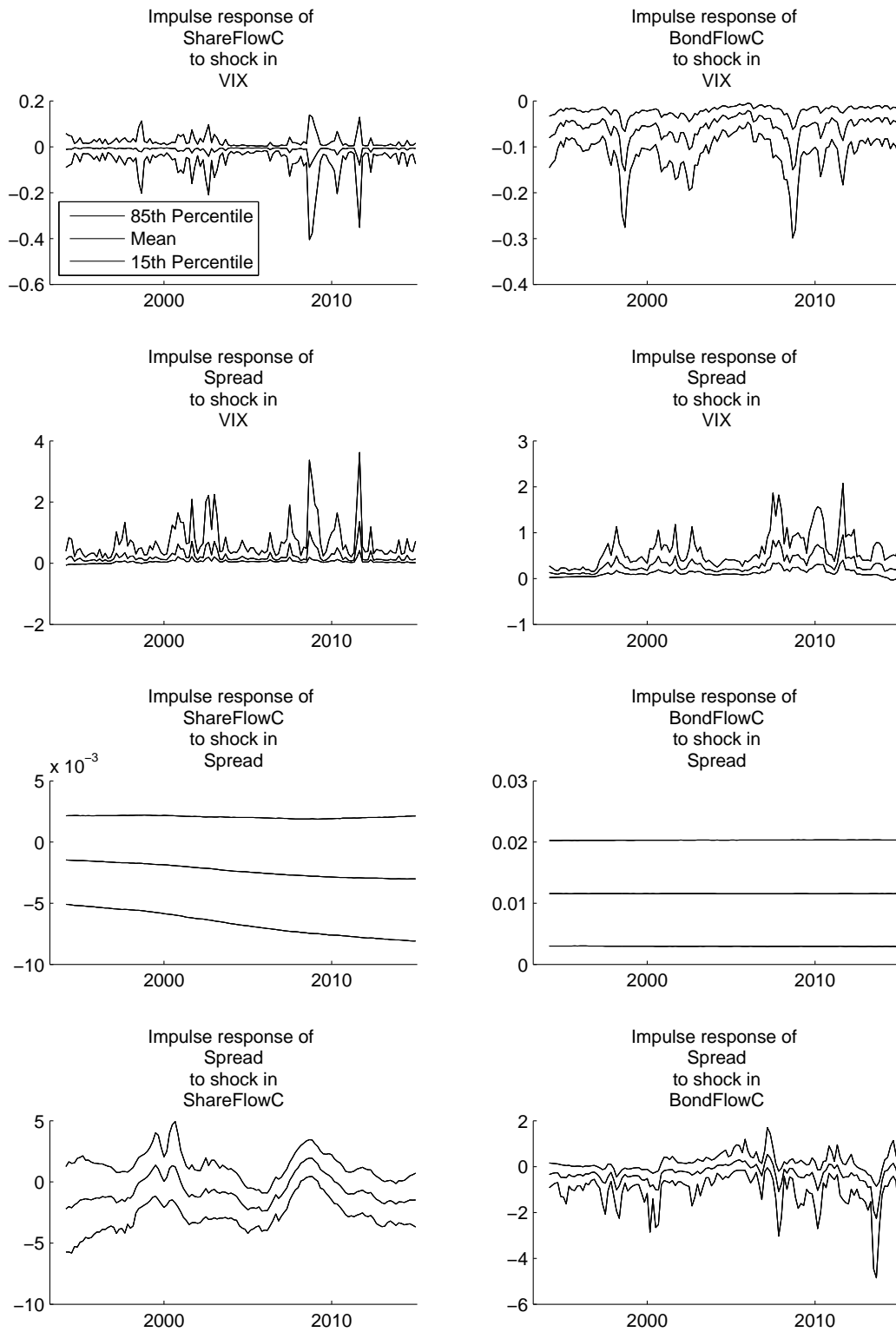


Figure 3-9: Time varying impulse responses of *cumulative* flows in the same month plotted with the simulated 15th and 85th percentiles.

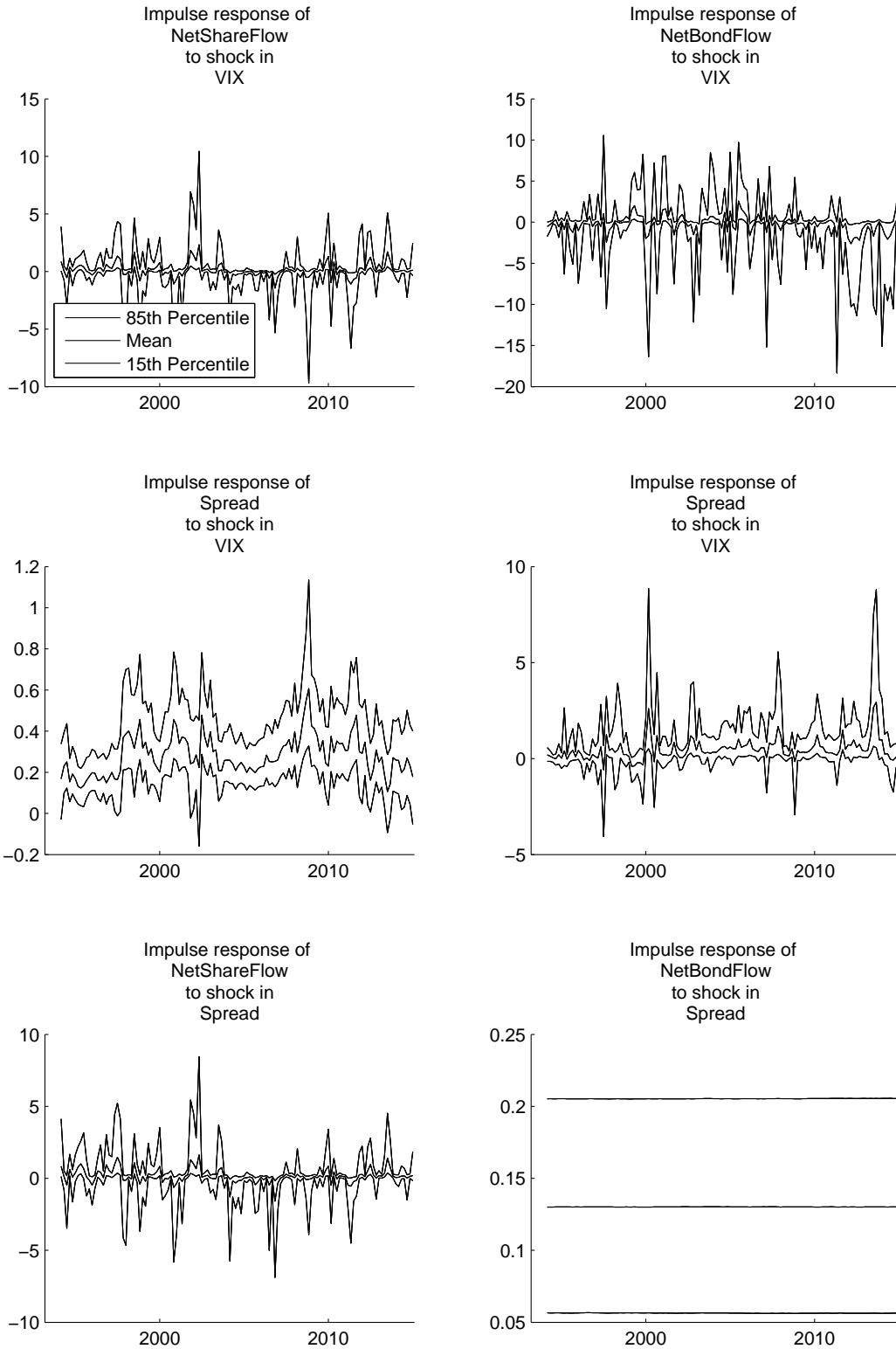


Figure 3-10: Time varying impulse responses of *net* flows in the same month plotted with the simulated 15th and 85th percentiles.

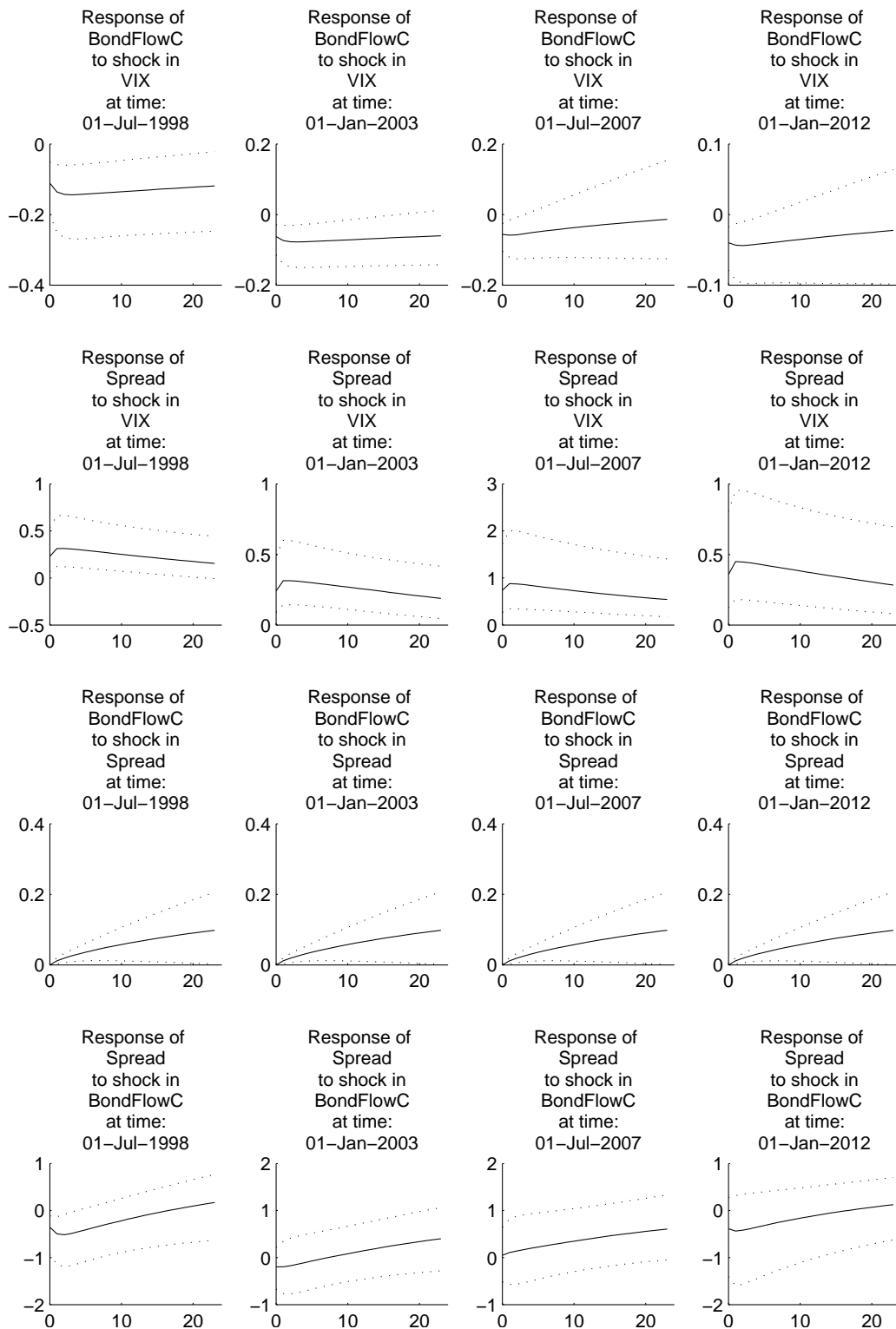


Figure 3-11: 24 month impulse responses of *cumulative* bond flows plotted as estimated at 6 separate points in time. The responses are plotted with the simulated 15th and 85th percentiles.

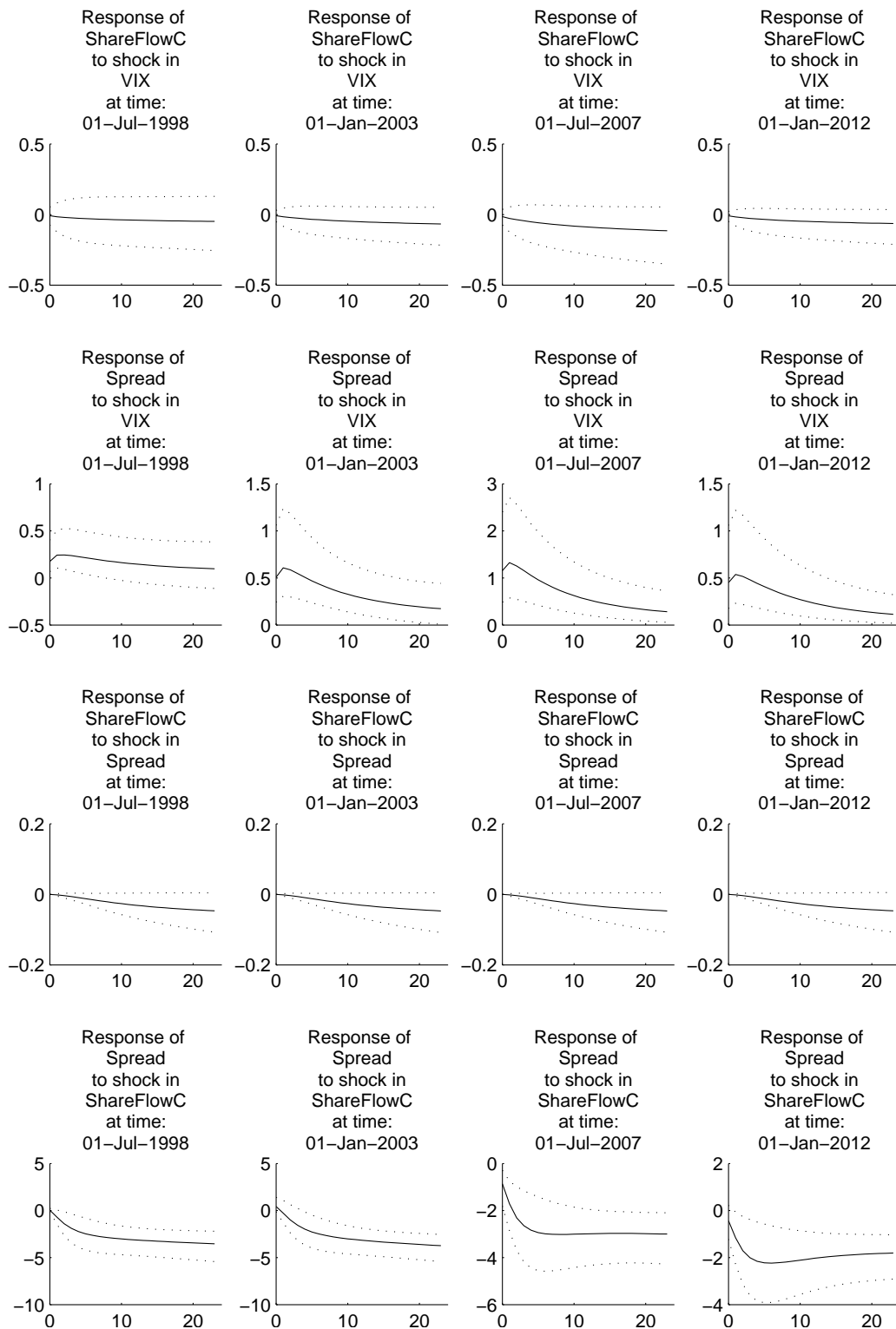


Figure 3-12: 24 month impulse responses of *cumulative* share flows plotted as estimated at 6 separate points in time. The responses are plotted with the simulated 15th and 85th percentiles.

Risk and monetary policy

Above we interpret the VIX as a measure of risk and risk aversion. We discussed in section 3.1.1 that the VIX may indeed capture the extraordinary quantitative easing by the US Federal Reserve. This policy has been found to significantly affect the VIX by reducing both risk and risk aversion (Bekaert et al., 2010). The quantitative easing policy and the so-called “operation twist”¹¹ may also have affected the yield spread between South African and US government bonds. In sum, recent extraordinary US monetary policy may have reduced the VIX and widened the spread. Both factors have significant positive effects on bond flows to South Africa, while limited and conflicting effects on share flows to South Africa. The model prediction is therefore that as long as this policy is in effect, we should expect to see significant bond flows to South Africa and limited share flows.

This matches observed data in *Figure 3-4* and *Figure 3-7* and can potentially explain the marked shift in the composition of portfolio flows. In the six years from January 2003 to January 2009, portfolio flows to South Africa consisted of a cumulated 300 billion rand share flows and a cumulated 20 billion rand bond flows. During the six years from January 2009 to January 2015, the cumulated portfolio flows added to 130 billion rands of share flows and 160 billion rands of bond flows.¹² The average monthly share flows after 2009 are less than half of what they used to be prior to 2009. The average monthly bond flows after 2009 are eight times the size of average bond flows prior to 2009. We do not find a significant shift in the coefficients on global push factors (risk and yields) that can explain this new behavior. Instead we find that there was a shift in the factors themselves that explains the new composition of portfolio flows. Risk has fallen to record low levels, while the yield spread has remained consistently wide. Once US monetary policy turns contractionary, we should expect to see higher risk and narrow spreads. Our estimates suggest this will cause a reduction of bond flows and possibly an increase in share flows to South Africa.

¹¹Extending the duration of the US Fed’s bond portfolio

¹²The net flows for each month have been inflated to January 2015 rands using the linked CPI measure from Statistics South Africa (2015).

Our estimates are useful in understanding the time variation in the effect of risk and interest rates on portfolio flows. We can break down observed flows to changes in factors themselves and changes in the impact of factors on flows. But the model cannot fully explain the drivers of such flows. The time variation in parameters comes at the cost of a highly parsimonious model that leaves out other potentially important variables. We therefore return to these questions in Chapter 5 where we present a structural general equilibrium model with more power to analyse the drivers of the size, direction and composition of portfolio flows.

Our results in context of the literature

The most comparable research in the current literature are Fratzscher (2011) and Duca (2012) who both look at shorter term, higher frequency relationships. Fratzscher (2011) uses constant parameters, but include a separate dummy for the financial crisis. Our findings for South Africa correspond to his findings for Latin America and Asia in that we find an increase in the VIX during the financial crisis to cause outflows from both equities and bonds in emerging markets, of which the response of bond flows is more significant.

We could only find a single paper using time varying parameters to estimate the determinants of capital flows. Duca (2012) does this on a sample of daily *equity flows* to emerging markets from 2007 to 2012. His model allows the coefficient on lagged determinants to be time varying, but he assumes a constant covariance matrix (homoskedasticity) with zero same-day determinants¹³. Under this framework, he finds the variation in risk and risk aversion to be the dominant factor during times of panic, but he finds local (regional) factors to become more important when risk increases moderately. Interestingly, he notes that the sovereign crisis in Europe and subsequent US rating downgrade in 2011 did not generate panic and the corresponding increase in the VIX did not drive equity flows out of emerging markets. His findings suggest that only in panic do foreign investors cut demand for emerging market shares

¹³Figure B-6 in the Appendix B.1 illustrate the significant time variation in the standard deviation of the variables included in our model. This time variation suggests that the assumption of homoskedasticity is likely to be violated on South African data.

more than the local emerging market investors. His findings match our findings. We see that in times of significant financial stress, the effect of risk is magnified on both shares and bonds. This may indicate that risk aversion turns into a panic, and risk becomes the dominant factor. This effect is more pronounced on bond flows than share flows.

3.4 Concluding Remarks

Bond flows and share flows respond differently to risk and risk aversion. Further, the response of share and bond flows to risk goes through significant changes over time. In the case of share flows, the VIX appears to have been important at the peak of the global financial crisis in 2008, but not at other periods in our sample. This finding highlights the importance of local asset demand in determining portfolio flows. It is likely that global demand for South African shares is significantly affected by risk and risk aversion, but we find that South African demand for South African shares is equally sensitive. Thus, a risk shock reduces demand from all investors and the direction of the portfolio flow is unpredictable.

The response of bond flows to risk shocks is highly significant. This implies that investor demand for South African bonds is sensitive to global risk shocks, but we cannot yet disentangle the effect of local demand from foreign demand. There are two potential explanations for the observed result. The result can be explained by foreign investors *reducing* demand for perceived risky South African bonds when global risk is high. Or the result can be explained by South African investors *increasing* demand for South African bonds when risk is high. If both arguments are true, risk shocks will give rise to strong bond outflows as South Africans purchase the bonds from foreigners. These arguments are explored further in Chapter 5.

The results suggest that the shift in the composition of portfolio flows was caused by changes in the factors (risk and interest rates) rather than changes in the coefficients. The time variation of coefficients show strong effects of financial stress, suggesting risk aversion (or even panic) becomes dominant when risk is high. But

the coefficients tend to revert to their long term mean and do not show evidence of a structural break that can explain the new composition of portfolio flows to South Africa.

Instead we argued the extraordinary monetary policy, quantitative easing and “operation twist”, by the US Federal Reserve can explain much of the shift in composition of portfolio flows to South Africa. Quantitative easing is found to reduce risk and risk aversion, and operation twist was aimed to reduce long term bond yields and implicitly also widen the yield spread compared to South African bonds. Both factors are significant drivers of bond flows to South Africa. Risk and risk aversion do not significantly affect share flows to South Africa and the wider yield spread is found to reduce share flows. The implication is that quantitative easing and “operation twist” will cause portfolio flows to be dominated by bonds. A normalisation of US monetary policy may cause the composition of portfolio flows to shift back from bonds to shares.

We argued that foreign investors may have a different perception of the risk associated with South African bonds compared to local investors. The differing views of risk is explained by market frictions such as capital controls and unhedged currency risk. We posited that this explains the strong response of bond flows to risk and the lacking response of share flows to risk. We take these findings further in Chapter 5 where we develop a two-country DSGE model of portfolio flows where currency risk cannot be hedged and emerging market investors are restricted from investing in global assets.

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Chapter 4

Transmission of portfolio flows to credit

Abstract

The literature has found conflicting evidence on the effect of gross bond and equity flows on credit extension in the recipient economy. In this chapter we explore the issue further by testing for a potential non-linear relationship. A possible hypothesis is that portfolio flows cause an injection of cash on bank balance sheets. During an expansionary credit cycle, there is a lacking supply of domestic savings, banks hold less cash, and therefore a cash injection will quickly be transformed to assets such as mortgages or other credit. We find evidence of a non-linear relationship between portfolio flows and credit extension. We also find evidence that the ratio of cash to total assets on bank balance sheets significantly determines the regimes in which portfolio flows have a greater or lesser impact on credit. We find evidence in support of the hypothesis that cash injections on bank balance sheets have a greater impact when the current cash ratio is low. The estimates suggest that non-resident purchases of shares, rather than bonds, are most likely to cause such a cash injection.

4.1 Introduction

Gross capital flows have been found to cause credit expansion in the recipient economies (Rodrik and Velasco, 1999; Lane and McQuade, 2013; Rey, 2013). Using data from 12 developed countries over a large sample from 1870-2008, Schularick and Taylor (2012) find strong evidence that credit expansions should be carefully watched by

policy makers due to their tendency to be followed by financial crises. The optimal policy response to portfolio flows requires proper understanding of the transmission channel through which capital flows affect credit.

In this thesis we look at portfolio flows partly because the evidence regarding the credit effect of portfolio flows is more mixed than for the effect of credit flows (Rey, 2013; Lane and McQuade, 2013). The mixed evidence reflects a need to better understand the impact of portfolio flows and their potential transmission channel to credit. The risk channel proposed by Borio and Zhu (2008); Adrian and Shin (2009) can offer one explanation of how portfolio flows affect credit. If the portfolio inflow is caused by higher foreign demand for local assets, the asset prices will increase and possibly induce the pro-cyclical leverage adjustment argued by Adrian and Shin (2009); Bruno and Shin (2013). This would explain the high correlation in global leverage and risk premia observed by Rey (2013). Another explanation may be that higher asset prices create a wealth effect or affect credit extension through the “balance sheet channel” suggested by Bernanke et al. (1999). Households with investments in domestic assets become more wealthy as asset prices rise, and therefore become less risky borrowers. The lower risk improves their access to credit (Bernanke and Gertler, 1995; Bernanke et al., 1999). “[...] a decline in asset values (for example, a fall in the home equity values) reduces available collateral, leads to an unplanned increase in leverage on the part of borrowers, and impedes potential borrowers access to credit” (Bernanke and Gertler, 1999). The risk story increases banks demand for assets, that is it increases supply of credit. The balance sheet story affect the credibility of borrowers, creating more demand for credit that satisfies the bank’s collateral requirements.

Lane and McQuade (2013) finds evidence from 54 emerging and advanced economies that bond and equity flows have different effects on local credit extension: “The difference is quite striking - net debt flows are highly significant but net equity flows are not significant. ” (Lane and McQuade,2013; p14). The different credit response to debt flows versus equity flows might offer a clue in our search for the transmission channel. A second clue lies in observations made by Kaminsky et al. (2005) and Rey

(2013). Kaminsky et al. (2005) show that capital flows are not only correlated to the local business cycle of the recipient economy, most developing countries also tend to have procyclical fiscal policy *and* procyclical monetary policy that both correlate to the the capital flows. Rey (2013) observes that “[...] cross sectionally, just like in the time series, credit flows seem more strongly related to the global [credit] cycle than other flows and in particular than equity flows.” (Rey, 2013; pp: 301-302).

We will introduce a hypothetical transmission channel that can potentially explain Lane and McQuade’s result in light of Rey’s observation: By our hypothesis, portfolio flows have a greater impact in an already expanding credit market. Debt flows are more correlated to the credit cycle implying that the majority of debt inflows arrive in an already expanding credit market. The debt flows arrive at a time when, by our hypothesis, flows in general have a greater impact on credit. Equity flows, on the other hand, arrive at all stages of the cycle and will therefore have a smaller impact on average. This non-linear relationship will not be captured by standard linear regressions as in Lane and McQuade (2013).

Rapid credit expansion is characterised by a high demand for savings relative to supply of savings. Even traditional deposit based banks may turn to wholesale money markets to fund their credit extension, as deposit liabilities cannot be increased at will (Adrian and Shin, 2009). However, the cost of such funding may be higher (Favero, Giavazzi, and Flabbi, 1999). In this environment where banks themselves are credit constrained, banks are less likely to hold excess cash that could rather have been invested in higher yielding loans to firms and households. We hypothesise that in such an environment, the arrival of portfolio flows may have a direct impact on credit supply. Portfolio inflows arise as foreigners purchase shares and bonds from domestic investors. The investors receive cash in return for the financial assets and part of this cash is likely to be deposited in local banks. During an expansion, when the banking sector lacks cash, this deposit will quickly be invested in credit. At the margin, a pending mortgage application that would otherwise not be approved due to an expected return slightly below the cost of wholesale market funding may now be approved thanks to the unexpected deposit from fund managers (the deposit reflects

an increase in supply of savings that ultimately came from the foreign investor).

Contrast this to portfolio flows that arrive at other stages of the credit cycle. When credit is stable or shrinking, the supply of savings is already equal or greater than demand for savings. Banks have enough deposit liabilities to fund their desired credit extension. An unexpected deposit from fund managers may be used to pay of non-deposit liabilities rather than invested in household credit. Or it may simply be held as cash or cash equivalents such as reserve bank debentures. Flows that arrive at this stage of the credit cycle will not stimulate more credit extension. Since most of capital flows tend to arrive during expansions (Kaminsky et al., 2005; Rey, 2013), it is not surprising that most empirical research finds a positive impact of capital flows on credit (Rodrik and Velasco, 1999; Lane and McQuade, 2013; Rey, 2013).

In order to identify this hypothetical channel in our empirical research, we may find important lessons from the literature on the transmission channel of monetary policy. Bernanke and Blinder (1992) show that monetary policy works by affecting both the assets and liabilities of banks. Liabilities are affected as the supply of deposits to banks (the “money channel”) changes with households demand for money. The “credit” channel has real macroeconomic effects due to firms and households being restricted from raising funds through other channels than financial intermediaries. When financial intermediaries are forced to cut lending, these firms and households will be credit constrained. Empirically it has been tricky to disentangle the effects on the asset side from the effects on the liability side, since by definition both aggregates must move in unison.

We are faced with the same challenge when studying the transmission of portfolio flows. We wish to understand whether portfolio flows increase demand for credit by making households more wealthy, or whether portfolio flows affect credit by increasing the supply of credit offered by banks. But since supply and demand are equal in equilibrium, we need a careful approach to identifying the transmission channel. One potential approach is to study whether the transmission of portfolio flows to credit depends on the balance sheet composition of the financial intermediaries. Favero et al. (1999) estimate the transmission of monetary policy to credit through bank balance

sheets by looking at the cross section of 651 European banks during on period of monetary contraction. They identify the “credit channel” by investigating whether banks with less cash and cash equivalents on their balance sheets are more affected by monetary policy. They posit that small banks are less able to substitute deposits for other market based liabilities. Therefore, small banks can only extend credit if they have sufficient cash and deposits. An increase in the required reserves should force them to cut lending if the bank does not hold excess cash. In total, a “credit channel” on bank balance sheets is identified if monetary policy disproportionately affects the lending of small banks with low cash reserves. They do not find significant statistical evidence of this in their cross section regression for Europe.

We will adopt a related approach to identifying the transmission of portfolio flows to credit in the recipient economy. We use South Africa as a case study. We saw in Chapter 3 that the country has received large portfolio inflows, consisting mainly of equity flows in the years prior to the global financial crisis, and mainly of bond flows in the years following the crisis. Here we will present data on the balance sheets of depositary institutions in the country and further investigate the responses of selected balance sheet items to portfolio flows. Our hypothesis is related to the “credit channel” of banks. If market based liabilities can not be readily substituted for deposits, banks will be more sensitive to deposit funding when their cash ratio is low. The cross section of South African banks in business during our sample consists of 39 banks, but is dominated by the 6 largest banks as illustrated in Figure 4-1. The six largest banks have similar structures of their balance sheet (at least compared to the remaining small banks) and there is not enough cross sectional variation to follow the exact approach of Favero et al. (1999). Instead we utilise the monthly time series data of the balance sheets over the last 13 years. If our hypothesis is correct, we should find that portfolio flows have a greater impact at times when banks have less cash as a ratio of their total assets. To investigate this, we begin with a broad view of the data, then conduct OLS regressions with interaction terms between portfolio flows and the cash ratio both on the aggregate balance sheet of the country’s banks and on the panel data of each individual bank. At last we estimate threshold vector

auto regressive models in which we study whether there is a threshold cash ratio that determines whether the credit cycle is in a state in which portfolio flows have a greater or small impact on credit.

4.2 An overview of South African banks' balance sheets

Figure 4-1 illustrate the dominance of the largest five banks in the SA banking sector. Any significant transmission channel must therefore be visible in these top five banks. In appendix B.2 we plot the composition of the five largest banks individually. The charts illustrate the similar structure of their balance sheets ¹. Due to the small number of significant banks and the lack of variability in balance sheet composition between them, we rather focus on a time series analysis of the aggregate balance sheets.

We estimate the correlation coefficient between each kind of portfolio flow (shares and bonds) and every balance sheet item reported to the South African Reserve Bank in the BA900 forms. The liability items with the highest correlation to share flows is reported in *Table 4.1* and to bond flows in *Table 4.2*. We then report the asset items with the highest correlations to shares and bonds in *Table 4.3* and *Table 4.4*.

¹A similar chart of the remaining smaller banks show vast differences in balance sheet composition, with several banks highly exposed to one asset class or liability class. An example is the recently failed African Bank that was almost fully funded by short term debt securities rather than deposits and almost fully invested in unsecured household credit

Item	Spearman Rho	P-value
Deposits: Other financial private sector	0.313	0.000
Deposits: Banks and private financials	0.299	0.000
Deposits: Banks plus public and private financials	0.259	0.001
Deposits: Private financial sector	0.249	0.002
Deposits: Non money market unit trusts	0.236	0.038
Borrowed Funds: Collateralised borrowing_Total	0.206	0.012
Borrowed Funds: Total	0.195	0.017
Borrowed Funds: Other	0.177	0.124
Total liabilities to the public	0.174	0.034

Table 4.1: Liability items with the highest correlation to share flows (We report the estimated Spearman's Rho correlation between monthly portfolio flows and *changes in* balance sheet items)

Item	Spearman Rho	P-value
Borrowed Funds: Collateralised: financial sector	0.245	0.032
Deposits: Banks plus public and private financials	0.230	0.005
Deposits: Public investment corporation	0.218	0.008
Deposits: Banks and private financials	0.178	0.030
Deposits: Pension funds	0.176	0.032
Other: Derivative instruments: domestic financials	0.161	0.162
Deposits: Private fund managers	0.147	0.201
Borrowed Funds: Repurchase: Other financials	0.145	0.208
Other Liabilities: Subordinated debt: SA Banks	0.143	0.214

Table 4.2: Liability items with the highest correlation to bond flows (We report the estimated Spearman's Rho correlation between monthly portfolio flows and *changes in* balance sheet items)

Item	Spearman Rho	P-value
Deposits: SA Banks: Maturity more than 6 months	0.241	0.003
Resale agreements: Insurers	0.238	0.037
Mortgages: Total	0.233	0.004
Mortgages: Residential Corporates	0.226	0.006
Investments: Asset backed securities: Non financial	0.223	0.052
Mortgages: Residential Household	0.220	0.007
Mortgages: Residential: Total	0.216	0.008
Investments: Commercial paper: Non liquid	0.199	0.015
Instalment debtors and leases: Other	0.183	0.112
Credit Card: Household	0.166	0.043

Table 4.3: Asset items with the highest correlation to share flows (We report the estimated Spearman's Rho correlation between monthly portfolio flows and *changes in* balance sheet items)

Item	Spearman Rho	P-value
CreditCard: Financial corporates	0.249	0.029
Instalment debtors and leases: Financial corporates	0.227	0.048
Overdrafts loans and advances: Households	0.192	0.019
Investments: Asset backed securities: Non financial	0.172	0.134
Non Financial Assets: Intangible: Computer software	0.170	0.038
Investments: Marketable RSA government stock	0.169	0.040
Other assets	0.162	0.048
Instalment debtors and leases: Other	0.158	0.169
Investments: Interest bearing government securities	0.148	0.073
Overdrafts: Private Financial corporates	0.147	0.075

Table 4.4: Asset items with the highest correlation to bond flows (We report the estimated Spearman's Rho correlation between monthly portfolio flows and *changes in* balance sheet items)

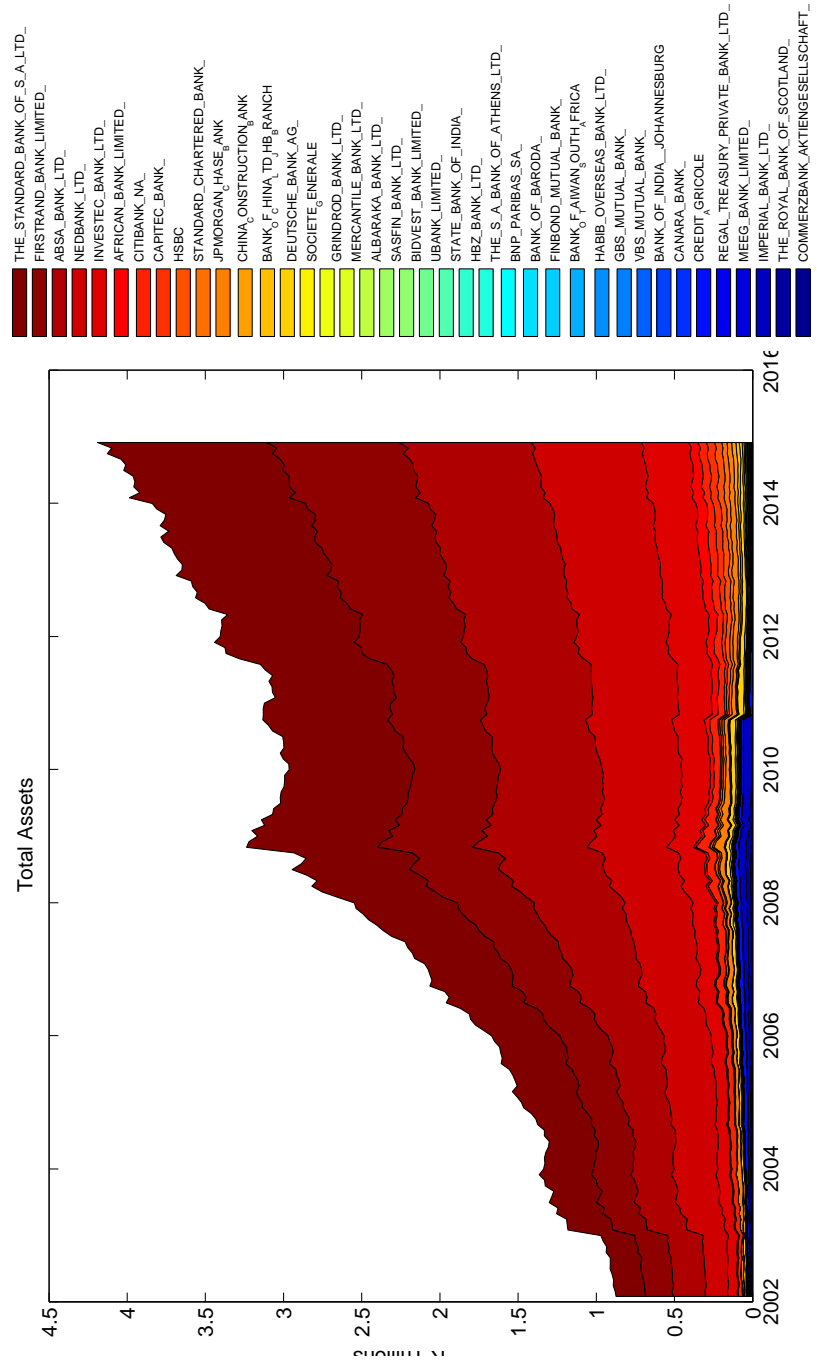


Figure 4-1: Total assets held by SA banks (Rand Trillions)

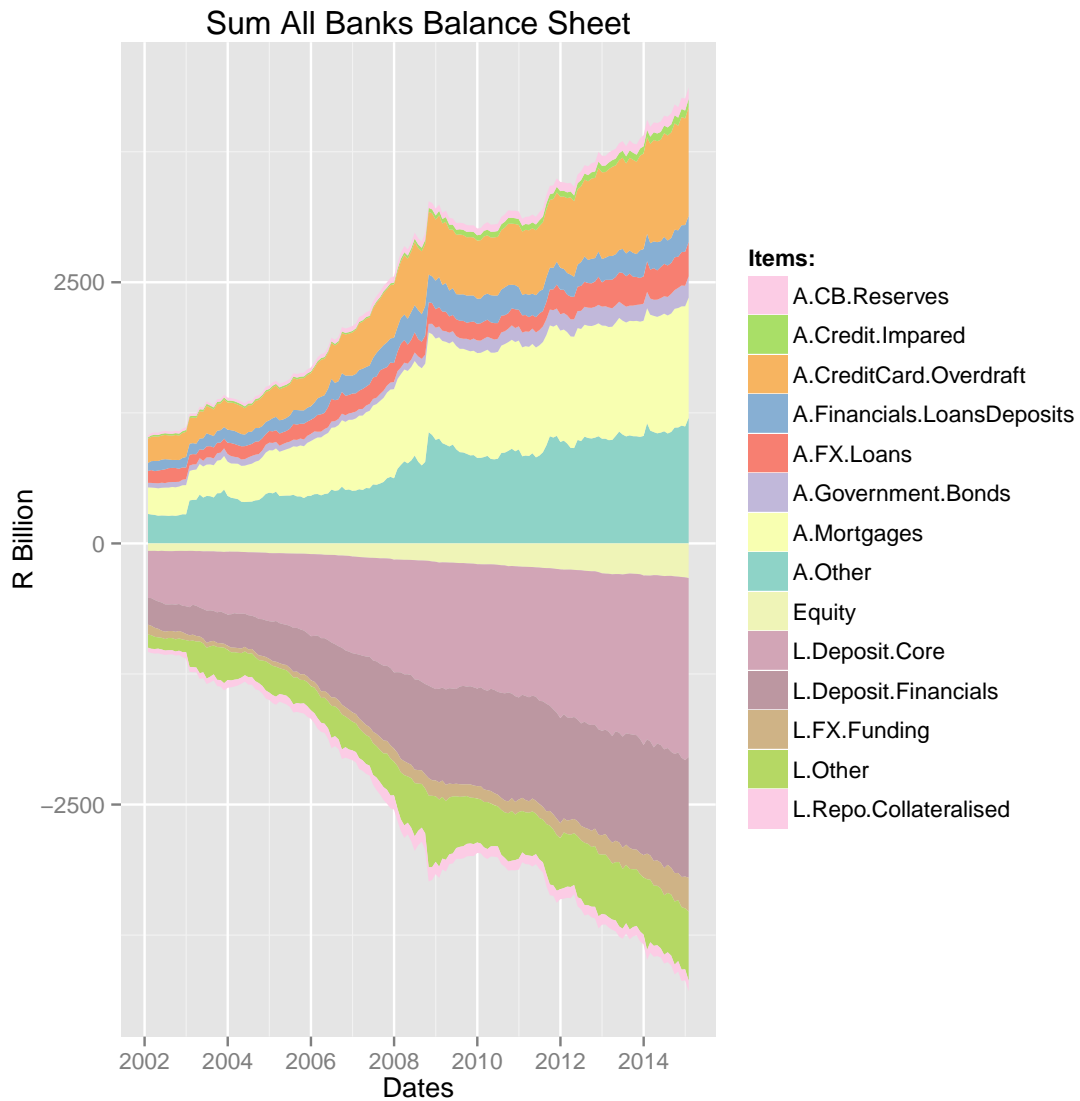


Figure 4-2: Composition of the aggregate balance sheet held by SA banks. Assets are recorded as positive numbers and liabilities as negative numbers.

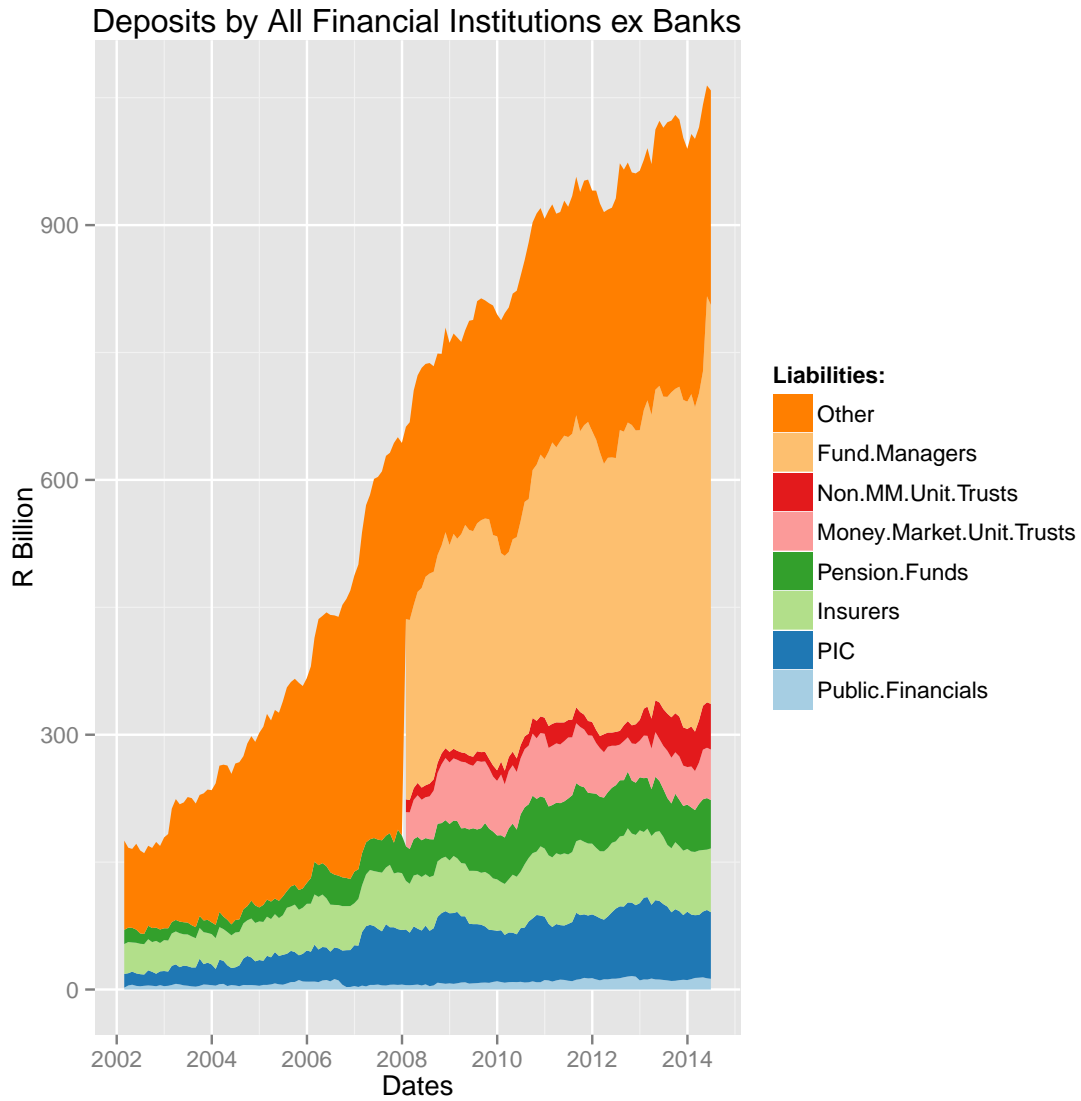


Figure 4-3: Composition of liabilities to all financial institutions excluding other banks.

On the liability side we see that the items with the highest correlation to portfolio flows are deposits from the financial sector, both including and excluding other banks. This supports the first element of our hypothesis that portfolio flows do affect the liability side of banks' balance sheets. The portfolio flow involves a transaction between a domestic fund manager and a non-resident investor. The fund manager sells domestic assets in return for cash. The fund manager then transfers parts of the cash to deposit accounts in the banking sector. The high, statistically significant, correlation between monthly share and bond flows and changes in deposits from fund managers is in line with what we expect based on this hypothesis.

We also find a positive correlation between portfolio flows and credit. We see that on average, the largest significant correlations between portfolio flows and asset items are found between flows and bank deposits, different kinds of mortgages and other types of debt. Firstly, a bank's deposits in other banks will have no effect in the aggregate. The deposit of one bank is the liability of another, and they do not cause an expansion of credit. The asset we are most interested in is mortgages. We see in *Figure 4-2* that this is the largest asset class by value. Furthermore, mortgages are interesting because households and firms are unlikely to raise the same kind of funding from other institutions than banks. Thus, an increase in the supply of mortgage funding from banks is likely to have significant macroeconomic effects, as this increase constitutes an actual expansion of credit rather than just a substitution to bank funding from alternative funding.

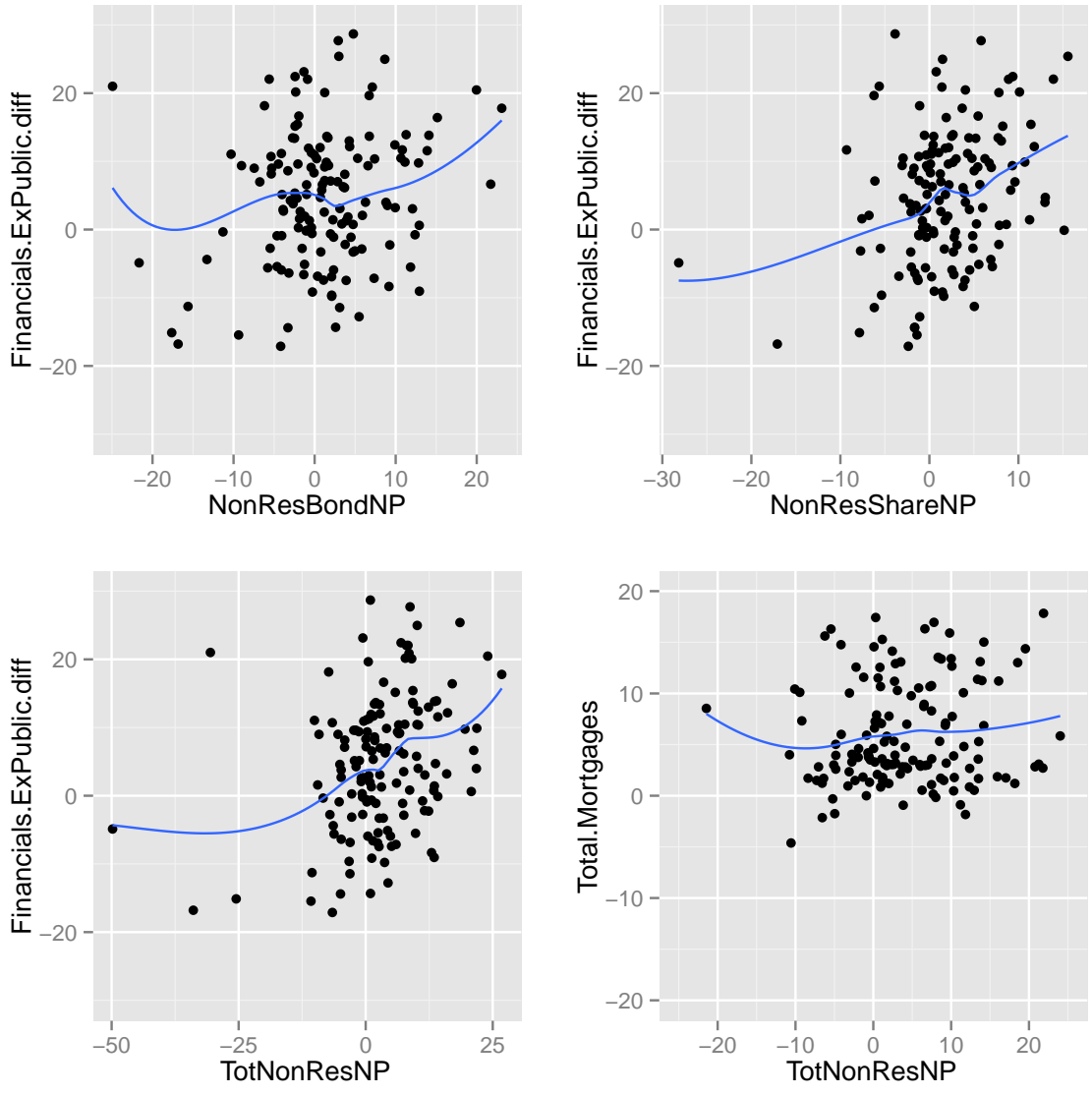


Figure 4-4: Scatterplot of portfolio flows with changes in deposits from private fund managers and pension funds. The bottom left panel shows total portfolio flows with change in mortgages. Flows and balance sheet items are all measured in Rand Billions.

The simple linear correlation coefficients reported this far are in line with the hypothesis. The next step is to test whether a causal linear relationship exists. *Table 4.5* reports results from a linear OLS regression explaining change in mortgages on lagged changes, lagged policy rates (SARB repurchase rate), lagged deposits by financial institutions, share flows, bond flows, the VIX and lagged bond yields.² We lag the policy rate, financial deposits and the bond yield to remove endogeneity issues (that is, we do not want the bond yield to capture the effect of bond flows, or the financial deposits to capture the effect of higher mortgages). The results suggest that there is significant autocorrelation in the growth of credit extension. We also see that share flows have a statistically significant positive effect on credit. There are no other statistically significant relationships in this model.

Figure 4-5 plot the impact of each observation on the estimated coefficients from a model similar to the one reported in *Table 4.6*. Each data point on the graph indicate the change in the respective coefficients if the observation corresponding to that date was deleted from the sample. There are clearly outliers with significant impact on the results. These outliers are removed in the results reported in *Table 4.6*. Results from the same regression with outliers included are reported in *Table A.4* in *Appendix A.2*. The signs are the same when outliers are included, but the significance is even higher, probably due to the larger variation in the data. The effect of individual observations on coefficient estimates when outliers have been removed are plotted in *Figure B-14* in *Appendix B.2*.

²We use first differences of non-stationary data to ensure stationarity of all variables. We include the lagged dependent variable to remove any autocorrelation from the errors.

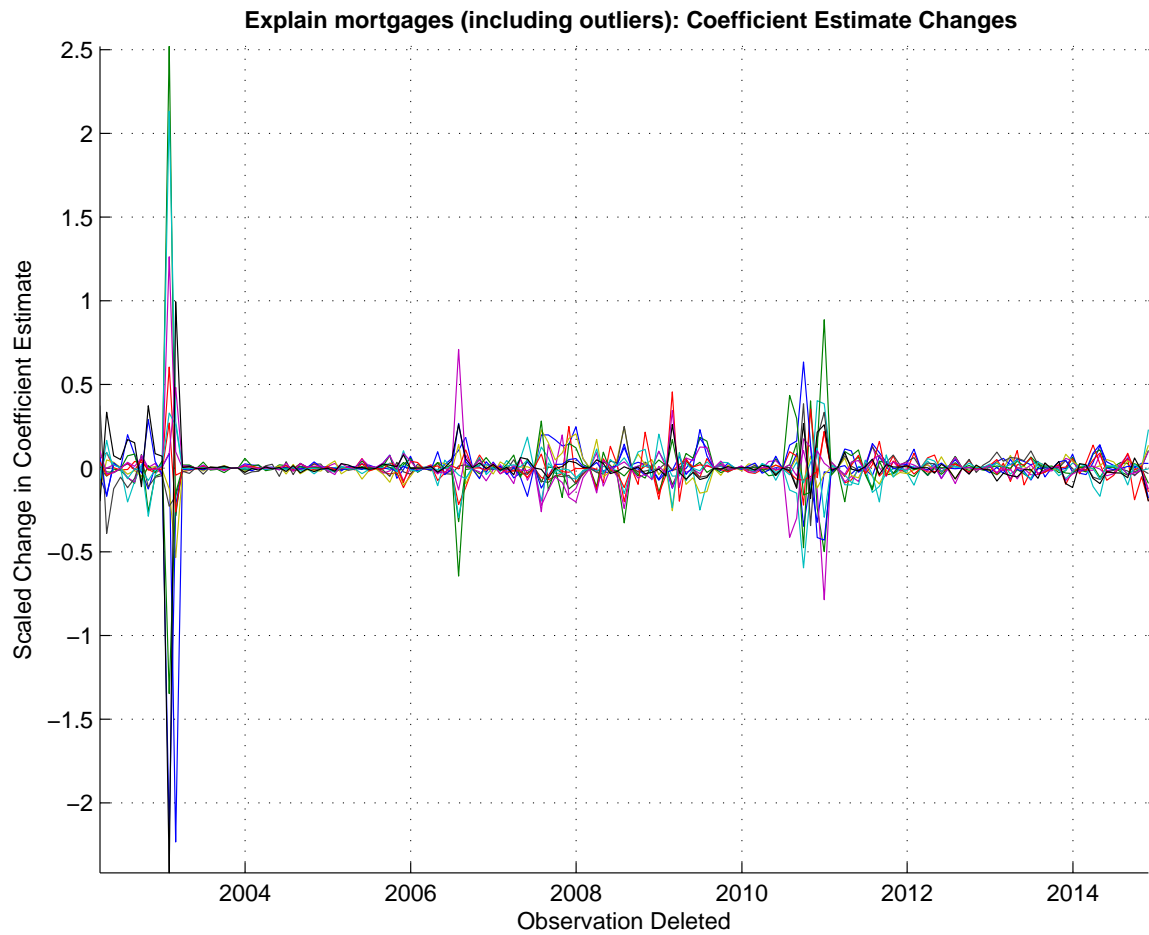


Figure 4-5: Outlier Diagnostics: The effect of removing each observation on the estimated coefficients.

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
'(Intercept)'	-0.658	3.029	-0.217	0.8283
'ldmortgages'	0.738	0.055	13.444	0.0000
'ldfinancials'	0.041	0.025	1.643	0.1028
'shareflow'	0.099	0.049	2.039	0.0434
'bondflow'	-0.034	0.036	-0.942	0.3479
'vix'	-0.009	0.033	-0.276	0.7828
'lbondyield'	0.232	0.352	0.660	0.5105

Explained Variable: Change in mortgages

Number of observations: 142, Error degrees of freedom: 135

Root Mean Squared Error: 3.17

R-squared: 0.616, Adjusted R-Squared 0.599

F-statistic vs. constant model: 36.2, p-value = 7.42e-26

Table 4.5: Results from linear regression explain change in mortgages. Outliers Removed.

The model estimated in *Table 4.5* is misspecified if there are non-linear relationships between the variables. We wish to test for one specific non-linearity: whether portfolio flows have a greater impact on credit when banks have already invested most of its assets in credit extension and have little spare cash to draw on. The lack of cash on balance sheets may be most restrictive during expansions when demand for credit is high. The first step in our analysis is to extend the linear OLS to include interaction terms between portfolio flows and the ratio of cash to total assets on bank balance sheets. We measure cash as money deposited at the Reserve Bank and money invested in Reserve Bank debentures. This is cash that is outside the banking system and can be drawn on when a further credit extension is desired by the banks.³

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
'(Intercept)'	1.212	4.228	0.287	0.7747
'ldmortgages'	0.493	0.073	6.797	0.0000
'lcashratio'	84.305	163.934	0.514	0.6079
'ldfinancials'	0.064	0.034	1.894	0.0603
'shareflow'	2.368	0.756	3.133	0.0021
'bondflow'	0.255	0.496	0.515	0.6077
'lbondyield'	0.290	0.394	0.736	0.4631
'lcashratio:shareflow'	-78.388	28.446	-2.756	0.0066
'lcashratio:bondflow'	-10.821	18.066	-0.599	0.5502
'shareflow:vix'	-0.006	0.006	-1.065	0.2889
'bondflow:vix'	0.002	0.007	0.316	0.7528
'vix'	-0.294	0.228	-1.293	0.1981
'vix ² '	0.004	0.004	1.120	0.2645

Explained Variable: Change in mortgages

Number of observations: 142, Error degrees of freedom: 130

Root Mean Squared Error: 3.02

R-squared: 0.664, Adjusted R-Squared 0.635

F-statistic vs. constant model: 23.3, p-value = 9.47e-26

Table 4.6: Model explaining change in mortgages. We include interaction terms between portfolio flows and the cash ratio as well as portfolio flows and the VIX. We include square VIX to control for other non-linear effects of risk. Outliers due to suspected data errors have been removed (results with outliers included are reported in Appendix A.2).

³As opposed to cash equivalents such as deposits in other banks, which in the aggregate cancel out and can not be drawn on to expand aggregate credit.

Table 4.6 reports results from the regression including interaction terms between the cash ratio and portfolio flows and risk and portfolio flows.⁴ The results suggest that share flows have a significant positive effect on portfolio flows, but the higher the cash ratio the smaller this effect is. The results on share flows are in line with our hypothesis and might reflect the greater impact of cash injections when there is already a lack of cash on banks' balance sheets. The signs on the effect of bond flows are the same, but the coefficients are not statistically significant. The lacking impact of bond flows is difficult to explain and can only be consistent with our hypothesis if for some reason fund managers put cash received from sales of shares to a different use than cash received from sales of bonds. Specifically, the proceeds from a share sale is deposited in banks, while the proceeds from a bond sale is invested elsewhere.

The next step of our analysis is therefore to estimate the causal effect of portfolio flows on fund manager deposits. In *Table 4.7* we report results from a regression explaining changes in deposits from fund managers, pension funds, unit trusts, the public investment corporations, etc. These are all portfolio managers whom are likely to be involved in the observed portfolio flow transactions. The results suggest that share flows have a significant positive effect on deposits from portfolio managers. Bond flows have no statistically significant effect. The results can explain why share flows are found to have a greater impact on credit than bond flows. Proceeds from share sales tend to be deposited in the banking system, providing a new source of cash that can be extended as credit. Proceeds from bond flows are not generally deposited in the banking system and therefore has no direct effect on bank balance sheets.

We have no results that can explain why the proceeds from share sales are deposited while proceeds from bond purchases are not. Presumably the explanation lies in the reason for the asset sales. In chapter 3 we saw that bond purchases by local fund managers (bond outflows) tend to be caused by higher risk. Our results *Table 4.7* show that financial deposits tend to increase when bonds are sold in times of high risk.

⁴The interaction between risk and portfolio flows as well as the squared VIX term are all included to control for other non-linearities in the relationship between risk and portfolio flows. We saw in chapter 3 that such non-linearities may be of importance. The results without these interaction terms are reported in *Figure A.6*. We see that the signs and statistical significance are unaffected by the inclusion of the interaction term.

We speculated that bond flows were more sensitive to risk than share flows because local fund managers reduce risk by selling local shares and purchasing local bonds, enabling foreigners to more easily sell emerging market bonds than shares when risk is high. Thus, when risk is high, bond purchases are funded by selling shares rather than drawing on bank deposits. If instead we observe in a given month a combination of high risk and local fund managers *selling* bonds (that is, the interaction term is positive, we have higher risk and bond inflows), they likely sell bonds to deposit the proceeds in even lower risk assets such as bank deposits. Therefore, bond flows only have a positive effect on deposits when risk is high. In other times, bonds are sold to invest in more risky assets and the proceeds will not reflect in higher bank deposits.

Sales of domestic shares may be initiated for different reasons. If shares are sold to reduce risk in a high risk environment, the proceeds are likely to be invested in local bonds since foreigners are willing to sell emerging market bonds at a lower price when risk is high. Thus, less of the share sale proceeds are deposited in bank accounts when risk is high. When risk is low, the proceeds from share sales are more likely to be deposited in banks since the bond rates are low due to high foreign demand.

While these explanations would be consistent with the observed results, the discussion remains highly speculative at this point. The model presented in chapter 5 provides more structure to the discussion. In the following we return focus to the question of whether the timing of portfolio flows matters for its impact on credit.

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
'(Intercept)'	12.956	10.952	1.183	0.2389
'ldfinancials'	-0.010	0.086	-0.117	0.9073
'shareflow'	0.820	0.362	2.267	0.0250
'bondflow'	-0.405	0.356	-1.140	0.2564
'vix'	0.183	0.547	0.335	0.7379
'lbondyield'	-1.435	1.261	-1.138	0.2570
'shareflow:vix'	-0.032	0.014	-2.219	0.0282
'bondflow:vix'	0.034	0.016	2.141	0.0341
'vix ² '	-0.000	0.010	-0.036	0.9710

Explained Variable: Change in deposits from financial institutions ex. banks

Number of observations: 142, Error degrees of freedom: 133

Root Mean Squared Error: 10.9

R-squared: 0.0975, Adjusted R-Squared 0.0432

F-statistic vs. constant model: 1.8, p-value = 0.0833

Table 4.7: Results from a OLS regression explaining change in deposits by fund managers, pension funds and unit trusts. The model includes interaction terms between portfolio flows and the VIX and the squared VIX to account for non-linearities in the effect of risk. Outliers are removed. Results with outliers included are reported in *Table A.5* in *Appendix A.2*

4.3 Fixed Effects panel regressions support findings from OLS

Here we continue with the model specification including all interaction terms. Results with only interaction between flows and the cash ratio are included in *Appendix A.2*. We use the data with outliers removed. *Table 4.8* reports results from a panel data regression with fixed effects on each bank using a Maximum Likelihood algorithm. We only include the largest five banks in the sample as these supply almost the entire mortgage market (the share of each bank in the mortgage market is plotted in *Figure B-12*).

'Explanatory Variables'	'Coefficient'	'Standard Error'	'tStat'	DF	pValue
'(Intercept)'	-0.347	1.353	-0.257	694	0.7974
'NEDBANK'	0.000	0.344	0.000	694	1
'ABSA BANK '	0.000	0.344	0.000	694	1
'FIRSTRAND '	0.000	0.344	0.000	694	1
'STANDARD BANK '	0.000	0.344	0.000	694	1
'ldmortgages'	0.678	0.024	28.247	694	1.92E-117
'ldfinancials'	0.049	0.010	4.743	694	2.56E-06
'shareflow'	1.381	0.247	5.586	694	3.33E-08
'bondflow'	-0.558	0.161	-3.465	694	5.63E-04
'vix'	-0.201	0.067	-2.992	694	0.0029
'lbondyield'	0.484	0.150	3.220	694	0.0013
'lcashratio:shareflow'	-41.714	9.219	-4.525	694	7.11E-06
'lcashratio:bondflow'	20.116	5.854	3.436	694	6.25E-04
'shareflow:vix'	-0.005	0.002	-3.030	694	0.0025
'bondflow:vix'	-0.001	0.002	-0.666	694	0.5056
'vix ² '	0.003	0.001	2.433	694	0.0152

Explained Variable: Change in mortgages

Number of observations: 710

Root Mean Squared Error: 8.3761

R-squared: 0.66364, Adjusted R-Squared: 0.65637

Log-Likelihood: -1761.9579

Table 4.8: Panel regression explaining change in mortgages. Outliers are excluded from the sample.

We see from *Table 4.8* that the panel data regression largely supports our previous

results. All variables except the fixed effects and the interaction between bond flows and the fix are statistically significant. Share flows have the effect on mortgages as expected by our hypothesis. Bond flows do not. By these results, bond flows have a greater impact on mortgage extension when the cash ratio is high. The coefficients suggest that only when the cash ratio is above 2.77 % will a bond flow cause an injection of cash on bank balance sheets. Instead, when the cash ratio is below 3.31%, a share flow will cause an increase in mortgage extension.⁵ Over the sample period we see that the cash ratio has almost always been within the range where share flows have a positive effect on credit (*Figure 4-6*). Approximately half of the sample period have the ratio been above the level where bond flows have a positive effect on credit.

The hypothesis laid out above is difficult to reconcile with the results that credit only increases in response to higher bond flows when banks hold more cash. However, some explanation is provided by the results from a panel regression explaining deposits from financial institutions. There is no reason why the cash ratio on bank balance sheet should affect the decision of portfolio managers to deposit the proceeds from an asset sale in a bank account or invest the proceeds in other assets. Thus, we do not include the cash ratio in the equation. It is however possible that the risk environment affects the decision to deposit or invest the proceeds from the asset sale. For example, the decision to deposit or invest may depend on the reason for the sale. And the reason for the sale is likely to be related to risk. *Table 4.9* shows that bond inflows only increase deposits from financial institutions in times when the VIX is above 12. The proceeds from share flows are only deposited when the VIX is below 26.⁶ *Figure 4-6* shows that over the majority of the sample period has the VIX been within the range where both share and bond flows increase deposits in banks.

Overall, the results from the panel regressions support the findings from the ag-

⁵The ratio yielding positive effects of portfolio flows is found by solving $\hat{\beta}_1 * Flow + \hat{\beta}_2 (CashRatio * Flow) > 0$, with solution $CashRatio = \frac{-\hat{\beta}_1}{\hat{\beta}_2}$. We estimate $\hat{\beta}_1 = -0.558$ and $\hat{\beta}_s = 20.116$ for bond flows and $\hat{\beta}_1 = 1.381$ and $\hat{\beta}_2 = -41.714$ for share flows. The threshold ratios are therefore: $\frac{0.558}{20.116} = 0.0277$ and $\frac{-1.381}{-41.714} = 0.0331$.

⁶The VIX at which flows cause higher deposits is found by solving $\hat{\beta}_1 * Flow + \hat{\beta}_2 (VIX * Flow) > 0$. The solution is $\frac{0.4054}{0.0342} = 11.85$ for bond flows and $\frac{-0.8198}{-0.0319} = 25.7$ for shares.

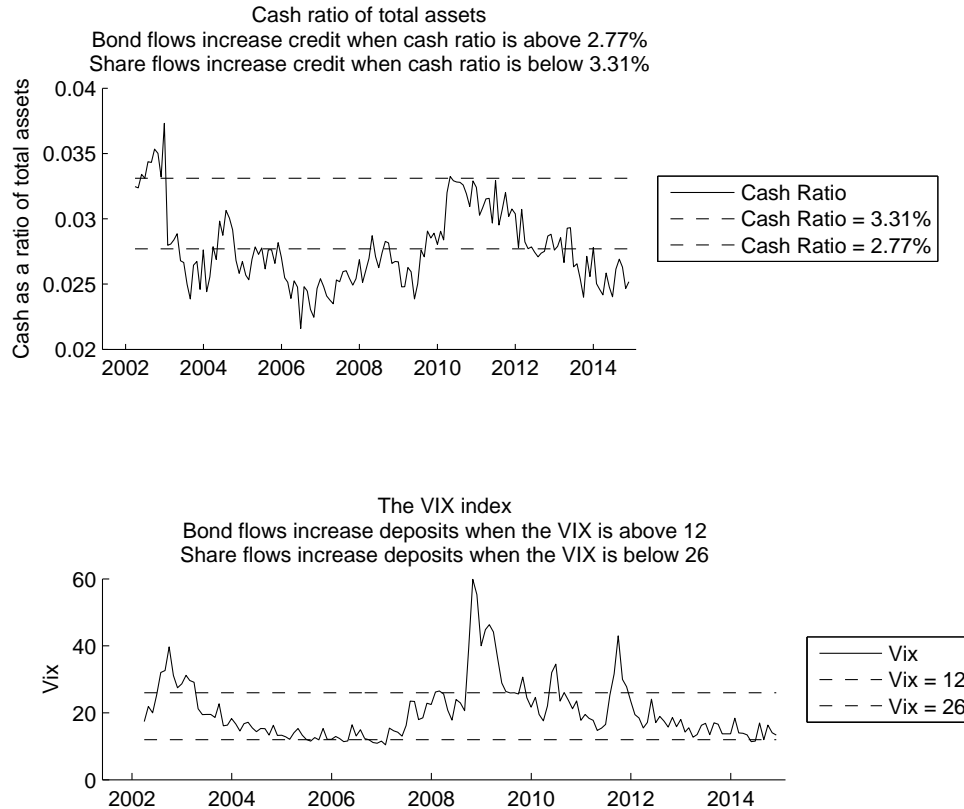


Figure 4-6: Cash (reserve bank money and debentures) as ratio of total assets (left) and the VIX (right).

gregate balance sheet of all banks. The recurring issue is the potential endogeneity of explanatory variables. The behavior of fund managers depends on variables such as risk and possibly also on past growth in credit. Thus, the portfolio flows and the decision to deposit or invest the proceeds will be endogenous. We explored some of these issues in this and the preceding chapter by estimating the response of portfolio flows to risk and yields, and regressing the response of fund manager bank deposits on flows and other variables. In the remainder of this chapter we attempt to tie it all together in a relatively simple non-linear threshold vector autoregressive model.

'Explanatory Variables'	'Coefficient'	'Standard Error'	'tStat'	DF	pValue
'(Intercept)'	12.9563	4.8059	2.6959	697	0.0072
'NEDBANK'	1.14E-14	1.2533	9.13E-15	697	1
'ABSA BANK'	8.54E-15	1.2533	6.81E-15	697	1
'FIRSTRAND'	8.46E-15	1.2533	6.75E-15	697	1
'THE STANDARD BANK'	1.08E-14	1.2533	8.60E-15	697	1
'ldfinancials'	-0.01	0.037	-0.2696	697	0.7875
'shareflow'	0.8198	0.1566	5.2367	697	2.17E-07
'bondflow'	-0.4054	0.1539	-2.6338	697	0.0086
'vix'	0.1833	0.2366	0.7747	697	0.4388
'bondyield'	-1.4353	0.5457	-2.6304	697	0.0087
'shareflow:vix'	-0.0319	0.0062	-5.127	697	3.82E-07
'bondflow:vix'	0.0342	0.0069	4.9478	697	9.42E-07
'vix ² '	-3.52E-04	0.0042	-0.084	697	0.9331

Explained Variable: Change in financials deposits

Number of observations: 710

Root Mean Squared Error: 111.5311

R-squared: 0.097473, Adjusted R-Squared: 0.081935

Log-Likelihood: -2681.0241

Table 4.9: Panel regression explaining change in deposits from fund managers, pension funds and unit trusts. Outliers are excluded from the sample.

4.4 Threshold VAR indicates significant non-linearities

We now test whether there is statistically significant evidence that there is a non-linear relationship. This is done by estimating a vector autoregressive model with the variables introduced above:

$$y_t = \begin{cases} \beta_1 y_{t-1} + u_t & \text{if } q_t > \gamma \\ \beta_2 y_{t-1} + u_t & \text{if } q_t \leq \gamma \end{cases} \quad (4.1)$$

where q_t is the selected threshold variable at time t (we test for two different threshold variables, the cash ratio and the VIX). The selected level of the threshold is indicated by γ . The endogenous variables in y_t are:

$$y_t = \begin{pmatrix} VIX_t \\ ShareFlow_t \\ BondFlow_t \\ BondYield_t \\ \Delta FinancialDeposits_t \\ \Delta Mortgages_t \end{pmatrix} \quad (4.2)$$

A Cholesky decomposition is used to get the structural residuals, covariance matrix and coefficients from the reduced form estimates. The order implies that the top variable can have immediate effects on the below variables. All variables can have lagged effects on all other variables. We follow the approach of Gonzalo and Pitarakis (2002, 2012) who show that the correct threshold can be found simply by selecting the threshold that yields the highest Wald type statistic. The Wald statistic is calculated as:

$$\max \frac{T(S_T - S_T(\gamma))}{S_T(\gamma)} \quad (4.3)$$

where T is the number of threshold values that are tested, S_T is the residual sum of squares of the linear model without a threshold, $S(\gamma)$ is the residual sum of square of the respective threshold value. We then select the model with the highest W under

the condition that this W is greater than the critical value. The critical value is determined by the equation:

$$c = T \left(e^{\frac{pc_T}{T}} - 1 \right) \quad (4.4)$$

where p is the number of variables and c_T is set to $c_T = \ln(T)$ as recommended in Gonzalo and Pitarakis (2002). We estimate the threshold to be where cash constitutes 3.1% of the total assets. The Wald statistic for this threshold is 41.62 compared to a critical value of 33.0774. The cash ratio indicates a statistically significant threshold. We run the same tests using the VIX as a threshold variable. It could be possible that the cash ratio simply worked as a proxy for the VIX and that global risk really determine the threshold. However, we do not find any significant threshold level with the VIX as the threshold variable. This is interesting in itself as it suggests that the main non-linearity is related to the local credit cycle and not the global risk cycle. Mortgage extension responds differently to other variables when the cash ratio is below 3.1% than it does when the cash ratio is above 3.1%. For the majority of the sample, the cash ratio is below this threshold of 3.1%. *Figure 4-7* plot the change in mortgages with the shaded area indicating times when the cash ratio is above the threshold of 3.1%.

Since there are very few observations with a cash ratio above the threshold of 3.1%, we have too few degrees of freedom for a meaningful Vector Auto Regression to be estimated on this sub-sample. For the purposes of comparing impulse responses above and below the threshold, we therefore use the lowest threshold that is found to be statistically significant: a cash ratio of 2.85%. In *Figure 4-7* we plot change in mortgages with the threshold state indicated by the shaded background. The left panel indicates the threshold with the greatest statistical significance, the right panel indicates the states using the lowest threshold that still is statistically significant. In the following we utilise the lower threshold, but we report all the figures and tables from the equivalent models using the higher threshold in *Appendix B.2*.

The resulting impulse responses from the non-linear threshold model are plotted in *Figure 4-9*, while the impulse responses from the equivalent linear model are plotted

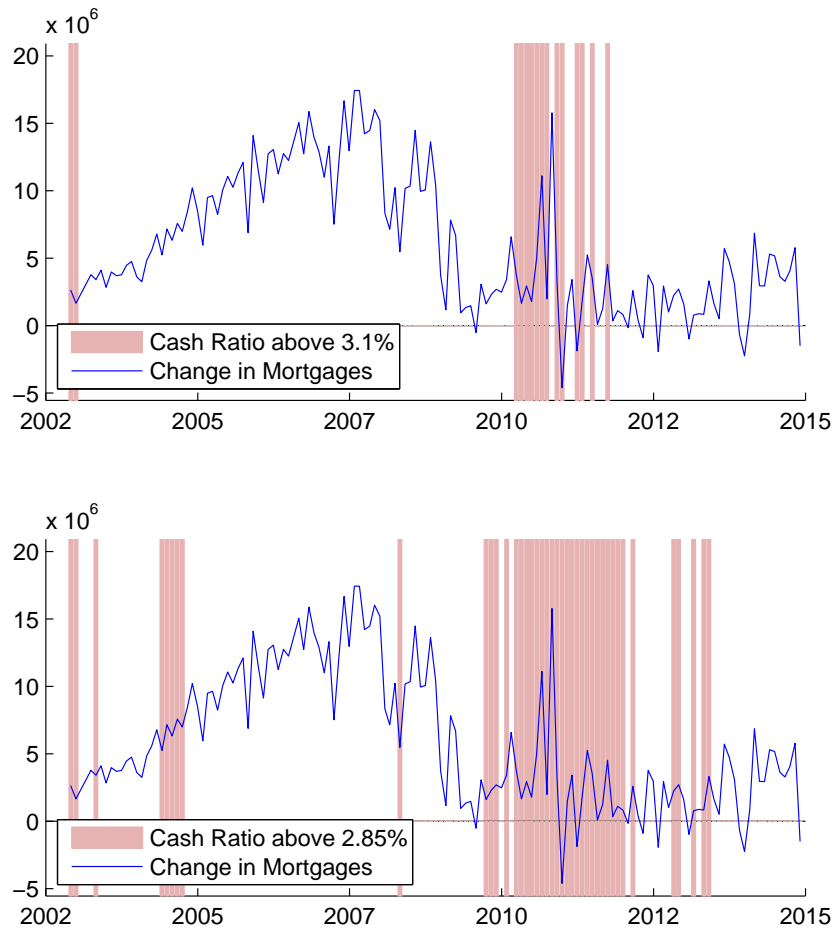


Figure 4-7: Change in mortgages with shaded area indicating time periods when the cash ratio is above the threshold of 3.1%.

in *Figure 4-8*. In the linear model we see that the VIX causes a statistically significant outflow in both shares and bonds, which after few months leads to a long lasting drop in the growth of mortgage extension. Fund manager deposits respond positively to both flows, but only the response of share flows is statistically significant. The deposits appear to also respond positively to the VIX, indicating that the total impact on deposits when the VIX is high is positive, despite the negative effects of the associated portfolio outflows. This may be explained by fund managers selling foreign assets and depositing the proceeds on banks at home when global risk is high. This is an important countercyclical benefit of allowing domestic investors to hold foreign assets.

We see that mortgages have a long lasting highly significant positive response to

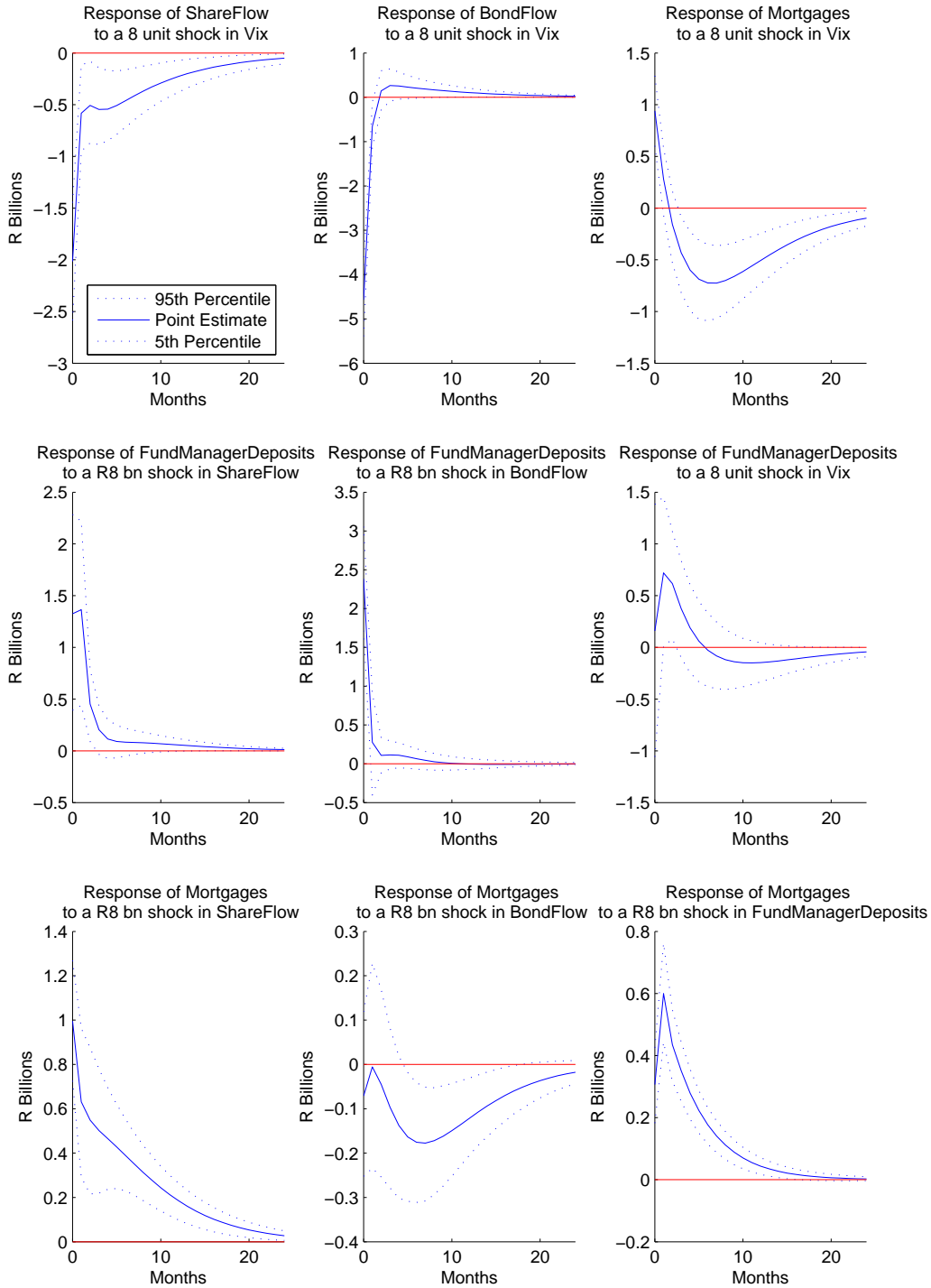


Figure 4-8: Impulse responses from constant parameter Vector Auto Regressive model.

share flows, but not significant response to bond flows. We also see a statistically significant response of mortgages to fund manager deposits. It is possible that mort-

gages respond stronger to share flows because the share flows have a more significant effect on fund manager deposits. Another explanation can be the timing of share flows compared to bond flows. For example, share flows may have tended to arrive when the threshold variable makes them more impactful on mortgages, while bond flows may have tended to arrive when these flows have a lesser impact on mortgages. These elements will not be captured in the (mis-specified) linear model.

The analysis of the linear model should essentially be discarded since we have evidence of non-linearities. The impulse responses from the non-linear threshold model are reported in *Figure 4-9*, and show that portfolio flows respond to the VIX in the same manner in both cash ratio regimes. However, when the cash ratio is below the threshold, that is during credit expansions when we posit that cash injections are more powerful, we see that the VIX has a much stronger long lasting effect on mortgages and fund manager deposits respond positively over an extended period to share flows. In this regime, share flows have an even longer lasting positive effect on mortgages. Bond flows have a negative, if any, effect on financial deposits and therefore a negative if any effect on mortgages. The most important test of our hypothesis lies in the bottom right panel. Fund manager deposits have strong long lasting effects on mortgages when banks have less cash on their balance sheet.

To summarise: If portfolio flows affect credit extension by affecting demand, we should see stronger effects when the cash ratio is high. We see indications of this in response to bond flows, suggesting that this transmission channel may exist. However, we also find strong support of our hypothesis that the transmission channel works by affecting banks' supply of credit. Share flows cause injections of deposits in banks from fund managers who sold the shares to non-residents. The injection of cash on bank balance sheets have a greater impact on credit when the cash ratio is low. This suggests that banks use the deposits for paying off other liabilities when they already have plenty of cash, but if credit demand is high and they have less cash, the banks use the deposits to extend new credit. This makes the effect of share flows pro-cyclical.

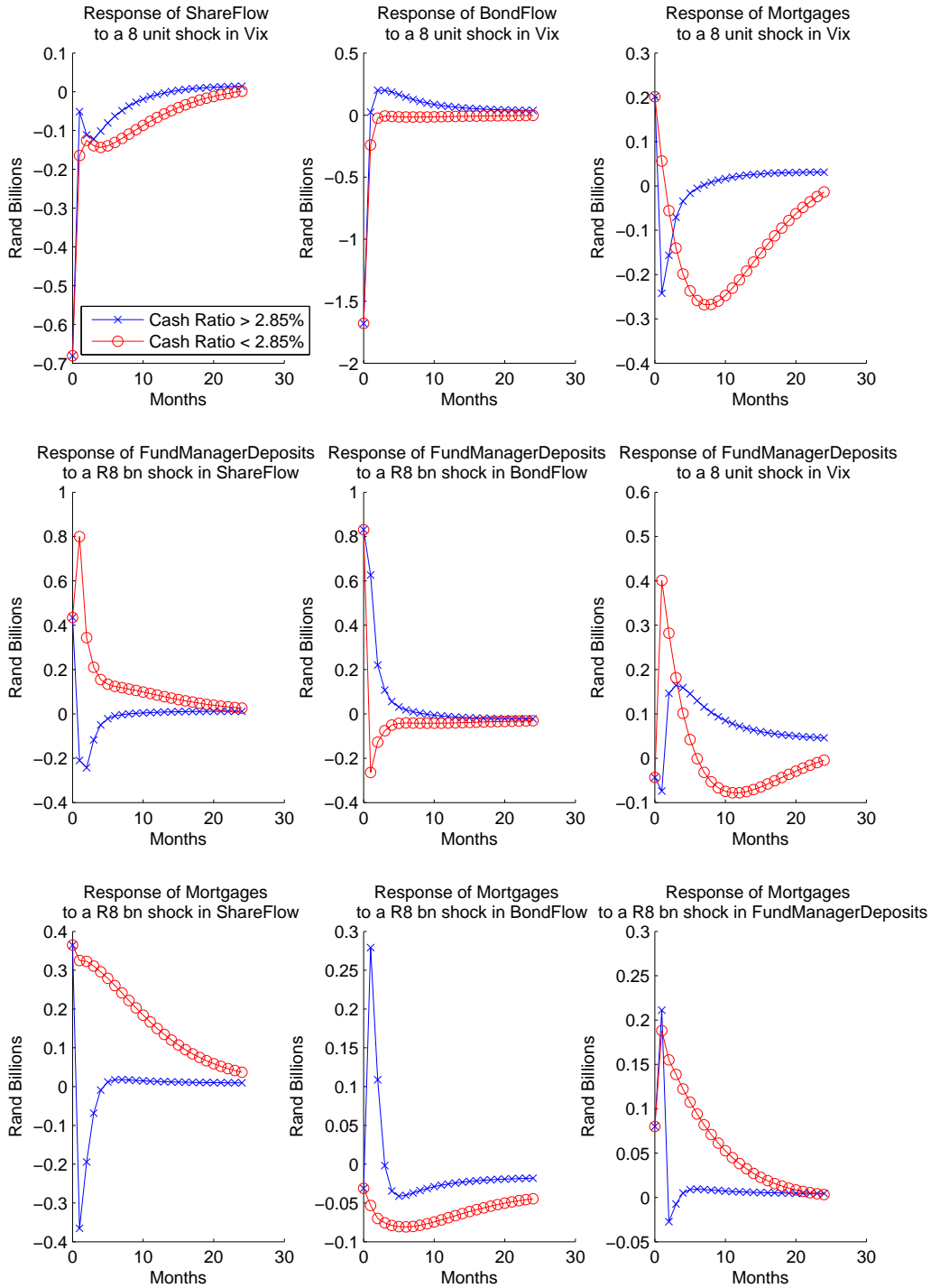


Figure 4-9: Impulse responses from a Threshold Vector Auto Regression. The (red) line marked with 'o'-es indicate responses when the cash ratio is above 2.85%. The (blue) line marked with 'x'-es indicate responses when the cash ratio is below 2.85%.

4.5 Conclusion

The effect of portfolio flows on local credit extension appears to depend on the reason for the portfolio flow. If the proceeds from the transaction (a non-resident purchase of domestic assets) is deposited in the domestic banking sector, there is potential for this to increase the supply of credit. If instead the proceeds are invested elsewhere, we cannot track any transmission through the banking sector.

The transmission through banks is further dependent on the timing of the flow. If the portfolio flow arrives at a time when banks already have plenty of cash on their balance sheet, a further injection in the form of fund manager deposits will not necessarily lead the bank to lend more. If the bank had wanted to lend more it could already have done so by drawing down its cash holdings. If instead the cash injection arrives at a time when the bank is eager to lend and have little spare cash, the cash injection may quickly be transformed into credit supply by the bank.

The implication of the above hypothesis is that portfolio flows that arrive during credit expansions when the banks' cash ratio is low will have a greater impact on credit supply. The portfolio flows become procyclical. Portfolio flows that arrive at other times have less, if any, impact. It appears that share flows largely arrived in times when the cash ratio was below the estimated threshold, while bond flows largely arrived at times when the cash ratio was above the threshold. In total, a linear model will therefore estimate that share flows have a greater impact than bond flows on credit. This conclusion would not necessarily be correct, as the linear model ignores the timing of the flows. However, the results from our non-linear threshold vector autoregressive model shows that share flows have indeed been more effective in increasing credit extension, largely because the proceeds from share sales by residents to non-residents are deposited in banks. We do not see a similar response of fund manager deposits when they sell bonds to non-residents.

One may conclude that our hypothesis suggests the transmission mechanism from portfolio flows to credit lies in the financial sector as a whole. The money arrives at the fund managers and is partly transmitted to banks who may decide to lend the it

out and thereby expand their balance sheet, or keep the balance sheet constant by using the injection to pay off other liabilities. We see that they tend to expand the balance sheet at times when their cash ratio is low, in other words at times when they are eager to lend but held back by a lacking supply of savings.

The key to breaking the transmission mechanism may lie in either the fund managers or in the banking sector. A potential area of interest lies in the different observed transmission of shares and bonds. In the case of bonds, the transmission is largely broken since the fund managers choose not to inject the proceeds from the transaction into the banking system. A better understanding of the reason behind this response will be important in better understanding the transmission mechanism as a whole. Another clue for policy makers is the threshold variable itself. Forcing banks to hold permanently higher cash ratio will not work as a cash injection from portfolio flows will still be pro-cyclical by increasing credit only when the banks operate at the binding cash ratio limit. A counter cyclical required cash ratio could potentially absorb the cash injections from portfolio flows before they turn into credit. Whether such a policy does more good than harm is a question beyond the scope of this paper. At last, less interventionist policy is to ensure that domestic agents are allowed to hold foreign assets. It appears that in times of high risk, the domestic agents will sell these foreign assets and deposit the proceeds at home. This ensures cash injections in the banking sector also in times of financial stress, when gross portfolio inflows will have the opposite effect.

To summarise, the data suggests there may be pro-cyclical effects of share flows on credit. The evidence with respect to bond flows is less clear. The potential pro-cyclical nature of portfolio flows makes them an important area of focus for macroprudential regulators. It seems likely that the transmission channel goes via the fund managers and the banking sector and any policy response may be aimed at this transmission or at external factors such as other sources of potentially counter-cyclical portfolio flows to dampen the impact gross portfolio inflows.

Chapter 5

Portfolio Flows in a two-country DSGE model with financial intermediaries

Abstract

The paper presents a two-country DSGE model with a risk constrained financial sector that intermediates portfolio flows. Portfolio flows arise as demand for financial assets from foreign investors changes *relative to* demand from domestic investors. When global investors face increased uncertainty of expected returns (risk shocks) we observe strong flows out of shares and modest flows out of bonds. Risk shocks that affect both the global and emerging market investor causes strong outflows from emerging market bonds and small inflows to emerging market shares.

The transmission channel that links portfolio flows to credit in emerging markets is the financial intermediary's balance sheet. A portfolio inflow implies an injection of cash on the balance sheet. The cash reduces demand for savings or equivalently increases supply of credit. This affects the interest rate on deposits and changes the optimal consumption and labour by the household.

Global policy makers can absorb shocks before they create a portfolio flow. Simulations show that financial shocks (eg: risk) can be absorbed by appropriate changes in the supply of global risk free assets. Global real shocks (eg: income) can be absorbed by keeping the supply of global financial assets fixed and allowing the prices to adjust. Local emerging market policy makers may attempt to use macroprudential policy to break the transmission channel to credit. The policy works by limiting the total risk exposure of the financial sector. Simulations show that tighter macroprudential policy does not succeed in reducing the impact of portfolio flows.

5.1 Introduction

Capital flows are thought to affect credit in the recipient economy. Policy makers may attempt to use capital controls, monetary policy, fiscal policy or macroprudential regulation to dampen the associated credit volatility. Finding the appropriate policy response requires proper understanding of the transmission channel that links capital flows to credit. Here we present a model that provides new insights into the transmission channel for one sub-set of capital flows: non-resident net purchases of domestic shares and bonds (henceforth *portfolio flows*). We show that gross portfolio flows can behave different from net portfolio flows. We use model simulations to guide our discussion of how global and domestic policy may affect the transmission of gross and net portfolio flows to the real economy.

Portfolio flows may affect the demand for credit, the supply of credit, or both. Demand for credit may increase as the portfolio flow causes asset prices to rise, creating a positive wealth effect. Supply of credit may increase as the portfolio flow causes an injection of cash on bank balance sheets, reducing the cost of funding for the banking sector. In Chapter 5 we find support for the presence of a supply channel in the South African data. Portfolio inflows come in the form of non-resident net purchases of domestic financial assets. The financial assets are most likely purchased from a domestic fund manager who receives cash in return for the assets. The fund manager must find use of this cash. He may return the cash to clients, purchase foreign assets, or deposit the funds in a bank account. The fraction that is deposited in bank accounts will fund the bank's expansion of credit supply. The model presented here gives rise to this type of transmission channel and allows us to study the transmission of global shocks to domestic macroeconomic activity and welfare.

The empirical literature has shown that global financial risk and risk aversion are important determinants of portfolio flows (Rey, 2013; Bekaert et al., 2010; Bruno and Shin, 2013). When financial assets are more risky, or the financial sector is more risk averse, the financial sector may reduce leverage to avoid letting the risk of its balance sheet exceed the target level (Adrian and Shin, 2010; Bekaert et al., 2010). A risk

shock will therefore affect portfolio flows directly as the leverage adjustment implies changes in demand for financial assets, including foreign assets. Here we present a model based partly on the insights from Adrian and Shin (2010); Bruno and Shin (2013); Rey (2013) in which we model the financial sector as operating at a binding risk constraint. The risk constraint may be viewed as macroprudential regulation.

The model presented will show how portfolio flows arise in response to shocks in financial variables, such as risk, and to shocks in real economic variables, such as productivity and income. The portfolio flow is always the product of changes in the foreign and domestic relative demand for domestic assets. A shift in relative demand from the domestic to the foreign intermediary will cause a portfolio inflow, that is net purchases of domestic assets by the foreigner. The relative shift in demand may for example be caused by increased saving in the foreign economy, causing a general increase in demand for financial assets by the foreign intermediary. A bond outflow may for example be caused by higher demand for bonds by local investors relative to foreign investors.

We show how fiscal and monetary policy in the originating economy can use different instruments to absorb volatility caused by different shocks. A financial shock to the global economy, for example an increase in the expected risk of global shares, can be absorbed almost completely by appropriate adjustments in the supply of global risk free assets. That is, the government adjusts its deficit with infinite elasticity, thus keeping the price of government bonds constant. A real shock to the global economy, for example an increased endowment to the households, will not be absorbed by adjustments in fiscal policy, but can be absorbed almost completely by allowing interest rates to respond freely while keeping the supply of global government bonds fixed. The distinction between the optimal response to real and financial shocks was highlighted in the classic paper by Poole (1970). The results of our model illustrates that Poole's findings remain relevant in a modern economy where the global financial markets link the shocks of one economy to the macroeconomic variables of another.

Policy makers at the receiving end of portfolio flows may use macroprudential

regulation as a tool to reduce the aggregate risk of its banking sector. This could potentially be expected to reduce the impact of portfolio flows on the domestic economy. One may for example link the maximum allowed leverage of bank balance sheets to the expected risk of the assets held by the bank. Our model simulations suggest such macroprudential regulation will increase the volatility of portfolio flows, while causing a very slight reduction in the volatility of consumption and labour. The impact on volatility of the real economy is minimal and not visible in the plotted impulse responses. It is conceivable that a more effective macroprudential policy would be achieved by adjusting the risk allowance in a counter-cyclical response to portfolio flows. This approach is recommended by for example Rey (2013). Such a counter-cyclical adjustment of policy variables is not modeled explicitly in this paper.

It is relevant to note that model simulations with tighter macroprudential policy modestly reduced real economic volatility despite increasing the volatility of gross portfolio flows. This illustrates that gross flows are important because they allow an optimal reallocation of the balance sheet, and this reallocation may alleviate the need to adjust the aggregate size of the balance sheet. In this case, as the volatility of gross flows increases, the volatility of net flows and the current account decreases. This is reflected in lower fluctuations in the demand for savings and less volatility in consumption, labour and output. The empirical literature has found a similar lack of correlation between net and gross capital flows, as we saw in Chapter 2.

The model adds insights to our understanding of the drivers of portfolio flows and their transmission to local credit extension. We saw in Chapter 1 that portfolio flows to emerging markets have caused rapid growth in their foreign equity and bond liabilities. The gross flows appear to have shifted from being dominated by non-resident share purchases to being dominated by non-resident bond purchases. In Chapter 3 we speculated whether this may be caused by extraordinary monetary policy in the US. We saw that the yield spread and risk shocks both affect bond flows more than they affect share flows. Here we study these questions further. We see that the strong effect of risk on bond flows is explained by risks that affect both local and global investors, causing local investors to demand more local bonds while foreign

investors reduce demand.

5.1.1 Desired model ingredients: risk, leverage and relative asset demand

It is possible to simulate portfolio flows in a model with only one economy. A shock that increases asset demand will lead agents to purchase assets from the rest of the world. Asset demand by agents in the rest of the world is assumed to be constant. But that assumption eliminates several dynamics in the relationship between the two countries. It is possible that agents in the rest of the world will also change their asset demand in response to the shock. The size and direction of the resulting portfolio flow is then unknown, unless we have a two-country model that explicitly specifies the asset demand function from both economies. The size and direction of the flow is determined by relative changes in asset demand between the two countries.

We can illustrate the importance of relative demand with an example. Say we observe a portfolio outflow in which foreigners sell domestic shares to domestic residents. This could be caused by a fall in foreign demand for local shares as long as foreign demand falls more than local demand. However, the outflow could also be caused by a shock that increases demand. For example, an increase in domestic productivity causes higher share demand from both locals and foreigners as they now expect higher dividends. Importantly, local demand increases more than foreign demand because the productivity shock also gives higher income and savings by the local households. The higher savings causes more demand for financial assets independent of their expected payoff. Hence, locals purchase local shares from foreigners.

1

¹A typical hypothesis of the casual market observer might be that portfolio inflows should, *ceteris paribus*, lead to an increase in the share price. This seems natural. But an increase in non-resident share purchases is just another name for an increase in resident sales of shares. An increase in selling pressure should, *ceteris paribus*, reduce the share price. Which statement is correct? A structural model allows us to disentangle the selling pressure from buying pressure and further analyse the links to other macroeconomic variables.

Risk adjusted leverage gives downward sloping asset demand

In the literature, asset demand is typically derived from utility maximizing behavior of households who save for future consumption by purchasing financial assets today. The household's demand for financial assets is represented by the first order conditions of the optimization problem, and will generally depend on the expected discounted cash flow of the asset. We can for example assume the household faces a simple two-period utility maximization problem represented as:

$$\begin{aligned} \max & u(c_t) + E_t[\beta u(c_{t+1})] \\ \text{s.t} & \\ & c_t + p_t \gamma_t = e_t + x_t \gamma_{t-1} \end{aligned}$$

where γ_t = holdings of the financial asset, p_t = price of the financial asset, x_t = payoff from financial asset, c_t = consumption, and e_t = endowment. The first order conditions of this problem gives a demand function:

$$p = E_t \left[\beta \frac{u'(c_{t+1})}{u'(c_t)} \right] \quad (5.1)$$

In steady state when consumption is constant the demand becomes perfectly elastic equal to β ; it does not depend on the quantity of assets held. Once an external shock pushes the consumption away from steady state there will be an adjustment during which the consumption path is non-constant and the demand is a downward sloping function assets held. This is not obvious from the equation, but note that the level of future consumption depends on the number of assets held today. If we hold more assets we get more future consumption and thus lower marginal utility of future consumption. The lower marginal utility of future consumption gives lower asset demand according to equation 5.1.

During the adjustment to a shock, the price the agent is willing to pay is a downward sloping function of the quantity held, but in steady state it is perfectly elastic at a price equal to the agents time preference discount factor.

Now, imagine there is a second agent, say from a foreign country, with a discount rate of β^f . In steady state, when demand equals the discount rate, the two demand functions cannot hold at the same time: $p = \beta \neq \beta^f$. By plotting the demand functions together (*Figure 5-1, Panel a*) we see that there is a boundary steady state solution where the household with the lower discount rate (higher β) holds all assets. An interior steady state solution is only possible if at least one agent has a downward sloping demand function. An example is plotted in *Figure 5-1*, where *Panel b* illustrates a hypothetical interior solution that arises when the two demand functions have *less – than – perfect* elasticity.

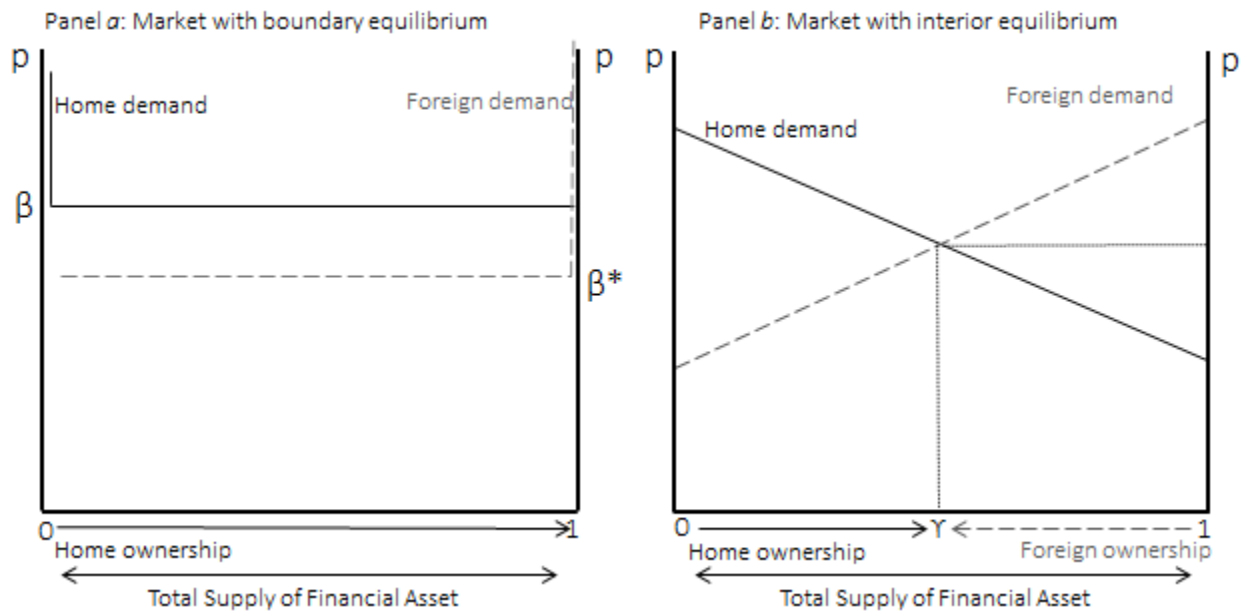


Figure 5-1: Equilibrium between home and foreign asset demand. Home demand is plotted from left to right and foreign demand plotted from right to left. *Panel a*: Demand from home and foreign are both perfectly elastic. *Panel b*: Home and foreign demand are both slightly inelastic (downward sloping).

There is no empirical support for the steady state boundary solution associated with the perfect elasticity of demand. In a two-country model, the boundary solution implies that all domestic assets are held either by residents or by non-residents. In reality we see that domestic financial assets are held partly by residents and partly by non-residents. There needs to be some other characteristic of the maximization problem that ensures an interior solution. This can only occur if asset demand is

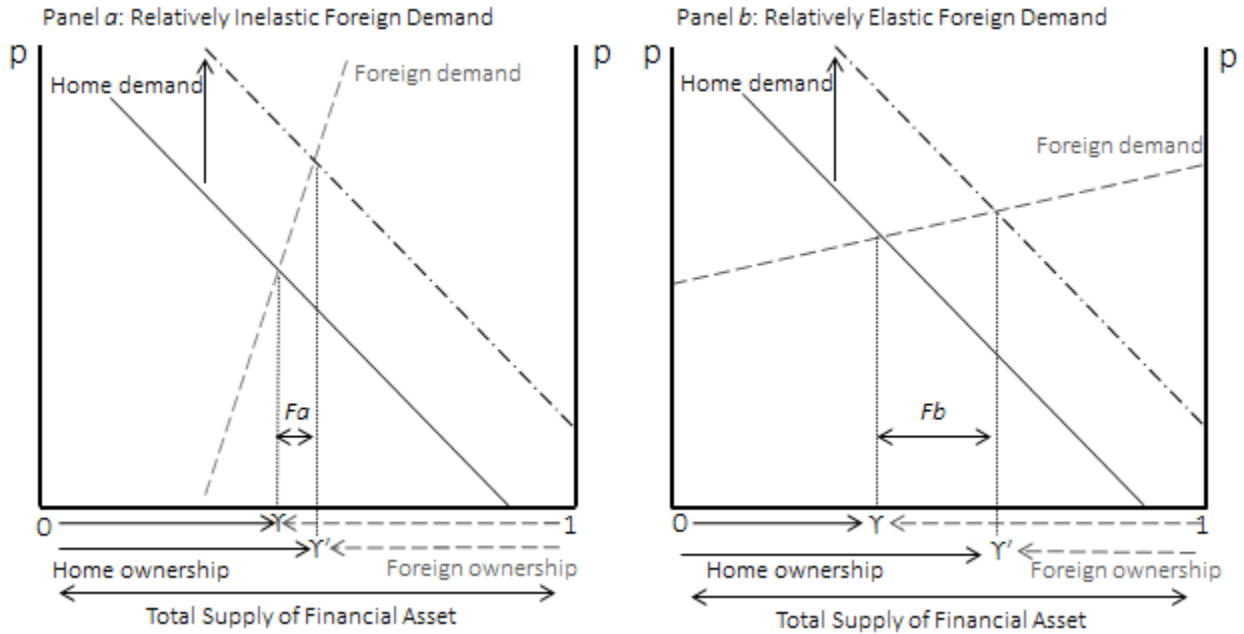


Figure 5-2: Capital flows in response to higher home asset demand. *Panel a:* Relatively inelastic demand by the foreign agent gives smaller capital flows. *Panel b:* Relatively elastic demand by the foreign household gives larger capital flows.

slightly inelastic in steady state (as in Panel b of *Figure 5-1*). The source of this inelasticity will determine the model's steady state distribution of financial asset ownership between residents and non-residents.

Furthermore, the elasticity of demand for financial assets will determine the size (and in some cases the sign) of portfolio flows in response to external shocks. This is illustrated in *Figure 5-2* where we shock the home agent's demand for the financial asset. In *Panel a* the foreign demand is relatively inelastic, leading to a small capital flow of size F_a . In *Panel b*, the foreign demand is relatively elastic, leading to a larger capital flow (F_b) in response to the same shock. In most cases, both demand functions will shift in response to the same shock, either in the same direction or opposite directions, making the elasticity even more significant in determining the size and sign of capital flows.

The literature lacks a model that binds empirical findings together

There has been significant progress in the modelling of aggregate demand for risky assets. A notable contribution is the series of papers including Adrian and Shin (2009, 2010) and Bruno and Shin (2012, 2013) who have carefully modelled the behavior of US market based banks and their demand for risky domestic and foreign securities. Most significantly, they argue that financial intermediaries optimise their objective function by targeting leverage and risk.

Adrian and Shin (2009) demonstrate how higher asset prices, *ceteris paribus* will reduce leverage and *Value at Risk (VaR)* on bank's balance sheets. This leads to increased risk appetite as the market based banks aim to increase *VaR* back to its binding limit. Based on these insights, Bruno and Shin (2012) and construct a model of cross border financial flows. Bruno and Shin (2013) utilize this model and show that market based banks actively keep *VaR* its binding limit to maximize profits and therefore must increase leverage as soon as markets are less volatile (risky). One way of adding risk to their balance sheet is by investing in *EM* assets.

While the risk targeting behaviour of market based banks create downward sloping demand for financial assets in the models mentioned above, they cannot explain portfolio flows that arise from changes in *relative* demand. This issue was addressed by Devereux and Saito (2006), Devereux and Sutherland (2009), Devereux and Sutherland (2011), and an almost identical solution was independently developed by Tille and van Wincoop (2010). Their models are solved by second order approximations in order to preserve the effect of variances and covariances of assets in the portfolio optimisation problem. The demand functions are downward sloping due to endogenous discount rates that depend on the expected variance of the portfolio. Devereux and Sutherland (2009) applies this approach to a two-country real business cycle model that explains portfolio flows to emerging markets as consequences of shifts in relative demand from households. Tille and van Wincoop (2010) also applies the solution approach to a two-country DSGE model of portfolio flows. As such, both models captures our interest in portfolio flows that arise from relative demand changes, but

they both lack the ability to study the role played by a risk targeting financial sector in transmitting global shocks to the recipient economy.

An alternative approach to solve portfolio choice problems while preserving that variance and covariance features of the risky variables in steady state was suggested by Coeurdacier, Rey, and Winant (2011). They show that it is possible to approximate the solution by simultaneously computing the dynamics and the ‘risky steady state’². This ensures that the households Euler equation depends on both the variance of future consumption and the covariance between returns and consumption. This approach could create less - than - infinitely elastic demand functions, and thereby yield an interior solution for portfolio allocation in the ‘risky steady state’. However, we will see below that this approach to preserving the variance / covariance characteristics is not strictly necessary once we include a risk adjusted leverage constraint on financial intermediaries.

The remaining gap in the literature is a general equilibrium model that incorporates the findings from Shin and co-authors in a two-country real business cycle model similar to Devereux and Sutherland. In this paper we construct a model with households and firms roughly similar to Devereux and Sutherland (2009), but we include a financial sector in each economy with characteristics similar to Bruno and Shin (2012) and Adrian and Shin (2010). The risk and leverage targeting characteristics of the financial intermediaries is introduced to the model by imposing a macroprudential policy that limits the financial sector balance sheet to a risk adjusted leverage constraint. This generates downward sloping asset demand functions and yields interior steady state solutions without the need for second order approximations.

5.1.2 Emerging markets are distinguished by capital controls on outward investments

We aim to model portfolio flows between advanced markets and emerging markets. To distinguish between the two markets we impose an admittedly exaggerated version

²The risky steady state is the equilibrium at which there are zero innovations and all variables therefore remain unchanged at their optimal level given the expected value of state variables

of the capital controls observed in practice. Using data on financial transactions for 91 countries between 1995 and 2005, Schindler (2009) finds that emerging markets tend to impose more controls on outflows than on inflows, and they do so to a much larger extent than developed economies. These controls are most prominent in South Asia and Sub-Saharan Africa, while least prominent in North America and Western Europe (Schindler, 2009). To best capture this contrast between capital controls in emerging and advanced markets, we impose a complete restriction on agents in the emerging economy from investing in the advanced economy.

The strict restriction imposed on emerging economies thus serves two purposes. It distinguishes emerging economies from advanced economies by imposing a restriction that is similar to capital controls observed in practice. But it is also crucial in closing the model. With no frictions, there is no unique equilibrium solution. A less rigid friction could potentially address both purposes, but would result in a more complicated and less tractable model. Unfortunately this strong assumption removes certain interesting dynamics from the model. Most importantly, we are not able to analyse how local repatriation of foreign investments may interact with global demand for local assets. For example, it is possible that local investors bring money home at the same time as we observe portfolio outflows caused by reduced demand from foreign investors. If this is the case, the total net portfolio flows would be reduced by allowing both countries to invest in foreign assets. Such dynamics are of high relevance, but cannot be studied in the presented model.

In Chapter 3 we discussed whether such capital controls could explain the stronger response of South African bond flows to risk shocks. If South African investors and foreign investors have the same perception of the risk of South African bonds, and they face the same pool of investable assets with no frictions, it is hard to explain why bond flows respond more consistently to risk than share flows do. However, if South African investors are restricted from purchasing risk free global assets, the South African bond becomes the closest thing they have to a risk free asset. Thus, higher risk aversion will lead South African investors to purchase more South African bonds, while the higher risk aversion causes global investors to demand less South African

bonds as they shift their portfolio home to the global risk free assets. Thus, higher risk aversion causes strong responses in emerging market bond flows. By imposing the strict capital controls on foreign investments by emerging market agents in the model, we are able to simulate and better understand these potential dynamics.

The structure of the resulting model is illustrated in Figure 5-3. The flow chart indicates the four agents of each economy and the markets in which they interact. The *home* economy is thought of as the emerging economy, and the *foreign* economy is thought of as an advanced economy. The remaining text is written from the perspective of the emerging economy. The text interchangeably uses the terms *global* and *foreign* for the advanced economy and *local* or *home* for the emerging economy.

Households provide work to the firm in return for wages. They interact with the financial sector by depositing savings in return for interest. They interact with the government by paying a tax that funds the governments interest expenses. The government borrows by issuing bonds to the financial sector. The financial sector takes deposits from households and invest these in government bonds in return for a discount rate and in firm shares in return for dividends. Lastly the *home* financial sector trades with the *foreign* financial sector and thereby links the two economies. The link is asymmetric; the *foreign* financial sector is allowed to purchase *home* assets, while the *home* financial sector is restricted from purchasing *foreign* assets.

The capital flow in the financial market will always be balanced by a current account deficit in the goods market. When *foreigners* increase their holdings of *home* assets, they must finance these purchases by exporting consumption goods. That is, they run a current account surplus. When *foreigners* sell their holdings of *home* assets, the proceeds from this sale will finance the *foreign* economy's current account deficit. In steady state, the *foreign* economy runs a current account deficit funded by dividend and interest income earned on the *foreigner's* steady state holdings of *home* assets. This implies that the *home* economy has a steady state current account surplus. That is, the *home* economy produces more goods than they consume, with the difference constituting net exports. The net exports will finance the *home* economy's dividend and interest expense paid to *foreign* holders of *home*

assets.

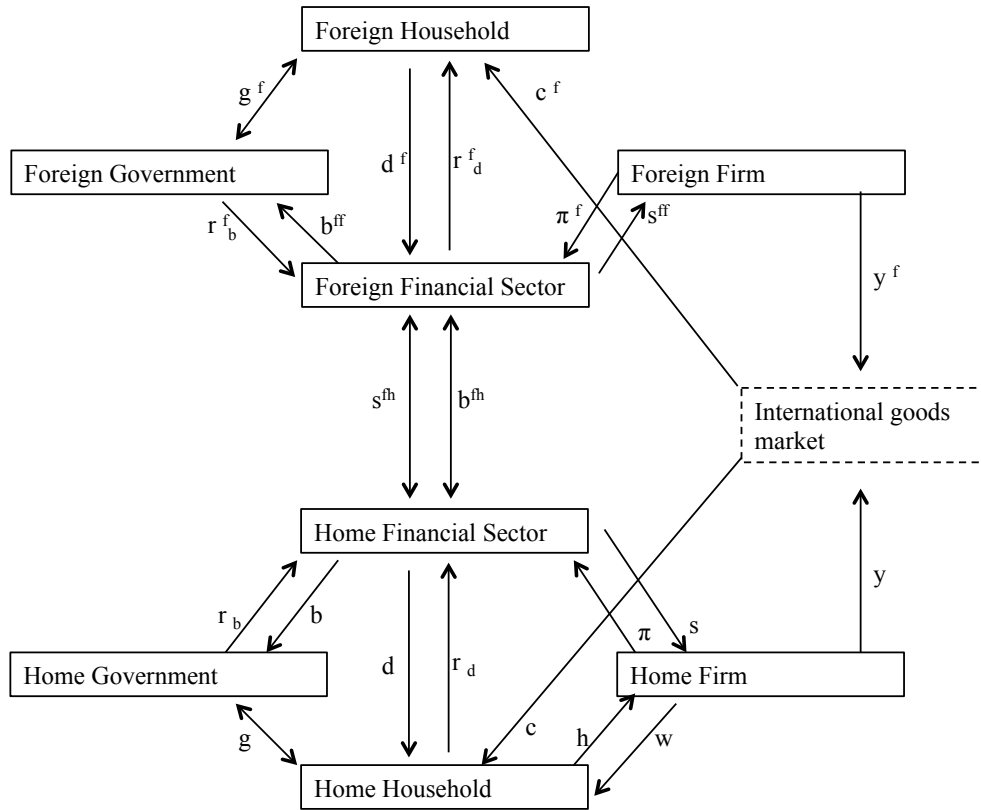


Figure 5-3: Flow chart all agents in the model. The two economies are linked by their financial sectors.

5.2 The model

The model presented is a two-country dynamic stochastic general equilibrium (DSGE) model. Most recent DSGE models in international finance and macroeconomics include money and frictions that give rise to a Keynesian multiplier and effective monetary policy. Such complications are not necessary for our purposes. Our goal is to understand the link between financial shocks and portfolio flows, and the role of financial intermediaries in transmitting portfolio flows to credit extension. Therefore, to keep the analysis as tractable as possible, we work in a parsimonious real business cycle (RBC) framework where we include only the most essential components required to capture the relevant dynamics.³

The model includes two countries, *home* and *foreign*. *Home* is thought of as an emerging economy while *foreign* is thought of as advanced. There is a single good traded in a friction free international market. Labour is not traded across borders. Each country have their own domestic financial sector which intermediates savings from households to firms and the governments. Households save by keeping deposits in banks. A reduction in deposits will reflect dissaving and can be viewed as an increase in household credit.

We structure the aggregate financial sector to capture the relationship between fund managers and banks as observed in Chapter 4. That is, in practice we saw that fund managers are linked to banks by depositing the proceeds from asset sales on bank balance sheets. In the model we combine the fund managers and banks in one aggregate financial intermediary, thus we assume that the entire proceeds from asset sales are deposited in banks, and the entire funding of asset purchases is raised from household deposits. The household deposits are liabilities of the financial intermediary and must be matched by assets. The assets of the financial intermediary are shares and government bonds. We said in section 5.1.2 that empirical data suggests emerging markets tend to impose more capital controls than advanced economies.

³While RBC models have lost favor in the academic field, there are several instances of recent research demonstrating that the more parsimonious RBC models can provide valuable insights. McGrattan and Prescott (2014) and Kydland and Zarazaga (2002) show that these models can replicate many empirical observations previously thought to be out of the range of RBC models.

Furthermore, the capital controls in emerging markets tend to be most restrictive on capital outflows, that is restricting residents from investing abroad. This empirical fact, we argued, can be utilized to distinguish between emerging and advanced economies in the model. Thus, the *home* intermediary is completely restricted from purchasing *foreign* assets, while the *foreign* intermediary is free to purchase both *home* and *foreign* assets.

The assets available are shares in firms and bonds issued by the governments. The firms own physical capital and hire labour from domestic households. There is perfect competition and the firms therefore earn profits equal to the required return on the physical capital they own. The profits are paid as dividends to the shareholders. The firms' objective is to maximize shareholder value; that is the present value of total current and future expected dividends.

The governments raise taxes to fund the cost of servicing its debt. The debt consists of one period government bonds. In the 'base case' model, the supply of bonds is fixed at 1. That is, in each period the government issues one government bond which can be divided between different bondholders. In an alternative 'fixed rate'-scenario, we model the price of *foreign* government bonds as fixed and instead the government issues bonds with perfect elasticity in response to demand.

In any given period, the current account and capital account must balance. That is, the current account deficit is funded by portfolio inflows and *vice versa*.

5.2.1 Households

Home household:

The representative *home* household receives income from labour and interest on deposits. Their only expenditure is consumption. Consumption increases utility, while labour reduces utility. The household problem is then to maximise expected utility

by choosing consumption, labour and deposits subject to their budget constraint:

$$\begin{aligned} \max_{\Sigma_{t=0}^{\infty} \beta^t E_0} & \left[\frac{c_t^{1-\rho}}{1-\rho} - \chi \frac{h_t^{1+\gamma}}{1+\gamma} \right] & \text{s.t} \\ c_t + d_t = g_t + w_t h_t + (1 + r_t^d) d_{t-1} - \frac{\psi_d}{2} d_t^2 \end{aligned} \quad (5.2)$$

which gives the following first order conditions:

$$c_t^{-\rho} = \chi \frac{h_t^\gamma}{w_t} \quad (5.3)$$

$$1 + r_{t+1}^d = E_t \left[\frac{1}{\beta} \left(\frac{c_{t+1}}{c_t} \right)^\rho \right] (1 + \psi_d d_t) \quad (5.4)$$

Note that we have imposed a small cost (baseline calibration has $\psi_d = 0.002$) on squared deposits.⁴ This is done to avoid perfect elasticity of household demand for deposits (i.e: supply of liabilities to the intermediary). It is important to note that the household saves by supplying deposits to the financial intermediary. This deposit is assumed to be risk free. The household is thus inhibited from investing directly in shares and bonds, but they do get indirect exposure through the intermediary. An increase in expected financial asset returns will increase the deposit rate, by increasing the intermediary's demand for deposit liabilities.

Foreign household:

The *foreign* household is identical to the *home* household except that they receive an exogenous endowment instead of working. This simplification is done in order to keep the model as parsimonious as possible. The *foreign* household maximises expected utility by choosing consumption and deposits in the *foreign* financial intermediary

⁴One can for example think of this as a cost of ensuring that deposits are risk free. That is, an exogenous deposit insurance.

subject to a budget constraint:

$$\begin{aligned} \max \sum_{t=0}^{\infty} \beta^t E_0 \left[\frac{c_t^{*1-\rho}}{1-\rho} \right] & \quad \text{s.t} \\ c_t^f + d_t^f = n_t + (1 + r_t^{df})d_{t-1}^f - \frac{\psi_d^f}{2}(d_t^f)^2 & \quad (5.5) \end{aligned}$$

which gives the following first order condition:

$$1 + r_{t+1}^{df} = E_t \left[\frac{1}{\beta} \left(\frac{c_{t+1}^f}{c_t^f} \right)^\rho \right] (1 + \psi_d^f d_t^f) \quad (5.6)$$

As for the *home* household, there is a cost of holding deposits reflected in the parameter ψ_d^f . In the ‘base case’ calibration, this cost is slightly lower in the advanced economy compared to the emerging economy, with $\psi_d^f = 0.001$ as opposed $\psi_d = 0.002$. This cost may be thought of as a deposit insurance cost that ensures the deposits are risk free. The slight difference in costs between the two economies is firstly motivated to ensure a unique steady state solution. We chose to set the cost higher in the emerging economy as the cost of insuring deposits here may be higher due to less efficient monitoring or due to the higher risk of assets held by the intermediary.

5.2.2 Financial Intermediaries

The financial intermediaries take deposits from households and invest in shares and bonds. They construct a portfolio at time t to maximize the payoff (θ) in the following period ($t+1$) subject to a risk adjusted leverage constraint.⁵ We will interchangeably

⁵Leverage is defined as Total Assets over Risk Free Assets. Since the only liability is household deposits, all assets are funded by deposits and therefore leverage can equivalently be defined as Household Deposits over Risk Free Assets.

use returns and prices in equations, where the relation between the two are as usual:

$$E_t(1 + r_{t+1}^s) \equiv E_t \frac{p_{t+1} + \pi_{t+1}}{p_t} \quad (5.7)$$

$$E_t(1 + r_{t+1}^{sf}) \equiv E_t \frac{p_{t+1}^f + \pi_{t+1}^f}{p_t^f} \quad (5.8)$$

$$1 + r_{t+1}^b \equiv \frac{1}{q_t} \quad (5.9)$$

$$1 + r_{t+1}^{bf} \equiv \frac{1}{q_t^f} \quad (5.10)$$

Macroprudential policy attaches exogenous risk factors to assets

The return on shares clearly depend on future expected profits (dividends). These expected dividends are the main drivers of the intermediary's asset demand. With zero frictions, the demand will simply be the present value of the expected future dividends. But it was argued in Chapter 2 that financial intermediaries tend to operate with a binding risk and leverage constraint. Here we view this constraint as a macro prudential policy that directly imposes a risk adjusted limit on total leverage. The more risky portfolio, the less leverage is permitted. The macro prudential policy calculates portfolio risk by attributing three different risk factors to the different assets. The risk factors are exogenous and together they determine how the risk of the portfolio is calculated.⁶

We hypothesised in Chapter 3 that the stronger risk sensitivity of bond flows compared to share flows can be explained by the different risk exposure carried by different agents. This is directly incorporated in the model presented here. Each asset and each intermediary have different exposure to the various risk factors. The factors are *home* share risk, *foreign* share risk and general emerging market risk. The third factor, general emerging market risk, can be viewed as the exchange rate risk of investing in emerging markets. As such, this risk only affects the advanced economy intermediary when they invest in emerging market assets.

⁶The fact that the risk factors are exogenous reflects the tendency of macro prudential policy to avoid using actual expected risk. Using expected risk will cause pro-cyclical policy because the increase in volatility observed during credit crises will force intermediaries to cut lending, thereby exaggerating the credit crunch.

The risk exposures of different assets are as follows: *Foreign* shares are only exposed to the *foreign* share risk, σ_{sf}^2 . *Foreign* bonds are risk free. *Home* shares held by the *home* intermediary are only exposed to *home* share risk, σ_s^2 . *Home* shares held by the *foreign* intermediary are exposed to *home* share risk, σ_s^2 , and emerging market risk, σ_x^2 . *Home* bonds held by the *home* intermediary are risk free. *Home* bonds held by the *foreign* intermediary are exposed to emerging market risk, σ_x^2 . Thus, for the *foreign* intermediary, the *home* assets are correlated via their common exposure to emerging market risk, σ_x^2 .

The required return on *home* shares by the foreigner can be decomposed into required compensation for the share risk and orthogonal emerging market risk. Similarly, the required return by the foreigner on the *home* bond can be decomposed to the risk free bond return and the emerging market risk:

$$\begin{aligned} E_t \left[1 + r_{t+1}^{s,f} \right] &= E_t \left[(1 + r_{t+1}^s)(1 + r_{t+1}^x) \right] \\ E_t \left[1 + r_{t+1}^{b,f} \right] &= E_t \left[(1 + r_{t+1}^b)(1 + r_{t+1}^x) \right] \end{aligned}$$

The risk of the different assets is independent in the sense that they are exposed to different exogenous risk factors. The only exception is the *foreigner's* return on the two *home* assets, $r_{t+1}^{s,f}$ and $r_{t+1}^{b,f}$. That is, the only assets that have exposure to a common risk factor are the *home* assets held by the *foreigner*. The foreigner takes exchange rate risk when holding emerging markets shares and bonds. The common exposure to emerging market risk causes a positive covariance between *home* shares and *home* bonds held by the *foreign* intermediary:

$$Cov(r_{t+1}^{s,f}, r_{t+1}^{b,f}) = \sigma_x^2 E_t \left[\left(\frac{\pi_{t+1}}{p_t} \right) \left(\frac{1 - q_t}{q_t} \right) \right] \quad (5.11)$$

From this we can calculate the distribution of returns on all assets held by the *foreign* intermediary:

$$\begin{aligned}
 r_{t+1}^{s,f} &\sim N\left(\frac{\pi_{t+1}^f}{p_t^f}, \sigma_{sf}^2\right) \\
 r_{t+1}^{b,f} &\sim N\left(\frac{1 - q_t^f}{q_t^f}, 0\right) \\
 r_{t+1}^{s,f} &\sim N\left(\frac{\pi_{t+1}}{p_t}, \sigma_s^2 + \sigma_x^2(1 + \sigma_s^2 + E_t[\frac{\pi_{t+1}}{p_t}]^2)\right) \\
 r_{t+1}^{b,f} &\sim N\left(\frac{1 - q_t}{q_t}, \sigma_x^2(1 + E_t[\frac{1 - q_t}{q_t}]^2)\right)
 \end{aligned}$$

The distribution of each asset held by the *home* intermediary is as follows:

$$\begin{aligned}
 r_{t+1}^{s,h} &\sim N\left(\frac{\pi_{t+1}}{p_t}, \sigma_s^2\right) \\
 r_{t+1}^{b,h} &\sim N\left(\frac{1 - q_t}{q_t}, 0\right)
 \end{aligned}$$

In the following sections, we define two new variables, $\sigma_{s,f}^2$ and $\sigma_{b,f}^2$ as the variance of the home assets held by the foreigner:

$$\sigma_{s,f}^2 \equiv \sigma_s^2 + \sigma_x^2(1 + \sigma_s^2 + E_t[\frac{\pi_{t+1}}{p_t}]^2) \quad (5.12)$$

$$\sigma_{b,f}^2 \equiv \sigma_x^2(1 + E_t[\frac{1 - q_t}{q_t}]^2) \quad (5.13)$$

It is important to emphasise that the probability distributions listed above are those used by the intermediaries in calculating the risk of their portfolio. It is this risk that determines the maximum permitted leverage. As such, they do not use the observed variance / covariance of the asset returns, but rather the variance / covariance that is exogenously determined as appropriate by the macro prudential

regulator.

There is therefore a difference between the actual observed variance / covariance between the different return processes and the variance / covariance used in the leverage constraint. The actual covariance depends on the responses of the different agents to different shocks. Certain shocks will give highly correlated return variations across assets, while other shocks will give different responses in different assets. In the deterministic steady state, the actual variance / covariance is zero. However, the variance / covariance used by intermediaries in the leverage constraint is dependent on the exogenous risk factors, σ_x^2 , σ_s^2 and $\sigma_{s_f}^2$ as determined by the regulator. These are greater than zero also in the deterministic steady state and always constant unless shocked directly.⁷

Home intermediary:

The *home* intermediary borrows from *home* households by raising deposits. These deposits are then invested in bonds and equity in order to maximize the profit in the investment period. The profit is simply the difference between the total payoff on assets and the total deposit and interest liabilities. There is a budget constraint and a constraint that limits leverage depending on the risk of the portfolio. If there is zero risk, the intermediary can have leverage approaching infinity. If the risk approaches infinity, the leverage must approach zero. We solve this using Kuhn-Tucker conditions and see that under certain conditions the optimal behavior is to always operate at the binding constraint where leverage is maximized.

The decision problem of the financial intermediary can be formally expressed as:

⁷ Alternatively, we can view the risk adjusted leverage target as internally imposed by the intermediary without the presence of a regulator. In this case, the three risk factors can be viewed as the intermediary's expected risk. Note that this view implies that the intermediary's risk expectations are not affected by the actual observed variation in asset returns.

$$\begin{aligned}
 & \max E_t(\theta_{t+1}) \\
 & \text{subject to:} \\
 & E_t(\theta_{t+1}) = E_t \left[(p_{t+1} + \pi_{t+1})s_t + b_t - (1 + r_{t+1}^d)d_t \right] \\
 & p_t s_t + q_t b_t = d_t + (p_t + \pi_t)s_{t-1} + b_{t-1} - (1 + r_t^d)d_{t-1} \\
 & \frac{q_t b_t}{d_t} \geq 1 - e^{-\psi \sigma_\theta^2}
 \end{aligned}$$

where the only risky asset is the shares. The expected risk on shares is an exogenous process, σ_s^2 . Thus the variance of the portfolio and its derivative with respect to s_t is:

$$\sigma_\theta^2 = \sigma_s^2 (p_t s_t)^2 \quad (5.14)$$

$$\frac{\delta \sigma_\theta^2}{\delta s_t} = 2p_t^2 \sigma_s^2 s_t \quad (5.15)$$

As long as the expected return on shares is greater than the rate on deposits, and the rate on deposits is greater than the rate on bonds, it will be optimal for the financial intermediaries to always operate at the maximum allowed risk (the leverage constraint is binding). This is intuitive: the fact that shares return more than the cost of deposit liabilities means the intermediary wishes to raise as much deposits as possible to invest in shares. The fact that bonds return less than returns on deposits means that the intermediary will invest as little as possible in bonds. Thus, the intermediary will always maximize the ratio of shares to bonds. Solving the optimisation problem at the binding leverage constraint gives the following first order conditions:

$$p_t = E_t \left[\frac{p_{t+1} + \pi_{t+1} - d_t \psi \frac{\delta \sigma_\theta^2}{\delta s_t} (r_{t+1}^d - r_{t+1}^b)}{1 + r_{t+1}^b + e^{\psi \sigma_\theta^2} (r_{t+1}^d - r_{t+1}^b)} \right] \quad (5.16)$$

$$b_t = \frac{p_t s_t}{q_t} (e^{\psi \sigma_\theta^2} - 1) \quad (5.17)$$

$$d_t = p_t s_t e^{\psi \sigma_\theta^2} \quad (5.18)$$

This holds as long as $r_t^s > r_t^d > r_t^b$, as is the case in the solved steady state. Since the derivative of total risk with respect to s_t and the total risk itself both increase with s_t , it appears from equation 5.17 that the demand for shares is downward sloping with respect to s_t . This is intuitive: the intermediary will add risk by increasing the position in high yield assets (shares) and reducing the position in low yielding bonds. This is done until the risk constraint is binding. At this point, adding more shares is only possible if the price is reduced (thereby keeping the exposure unchanged) or if it is combined with an increased position in risk free assets funded by increased deposits. The increased demand for deposit liabilities will pull up the rates on deposits. The increased demand for bonds will push down the rates on bonds. Thus, the loss on the spread between bond rates and deposit rates will increase as the share position is increased. To compensate for this increasing loss the higher share position is only optimal if the expected return on shares is higher, that is, the price is lower. Thus we have a downward sloping demand for shares: The intermediaries require higher returns (lower price) the more shares they hold.

This is a vital characteristic of the financial intermediary's behavior. We saw in section 5.1.1 that a downward sloping, *less-than-perfect* elasticity of demand, is required to yield an interior solution in the asset allocation problem. Thus, the risk constraint serves a dual purpose in the model: It enables an interior solution and it allows us to study the effects of macroprudential policy on capital flows and the macro economy.

Foreign intermediary:

The *foreign* intermediary maximises expected profit by investing in *home* and *foreign* assets. All *home* assets carry an additional risk orthogonal on the other risk factors. This risk factor may for example be thought of as an exchange rate risk or intermediation risk that only affects *foreign* investors when investing in *home* (emerging market) assets. The *foreign* bonds are perfectly risk free.

We can express the maximization problem as:

$$\max E_t(\theta_{t+1}^f)$$

subject to:

$$E_t(\theta_{t+1}^f) = E_t \left[(p_{t+1} + \pi_{t+1})p_t s_t^{fh} + (p_{t+1}^f + \pi_{t+1}^f)s_t^{ff} + b_t^{fh} + b_t^{ff} - (1 + r_{t+1}^{df})d_t^f \right]$$

$$p_t s_t^{fh} + p_t^f s_t^{ff} + q_t b_t^{fh} + q_t^f b_t^{ff} = d_t^f + (p_t + \pi_t)s_{t-1}^{fh} + (p_t^f + \pi_t^f)s_{t-1}^{ff} + b_{t-1}^{fh} + b_{t-1}^{ff} - (1 + r_t^{d,f})d_{t-1}^f$$

$$\frac{q_t^f b_t^{ff}}{d_t^f} \geq 1 - e^{-\psi^f \sigma_{\theta^f}^2}$$

The variance of the *foreign* intermediary's payoff is therefore more complex than for *home*, as it depends on the emerging market risk (σ_x^2), orthogonal *home* share risk (σ_s^2) and orthogonal *foreign* share risk ($\sigma_{s^f}^2$). Importantly, the foreigner's expected *total* return on *home* shares and bonds is correlated via the emerging market risk compensation.

The variance of the total payoff and its derivatives are then:

$$\begin{aligned}
 \sigma_{\theta^f}^2 &= (p_t s_t^{fh})^2 \sigma_{s,f}^2 \\
 &+ (q_t b_t^{fh})^2 \sigma_{b,f}^2 \\
 &+ 2p_t s_t^{fh} q_t b_t^{fh} Cov(r_{t+1}^{s,f}, r_{t+1}^{b,f}) \\
 &+ (s_t^{ff} p_t^f)^2 \sigma_{s^f}^2
 \end{aligned} \tag{5.19}$$

$$\begin{aligned}
 \frac{\delta \sigma_{\theta^f}^2}{\delta s_t^{fh}} &= 2p_t^2 s_t^{fh} \sigma_{s,f}^2 \\
 &+ 2p_t q_t b_t Cov(r_{t+1}^{s,f}, r_{t+1}^{b,f})
 \end{aligned} \tag{5.20}$$

$$\begin{aligned}
 \frac{\delta \sigma_{\theta^f}^2}{\delta b_t^{fh}} &= 2q_t^2 b_t^{fh} \sigma_{b,f}^2 \\
 &+ 2p_t s_t q_t Cov(r_{t+1}^{s,f}, r_{t+1}^{b,f})
 \end{aligned} \tag{5.21}$$

$$\frac{\delta \sigma_{\theta^f}^2}{\delta s_t^{ff}} = 2s_t^{ff} (p_t^f)^2 \sigma_{s^f}^2 \tag{5.22}$$

Where the covariance terms are defined earlier in equations 5.11, 5.12 and 5.13.

As long as the risk free rate of return is less than the funding rate (deposit rate) the first order conditions are:

$$p_t = E_t \left[\frac{p_{t+1} + \pi_{t+1} - d_t^f \psi^f \frac{\delta \sigma_{\theta^f}^2}{\delta s_t^{fh}} (r_{t+1}^{df} - r_{t+1}^{bf})}{1 + r_{t+1}^{bf} + e^{\psi^f \sigma_{\theta^f}^2} (r_{t+1}^{df} - r_{t+1}^{bf})} \right] \tag{5.23}$$

$$p_t^f = E_t \left[\frac{p_{t+1}^f + \pi_{t+1}^f - d_t^f \psi^f \frac{\delta \sigma_{\theta^f}^2}{\delta s_t^{ff}} (r_{t+1}^{df} - r_{t+1}^{bf})}{1 + r_{t+1}^{bf} + e^{\psi^f \sigma_{\theta^f}^2} (r_{t+1}^{df} - r_{t+1}^{bf})} \right] \tag{5.24}$$

$$q = E_t \left[\frac{1 + r_{t+1}^f - d_{t+1}^f \psi^f \frac{\delta \sigma_{\theta^f}^2}{\delta b_t^{fh}} (r_{t+1}^{df} - r_{t+1}^{bf})}{1 + r_{t+1}^{bf} + e^{\psi^f \sigma_{\theta^f}^2} (r_{t+1}^{df} - r_{t+1}^{bf})} \right] \tag{5.25}$$

$$b_t^{fh} = (p_t s_t^{fh} + p_t^f s_t^{ff}) (e^{\psi \sigma_{\theta}^2} - 1) \tag{5.26}$$

$$d_t^f = (p_t s_t^{fh} + p_t^f s_t^{ff}) e^{\psi \sigma_{\theta}^2} \tag{5.27}$$

5.2.3 The firm

The *foreign* firm is not modelled explicitly and simply provides an exogenous dividend stream to the share holders. The *home* firm produces a global good using *home* labour and its own invested capital. The firm is a price taker and earns profits sufficient to compensate for the required return on capital owned by the firm itself.

The *home* firm maximizes share holder value by maximizing the present value of current and future expected dividends. The firm's decision involves investing in physical capital as well as hiring employees. Note that the firm owns the capital used in production and funds investment in capital by reinvesting profits. The investment decision for the firm depends on whether the present value of the capital investment is greater than the foregone dividend payment. There is an adjustment cost (ϕ) associated with investing in physical capital.

$$\begin{aligned} \max E_0 \sum_{t=0}^{\infty} \beta^t \left[a_t k_t^\mu h_t^{1-\mu} - w_t h_t - i_t - \frac{\phi}{2} i_t^2 \right] \quad \text{s.t:} \\ k_{t+1} = i_t + (1 - \delta) k_t \end{aligned} \quad (5.28)$$

which yields the FOCs:

$$w_t = (1 - \mu) a_t \left(\frac{k_t}{h_t} \right)^\mu \quad (5.29)$$

$$i_t = E_t \frac{\beta}{\phi} \left[\mu a_{t+1} \left(\frac{h_{t+1}}{k_{t+1}} \right)^{1-\mu} + (1 - \delta)(1 + \phi i_{t+1}) \right] - \frac{1}{\phi} \quad (5.30)$$

Dividends paid to the share owners are equal to total revenue less labour cost, investment and investment cost:

$$\pi_t = a_t k_t^\mu h_t^{1-\mu} - w_t h_t - i_t - \frac{\phi}{2} i_t^2 \quad (5.31)$$

5.2.4 Government

The respective governments borrow by issuing bonds and raise taxes (g) on the domestic household to fund the debt service cost:

$$g_t = q_t b_t^S - b_{t-1}^S \quad (5.32)$$

$$g^*_t = q_t^f b_t^{s^{fh}} - b_{t-1}^{s^{fh}} \quad (5.33)$$

5.2.5 Market Clearing

The *home* bond and equity markets clear when domestic and foreign agents demand all issued bonds and shares. The *foreign* bond and share markets clear when all issued assets are demanded by the *foreign* intermediary.

$$b_t + b_t^f = b_t^S \quad (5.34)$$

$$b_t^{ff} = b_t^{s^{fh}} \quad (5.35)$$

$$s_t + s_t^{fh} = 1 \quad (5.36)$$

$$s_t^{ff} = 1 \quad (5.37)$$

5.3 Calibration, Steady State and Volatility

5.3.1 Calibration

We calibrate the model with four different scenarios: ‘closed economy’, ‘base case’, ‘tight home leverage constraint’ and ‘fixed global risk free rates’. Under the first scenario the *home* economy is completely closed, that is, the *foreign* intermediary cannot invest in *home* assets and the *foreign* economy is therefore completely removed from the model. We keep all remaining parameters in the closed economy as they are in the base case open economy calibration. In the ‘tight leverage constraint’ scenario, all the parameters are identical to the base case, with the exception of the penalty on risk (ψ) which is higher in the ‘tight leverage constraint’ scenario. At last

we have the fixed rate scenario, in which the global risk free rate is fixed at zero, while allowing the supply of bonds to adjust to demand. In the base case scenario, the supply of bonds is fixed at unity, while the price of bonds adjusts to demand. Other than the fixed rate on risk free bonds, the calibration of the ‘fixed global risk free rates’ scenario is identical to the ‘base case’. The ‘base case’ calibration is listed in *Table 5.1*.

We base most of the standard parameters on the calibration of Devereux and Sutherland (2009) with the exception that we use quarterly rates rather than annualised rates. Since Devereux and Sutherland (2009) use a rather non-traditional calibration for emerging market share of capital in production of 0.5, we rather use a more common emerging market calibration of 0.33 as found in for example Mendoza (2010). The calibration of the investment cost is based on the recommendation of Bernanke et al. (1999) who refers to the lack of consensus in the literature and therefore suggests a value between 0 and 0.5.

The standard deviation of asset returns is calibrated to reflect US stock market data for the *foreign* economy, and South African stock market data for the *home* economy. The quarterly standard deviation of total returns on the iShares SPDR S&P 500 ETF over the last 10 years was approximately 8%. The quarterly standard deviation of the South African Johannesburg Stock Exchange index (JSE-All Share) over the same time period was approximately 9.5%. The last risk factor in the model is the emerging market risk carried by foreigners holding home assets. This risk factor must be orthogonal on the *home* share risk and have expected return of zero. We estimate this by regressing the US dollar returns from investing in the (unhedged) iShares MSCI South Africa ETF on the rand returns on the JSE All-Share index. The residual indicates the risk not associated with the shares themselves, and therefore captures the remaining orthogonal currency risk with zero expected returns. The standard deviation of the residual is 12%. We use these estimates in the model calibration.⁸

It is more complicated to find reasonable calibrations for the parameters related

⁸All data used in calculations are accessed from Yahoo Finance.

to the financial intermediary. In the literature, the cost of deposits is typically zero (that is, there is usually no cost of deposits). We therefore use the lowest calibration possible that generates reasonable steady state results for leverage and interest rates. The penalty on risk in the leverage constraint is set at 1, implying steady state leverage of 9 in the emerging economy and 6.5 in the advanced economy. In the ‘tight home leverage constraint’ scenario, the risk penalty on the *home* intermediary is set at 2. This scenario yields steady state leverage of 5.6 in the *home* economy and 6.5 in the *foreign* economy.

Table 5.1: Base Case Calibration

Parameter	Symbol	Calibration	Source
Autocorrelation of shocks	α	0.8	
Discount factor of home household	β	0.99	(Devereux and Sutherland, 2009)
Discount factor of firms	β^{firm}	0.99	(Devereux and Sutherland, 2009)
Discount factor of foreign household	β^f	0.99	(Devereux and Sutherland, 2009)
Labour disutility	χ	8	Steady state labour = approx 35%
Capital depreciation rate	δ	0.025	(Devereux and Sutherland, 2009)
Labour supply elasticity	γ	1	(Devereux and Sutherland, 2009)
Capital share of production	μ	0.33	(Mendoza, 2010)
Investment cost	ϕ	0.1	(Bernanke et al., 1999)
Deposit cost - home	ψ^d	0.002	See discussion
Deposit cost - foreign	ψ^{df}	0.001	See discussion
Risk penalty - foreign	ψ^f	1	See discussion
Risk penalty - home (base case)	ψ	1	See discussion
Risk penalty - home (tight constraint)	ψ	2	See discussion
Intertemporal elasticity of substitution	ρ	1	(Devereux and Sutherland, 2009)
St. Dev. Home shares	σ	0.095	See discussion
St. Dev. foreign shares	σ^f	0.08	See discussion
St. Dev. Emerging Market risk	σ^x	0.12	See discussion

5.3.2 Steady state results: Financial intermediaries display home bias

The steady state results generally look reasonable. In the following we compare some key financial ratios for the *home* economy to those of South Africa in 2014. The model is calibrated with a total supply of *home* shares equal to 1, and total supply of

home bonds equal to 1. The steady state price of shares is 5.39 and the price of bonds is 0.982. This implies that the market capitalisation of the stock market is roughly 5.5 times the size of the local debt market. In comparison, the market capitalisation of the Johannesburg Stock Exchange in South Africa is roughly 7 times the size of the domestic marketable government debt issue (South African Reserve Bank, 2015a).

In the base case scenario, we find that the *home* intermediary has slightly higher leverage than the *foreign* intermediary, meaning they hold more risky asset relative to risk free assets. The leverage (total holdings of shares and bonds over bond holdings) is 9.2 in the base case calibration. In South Africa, the total domestic holdings of shares and bonds are approximately 4 times the value of total bond holdings (South African Reserve Bank, 2015a). If we calibrate the penalty on risk in the leverage constraint to be higher in the *home* (emerging market) economy, we see that the leverage drops to 5.6, closer to the observed ratio in South Africa.

The *home* (emerging market) intermediary holds roughly 45% of the *home* bond issue and 65% of the *home* share issue, with the remaining held by the foreign intermediary. In comparison, based on data for South Africa at the end of 2014 we estimate that residents owned approximately 60% of the local bond issue and close to 90% of the local equity issue IMF (2014a,b); South African Reserve Bank (2015a).

The *home* intermediary is forced to hold only home assets. The *foreign* intermediary is free to hold both home and foreign assets. In steady state, the market value of the foreign intermediary is 6.24, of which 37.7% is invested in emerging market assets and the remaining 62.26% is invested in the foreigner's domestic assets. The model most similar to ours in the current literature is found in Devereux and Sutherland (2009). As explained earlier, they develop a two country real business cycle model with no frictions, but an endogenous discount factor that yields a unique portfolio solution in the stochastic steady state. They find the steady state portfolio of the 'developed' country to hold 234% of the 'developing country' shares, while the 'developing' country holds 350% of the home shares. This is balanced by large short positions in their domestic shares. This result shows that in a frictionless economy, risk sharing is possible and optimal. Households minimise consumption risk by having

short position in their employers stock. A short position in domestic equity is found to be optimal in several other models for this same reason, see for example Baxter and Jermann (1997). In our model, however, the financial intermediaries display a strong ‘home bias’ compared to the portfolio that would be optimal if households invested on their own behalf in friction free markets.

One of the major puzzles in the macro-finance literature is the documented presence of home bias in international equity portfolio allocation French and Poterba (1991). The macro finance literature has now come a long way to explain this puzzle, with important contributions from Kollmann (2006), Engel and Matsumoto (2006) and Coeurdacier and Gourinchas (2011). Much of the explanation tend to lie in the cost of trading physical goods, thus restricting the consumption smoothing achieved even with financial risk sharing (Obstfeld and Rogoff, 2001).

In our model, the resulting portfolio of the foreign intermediary displays strong home bias compared to the friction-free results simulated in Devereux and Sutherland (2009). Unfortunately, the home bias of the foreign intermediary in our model does not mean our model has solved the ‘home bias puzzle’. Firstly, the *home* intermediary is forced by capital controls to allocate 100% of their portfolio in domestic assets. If the capital control was relaxed, the *home* intermediary would likely reduce exposure to domestic assets by selling the assets to the *foreign* intermediary in return for *foreign* assets. This would reduce the home bias of the foreign investor. Thus, capital controls restricting agents in emerging markets from investing in foreign assets will likely have the side effect that foreigners invest less in emerging markets and therefore they display more home bias.

However, the main reason for the home bias displayed in our model is that the financial intermediaries allocate their portfolio according to expected payoffs and the risk factors imposed on them by the macroprudential regulator. They do not consider the correlation between returns and consumption. The home bias puzzle arises if instead households were the equity holders. In models like Devereux and Sutherland (2009), the households then allocate the portfolio based on the expected correlation to their own consumption. This leads to low (even negative) portfolio

weights in their home country where the payoffs are highly correlated to the wages paid on their labour.

Table 5.2: Steady State Means

Variable	Symbol	Closed	Base Case	Tight Constraint	Fixed Rate
Leverage home	L	5.6565	9.1827	5.5760	7.3474
Leverage foreign	L^f	-	6.5518	6.4902	13.1167
Share of bonds held by home	b	1.0000	0.4467	0.7428	0.6548
Share of bonds held by foreign	b^f	-	0.5533	0.2572	0.3452
Share of shares held by home	s	1.0000	0.6637	0.6213	0.8256
Share of shares held by foreign	s^f	-	0.3363	0.3787	0.1744
Price of shares - home	p	4.6428	5.3854	5.3262	4.8767
Price of shares - foreign	p^f	-	2.8997	2.8952	2.8394
Price of bonds - home	q	0.9783	0.9824	0.9823	0.9815
Price of bonds - foreign	q^{rf}	-	0.9856	0.9860	1.0000
Return on bonds - home	r^b	0.0221	0.0179	0.0180	0.0189
Return on bonds - foreign	r^{rf}	-	0.0146	0.0142	0.0000
Return on shares - home	r^s	0.0207	0.0184	0.0186	0.0200
Return on shares - foreign	r^{sf}	-	0.0172	0.0173	0.0176
Return on deposits - home	r^d	0.0213	0.0182	0.0183	0.0196
Return on deposits - foreign	r^{df}	-	0.0166	0.0166	0.0150
Consumption home	c	0.7561	0.7347	0.7352	0.7444
Consumption foreign	c^f	-	1.0930	1.0920	1.0734
Deposits home	d	5.5340	4.0299	4.0685	4.7220
Deposits foreign	d^f	-	6.4578	6.3992	4.8839
Government transfers home	g	-0.0217	-0.0176	-0.0177	-0.0185
Government transfers foreign	g^f	-	-0.0144	-0.0140	0.0000
Employment	h	0.3303	0.3398	0.3396	0.3355
Investment	i	0.2264	0.2327	0.2326	0.2298
Capital stock	k	9.0563	9.3086	9.3025	9.1929
Wages	w	1.9981	1.9975	1.9975	1.9978
Output	y	0.9851	1.0132	1.0125	1.0003

Tighter leverage constraint increases steady state welfare

The penalty on risk (ψ) in the leverage constraint has a direct effect on total steady state leverage. The ‘tight constraint’ calibration yields a simulated leverage of 5.6 in steady state, compared to 9.2 in the ‘base case’. This is reflected in a greater *home* ownership of *home* bonds, with 74.3% of the issue owned by the *home* intermediary versus 44.7% in the ‘base case’. In the share market, the tighter leverage constraint means that the *home* intermediary holds 62.1% versus 66.4% in the ‘base case’. The remaining financial variables are largely unaffected by the tightness of the leverage constraint. Of the real variables, we see that the tighter leverage constraint is associated with more consumption, less employment and higher taxes (negative transfers from the government (g)). This is all funded by higher returns ($r_d = 2.86\%$ vs $r_d = 1.84\%$) on higher savings ($d = 4/07$ vs $d = 4.03$). The higher return is explained by the financial intermediary’s greater demand for deposits to invest in safe assets in order to keep leverage below the tighter constraint. The reduced supply of labour leads to reduced investment in physical capital, and therefore lower capital stock and lower output.

Table 5.3 reports the standard deviation of variables in response to a one percentage point increase in the standard deviation of the three risk factors: home shares, foreign shares and emerging market risk. A tighter leverage constraint on the *home* intermediary reduces the volatility of *home* leverage in response to risk shocks, but increases the volatility of portfolio flows in both bonds and shares. All asset returns become less volatile. Savings, consumption and employment at home are all slightly less volatile, causing higher welfare. However, the impulse responses plotted in section 5.4.3 show that the impact of macroprudential regulation is minimal.

Elastic supply of risk free bonds can absorb risk shocks

A shock that increases the risk of assets will force the financial intermediaries to reduce leverage. Delevering by the intermediary implies purchasing more risk free bonds, either funded by selling shares or by raising deposits. Demanding more deposits will

increase the rate of return offered on deposits. And the higher demand for bonds will pull up their price, reducing their return. Thus, the spread between deposit returns and bond returns will widen, increasing the loss associated with reducing risk.

However, it is feasible, at least in the model world simulated here, to drastically reduce the variability in the cost of reducing risk. This is done by providing an infinitely elastic supply of risk free global bonds and thereby keeping the risk free rate fixed. Such a policy will enable the *foreign* intermediary to adjust its leverage to risk shocks at a much lower cost than before. That is, the cost of reducing risk does not increase with demand for risk free assets.

We simulate such a model in the ‘Fixed Rate’ calibration. This calibration yields higher steady state consumption and lower labour, both implying greater welfare. The remaining factors affecting welfare are the volatility of consumption and labour. We see that the fixed rate policy causes a significant increase in the volatility of leverage in the *foreign* financial sector in response to the three risk shocks. The large fluctuations in the balance sheet of the financial sector is explained by the now lower cost of adjusting leverage. The balance sheet fluctuations imply greater fluctuations in portfolio flows. However, the remaining financial and real variables are now remarkably stable. The volatility of consumption and labour in response to risk shocks are significantly lower, also suggesting higher welfare. As with the macroprudential policy, we see that welfare increases despite more volatility in portfolio flows. It appears as if the balance sheet variables absorb the risk shock by reallocating assets between the two intermediaries, reducing the need for adjustments in the real economy. In the following sections we will carefully analyse the transmission mechanism from risk shocks via the financial sector to the household and the real variables that affect welfare. This will enable us to better understand the role of policies such as leverage constraints and fixed versus floating risk free rates.

Table 5.3: Standard Deviations in response to risk shocks

Variable	Symbol	Base Case	Tight Constraint	Fixed Rate
Leverage home	L	2.5750	1.325373	1.835217
Leverage foreign	L^f	0.5686	0.548702	3.525134
Share of bonds held by home	b	0.1350	0.195602	0.163325
Share of bonds held by foreign	b^f	0.1350	0.195602	0.163325
Share of shares held by home	s	0.0272	0.028508	0.032318
Share of shares held by foreign	s^f	0.0272	0.028508	0.032318
Price of shares - home	p	0.3178	0.325497	0.011842
Price of shares - foreign	p^f	0.0535	0.045179	0.010898
Price of bonds - home	q	0.0170	0.01564	0.000482
Price of bonds - foreign	q^{rf}	0.1075	0.098308	0
Return on bonds - home	r^b	0.0176	0.016208	0.0005
Return on bonds - foreign	r^{rf}	0.1106	0.101123	0
Return on shares - home	r^s	0.0610	0.061145	0.001702
Return on shares - foreign	r^{sf}	0.0163	0.012831	0.002445
Return on deposits - home	r^d	0.0501	0.043921	0.001174
Return on deposits - foreign	r^{df}	0.0416	0.035966	0.000993
Consumption home	c	0.0375	0.035047	0.001179
Consumption foreign	c^f	0.0666	0.062686	0.001914
Deposits home	d	0.2079	0.205537	0.013242
Deposits foreign	d^f	0.2975	0.279368	0.101606
Government transfers home	g	0.0170	0.01564	0.000482
Government transfers foreign	g^f	0.1075	0.098308	0.06897
Employment	h	0.0132	0.012403	0.000414
Investment	i	0.0104	0.01085	0.000402
Capital stock	k	0.0627	0.067275	0.003728
Wages	w	0.0244	0.022593	0.000726
Output	y	0.0273	0.025836	0.0009

5.4 Portfolio Flows and Credit

5.4.1 Comparing the open economy to a closed economy

If we close the home economy completely, this becomes a rather standard simple RBC model with the exception of the risk constrained financial intermediary. We can better understand the effects of the model innovations by studying the comparing the impulse responses of this closed model to those we would expect from the standard closed economy RBC model. The most typical shock would be to the productivity of the firm. We plot the responses to such a shock in *Figure 5-4*. The (red) lines marked with 'x'-es indicate the responses in the closed economy, while the (blue) lines marked with 'o'-es indicate the responses in the open economy.

The higher productivity leads to higher wages (marginal product of labour) and greater investment in physical capital due to the higher marginal product of capital. The higher wages attract more labour supply. The combination of more labour and higher wages causes a great increase in household income. The household gets a further boost to income from the government transfers due to the now higher bond prices. The increase in income and government transfers must be allocated to consumption and savings by the household. We therefore see that both consumption and deposits (savings) increase. All these responses are similar to what one would expect from a basic RBC with no financial frictions. Whether the economy is open or closed does not have a great impact on any of these real responses. The only real variable with a significantly different response in the open economy is household consumption. When the economy is open, the households are better able to smooth consumption over time in response to increased productivity. The inter temporal smoothing is possible because they can run a current account surplus by purchasing domestic financial assets from the foreigner, who in return purchases goods from the home firm. This buildup of home savings will gradually be unwound in the following periods as the home agents sell the assets back to the foreigner until the economy has returned to the steady state.

The same result is found in other two-country DSGE models of portfolio flows.

Devereux and Sutherland (2009) found that a positive shock to home productivity led the home agent purchase home shares partly funded by selling foreign shares and partly funded by running a current account surplus. Similarly, Tille and van Wincoop (2010) found a positive productivity shock at home to cause agents to sell foreign assets to the foreigner and purchase home assets from the foreigner. Exactly as in Devereux and Sutherland (2009), they purchase more assets than they sell, reflecting a current account surplus to distribute the higher income over several future periods of consumption. Our model presented here, like the models by Tille *et.al* and Devereux *et.al* are deliberately parsimonious in order to highlight only the most relevant relationships. However, the equivalent responses to a productivity shock are encouraging. It suggests a certain robustness of the framework. The responses are the same under a neoclassical model with zero frictions and symmetric equity markets in which households consider the correlation of asset returns to future income (Devereux and Sutherland, 2009), in a model with finite-lifespan agents who need not consider the correlation between returns and productivity (Tille and van Wincoop, 2010), and lastly in our model where investments are allocated by financial intermediaries with externally imposed leverage constraints.

In our simulations, the financial variables are more affected than real variables by opening the financial markets than real variables like consumption and labour. Naturally there is no foreign holding of home shares and bonds in the closed model, and therefore no response in portfolio flows. In both the closed and open economy, there is a sharp increase in supply of deposit liabilities due to higher household savings. In the open economy, the home intermediary uses the increased supply of deposit liabilities to fund purchases of both shares and bonds. The intermediary purchases more bonds than shares, causing a drop in leverage (defined as total assets over risk free bonds). The ability to purchase bonds from the foreign intermediary is essential. In the open economy, the foreigner stands ready to sell his holding of home bonds, and thus the increased demand for these bonds by the home intermediary does not have a great impact on the price. This means that the cost of reducing leverage is lower than in the closed economy. This further means that the cost of purchasing shares is lower

than in the closed economy. At last, this explains why leverage increases and share prices drop in the closed economy, while leverage drops and share prices increase in the open economy.

To conclude, most of the differences between the open and closed economies are absorbed by the financial variables and will therefore not significantly affect welfare. However, open capital markets enable the home economy to run a current account surplus in periods of unexpectedly high output followed by current account deficits as productivity returns to normal, thereby smoothing consumption across time. The drawback is that the economy will have a permanent current account surplus in steady state (due to the asymmetric capital controls) and therefore lower consumption in the open steady state compared to the closed steady state.

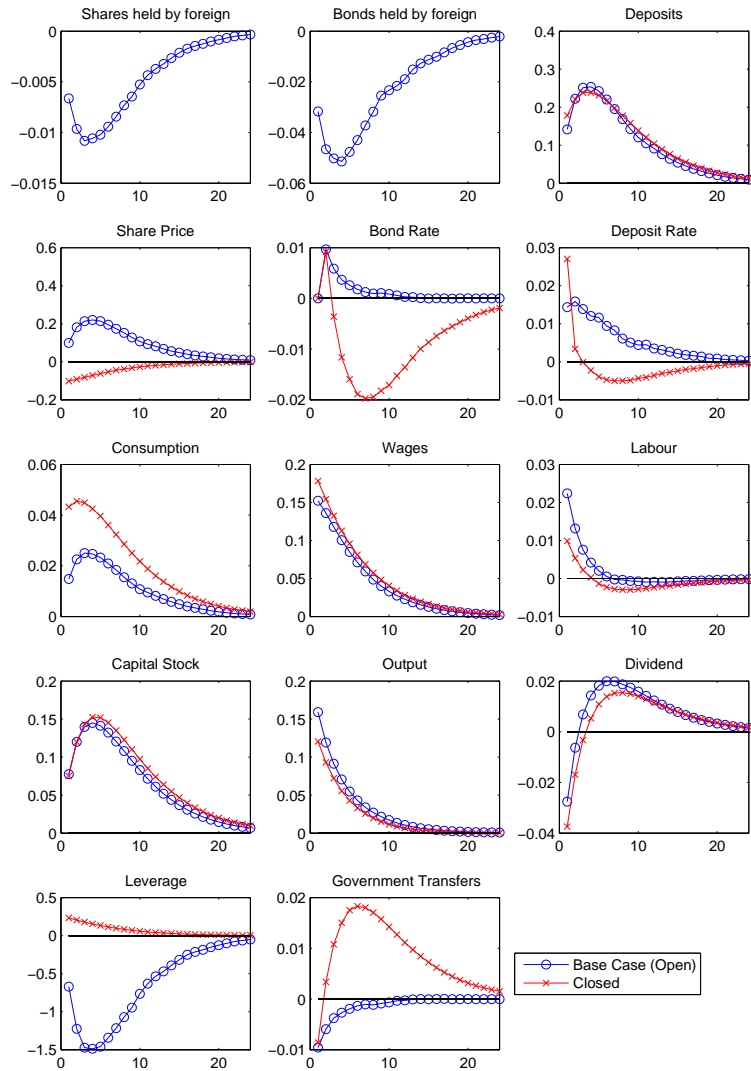


Figure 5-4: **Productivity shocks** in the closed and open economy. Higher productivity cause portfolio outflows and higher consumption and investment.

5.4.2 Increasing risk causes current account surpluses in emerging economies

The academic literature has increasingly focused on the relationship between risk, leverage and capital flows. Risk is generally thought to cause lower leverage and portfolio outflows from emerging markets (Rey, 2013; Bruno and Shin, 2013; Adrian and Shin, 2009; McCauley, 2012). Portfolio outflows are further thought to reduce credit / increase savings (Rey, 2013; Magud, Reinhart, and Vesperoni, 2014; Lane and McQuade, 2013; Calvo, 1998). The results of our model support this story. The impulse responses to the three different risk shocks are plotted in *Figure 5-5*. The (green) dotted lines plot the responses to a shock in *home* share risk. The (blue) lines marked with 'x'-es plot the responses to a shock in *foreign* share risk. The (red) lines marked with 'o'-es plot the responses to a shock in emerging market risk carried by the *foreign* intermediary.

Risks that affect the foreigner (that is foreign share risk and emerging market risk) cause portfolio flows out of emerging markets. *Figure 5-5* shows that this is the case in both shares and bonds, but mainly in shares. Since the shock does not affect the *home* agent directly, the different response of bonds compared to shares is likely reflecting a greater elasticity of share demand with respect to risk than the elasticity of bond demand with respect to risk. The reason is likely to be the greater total risk of shares, thus reducing share exposure is more effective in reducing total risk on the foreign intermediary's balance sheet. The outcome is a relative shift in demand for *home* assets away from the foreign intermediary towards the home intermediary.

It may be surprising that a shock to *foreign* share risk causes a portfolio flow out of *home* shares. The reason is that the higher risk forces the foreign intermediary to cut leverage. Therefore the foreign intermediary reduces demand for all risky assets. It is possible that the risk shocks makes emerging market shares relatively more attractive compared to foreign shares, but this substitution effect does not outweigh the total "wealth" effect of the foreign intermediary reducing demand for all risky assets.

The portfolio flows respond differently to a shock in *home* (emerging market) share risk. This shock directly affects both the global and emerging market financial intermediaries. This forces both intermediaries to reduce leverage which means the *home* intermediary will reduce demand for shares and increase demand for *home* bonds. The higher risk on shares will also reduce the *foreign* intermediary's demand for *home* shares, but the net effect is that the *foreigner* buys shares from the *home* intermediary. In other words, the direction of the portfolio flow is determined by the relative change in demand, and in this case the *home* demand fell more than the *foreign* demand. This gives rise to a negative correlation between share prices and portfolio flows: share prices dropped as foreigners bought shares. The bond price, however, rises while there is a bond outflow. It is unclear whether the *foreign* intermediary demands more or less *home* bonds in response to the risk shock. The *home* intermediary is certain to demand more *home* bonds to reduce leverage. The outcome is that the *home* intermediary purchases *home* bonds from the foreigner, reflected in a portfolio outflow from the bond market. The higher price associated with this outflow is explained by higher demand for *home* bonds by the home intermediary. These simulated impulse responses can potentially explain the results observed in Chapter 3. We observed that risk shocks consistently cause portfolio outflows from South African bonds, but not significant flows in shares. This is consistent with a risk shock that affects both the global and local emerging market investors.

Figure 5-5 also illustrates that the source of risk and direction of flows do not matter much for the response of real variables. Home consumption, labour and output respond in almost exactly the same way to an increase in *home* share risk as to a shock in *foreign* share risk or general emerging market risk. This similarity in effects of the different risk shocks is not trivial. The real effects are independent on the source of risk only because each risk shock happens to have the same effect on the *home* intermediary's demand for deposit liabilities. This is the only link between the financial sector and real sector of the economy. It is the rate of return offered on deposits that cause all adjustments by households. The adjustments by the households further cause adjustments by the firm. The corollary is that our

understanding of the real effects of a risk shock depends on our understanding of the effect the shock has on the financial intermediary's demand for savings (deposit liabilities).

All risk shocks increase demand for deposit liabilities...

A shock to *home* risk causes a drop in leverage. The drop in leverage is a direct consequence of the risk adjusted leverage constraint. Leverage equals the ratio of household savings (deposits) to risk free assets. In order to reduce leverage, the intermediary must either sell risky assets, or raise more deposit liabilities from households to invest in risk free assets. The intermediary does both simultaneously in response to a risk shock. This implies a higher demand for deposit liabilities, causing the interest rate offered on deposits to increase.

It is perhaps less obvious how a shock to *foreign* share risk will affect the *home* intermediary. In this case, the foreign intermediary is directly forced to reduce risk, and will do so evenly across their portfolio. Since both *home* shares and *home* bonds are risky in the eyes of the foreigner, they will reduce demand for both. This leads to a portfolio outflow. The outflow implies that the home intermediary purchases *home* shares and bonds causing a temporarily higher leverage. The purchase of shares is optimal because the price has dropped due to the lower foreign demand. The purchase of bonds is required to keep the leverage at its constraint when more risky shares are added to the balance sheet. The combined purchase of shares and bonds requires the financial intermediary to raise funds by taking more household deposits. Again, this implies a higher demand for deposit liabilities, causing the interest rate offered on deposits to increase.

The last risk shock was to general emerging market risk. This is the risk that is associated with investing in *home* shares and bonds by the *foreign* intermediary. The *home* intermediary has no exposure to this type of risk. But again we see that despite their lack of exposure, the home intermediary is affected. The effects are similar to that of a shock in *foreign* share risk. The foreigner's cost of holding *home* shares and bonds are now higher, causing them to reduce demand for both.

The home intermediary's demand for these assets has not changed, and therefore the home intermediary will purchase these assets as the price drops due to the lower foreign demand. Again we see that the *home* intermediary must fund this by raising deposits. As with the other two risk shocks, this implies a higher demand for deposit liabilities, causing the interest rate offered on deposits to increase.

...Therefore all risk shocks have similar real effects.

Nobody would care about the financial sector if it did not have real effects that determine our welfare. But so it does. When any kind of risk increases we saw that the *home* intermediary purchases more *home* assets. We saw that the three different risk shocks had for different reasons the exact same effect on demand for household deposits. The financial intermediary demands more household deposits, causing the interest rate offered on these savings to increase. And this is the financial variable that transmits into the real sector where welfare is derived.

All three risk shocks caused higher rates offered for household deposits. The higher rates offered induce more saving. The increased saving is funded by less consumption and more labour. The increased supply of labour causes a drop in the marginal productivity of labour, reflected in lower wages. The reduced cost of labour will also lead to temporary disinvestment in physical capital. This causes an increase in dividends, as the return on capital is greater and profits are paid as dividends rather than reinvested. Further, the proceeds from disinvestments are also paid as dividends. This is a counter-cyclical feature of the firm, reducing the negative impact of risk on share prices.

The outcome is that portfolio flows, credit, leverage, consumption and investment all respond in a manner consistent with findings of the empirical literature. Output increases temporarily as more labour is supplied, but this added output is exported rather than consumed, reflecting a current account surplus that balances the portfolio outflows. Furthermore, we observe that the welfare effects of the risk shocks are negative. Households derive utility from consumption and leisure, both of which decline in response to risk shocks. The challenge is now to find a policy response that

reduces the fluctuations of consumption and labour in response to exogenous shocks.

The transmission channel from the initial shock to the *home* household goes through the *home* financial intermediary's demand for deposit liabilities. If the shock does not cause a change in the interest rate offered on deposits, the household's savings decision will not be affected. And if savings are not affected, then neither are consumption and labour. There are consequently no welfare implications. Targeting the transmission channel means targeting the financial intermediary's demand for savings / supply of credit. The optimal policy in response to portfolio flows is that which keeps the financial intermediary's demand for deposit liabilities unchanged.

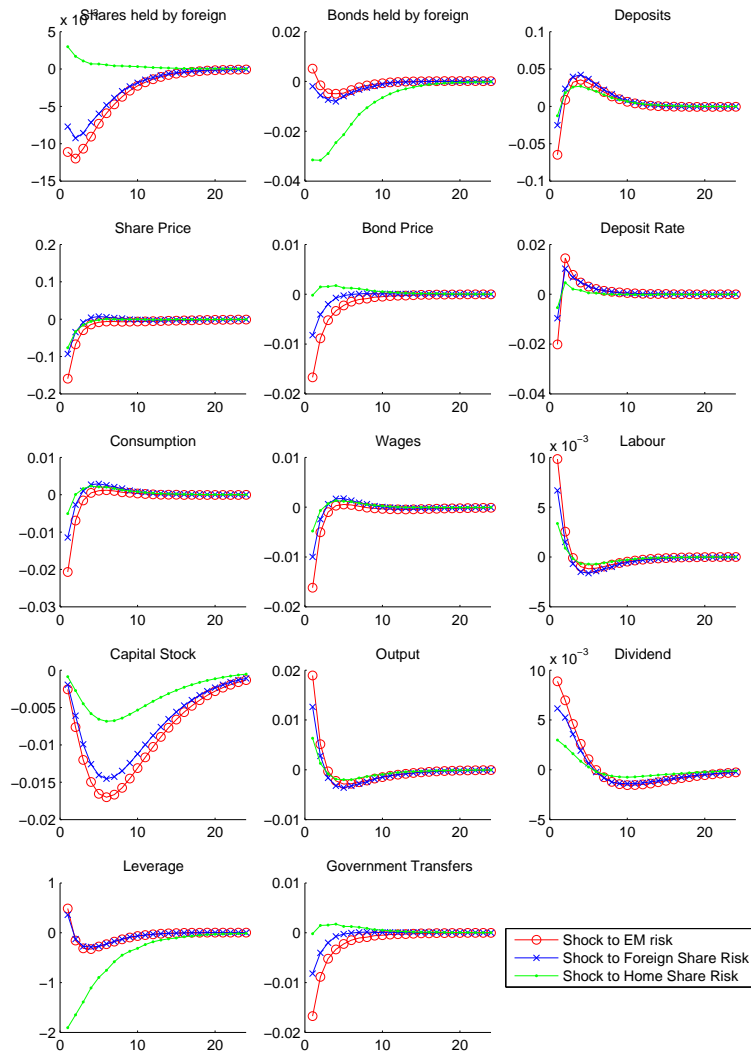


Figure 5-5: **Risk shocks** cause portfolio outflows, less credit (more saving) and lower consumption. The shocks are to home share risk, foreign share risk, and general emerging market risk.

5.4.3 Macroprudential policy increases portfolio flow volatility but may improve welfare

We argued above that the optimal policy in the recipient economy is one which reduces the volatility of intermediary's demand for savings. In this section we explore the power of macroprudential policy in achieving this goal. We see that tightening the leverage constraint on *home* financial intermediaries will improve welfare, but the effect on macroeconomic volatility is minimal. In *Figures 5-6 - 5-8*, the (green) lines marked with 'x'-es and the (blue) lines marked with dots indicate the impulse responses from a calibration with $\psi = 1$ (risk penalized less) and $\psi = 2$ (risk penalized more). That is, for any given level of total portfolio risk, a higher ψ reduces the maximum allowed leverage (total assets over risk free assets). We view this as tighter macroprudential regulation.

The transmission mechanism from the risk shock to the financial sector and real sector are all as described above. The only variables that significantly change their response to risk shocks are portfolio flows and financial sector leverage. Firstly, steady state leverage is significantly lower when the risk is penalized more ($\psi = 2$). Therefore it is not surprising that the cut in leverage in response to risk shocks is smaller when $\psi = 2$.

In steady state, the *home* intermediary will hold 76.4% of the *home* bonds when risk is penalized more, as opposed to 47.9% when risk is penalized less. Consequently, they will sell more bonds to foreigners in response to risk shocks when risk is penalized more. In the share market, the *home* intermediary holds 53.3% of the *home* shares in the base case steady state, while they hold 42.8% of the shares in the steady state where risk is penalized more. The smaller steady state position is reflected in a smaller adjustment in the share market to *home* risk shocks.

The tightness of macroprudential regulation does not have great effects on the adjustment of real variables to financial shocks. However, we did see that the tighter risk constraint improved steady state welfare by increasing steady state consumption and reducing steady state labour. These effects are presumably happily embraced, but

they do not reflect the goal of the policy which was to reduce real economic volatility. While it is difficult to read from the plotted impulse responses, we see in *Table 5.2* that the fluctuations of consumption and labour are slightly lower in response to risk shocks when macroprudential policy is tighter. This is largely reflected in the contemporaneous response to a shock. Other than the slightly lower immediate volatility of the real economy, we see that the sign and duration of all real economy impulse responses look identical independent of the tightness of macroprudential policy. The similarity in responses of real variables indicate that the transmission channel is not affected by the macroprudential policy. Above we discovered that the transmission channel goes through the intermediary's demand for household savings. We see in *Figures 5-6 - 5-8* that the demand for savings (that is the rate offered on household deposits) responds in the same manner independent of changes to macroprudential policy. Essentially, the entire effect of the tighter leverage constraint is absorbed in the greater fluctuations of gross portfolio flows.

The volatility of gross portfolio flows has no negative welfare effects by itself. On the contrary, portfolio flows enable the *home* intermediary to better manage its leverage without having large impacts on the price of assets. The lower volatility in asset returns further ensures lower volatility of deposit rates. Lower volatility of deposit rates ensures lower volatility of savings, and therefore lower volatility of consumption and labour.

Portfolio flows enable the *home* economy to transfer some of the adjustments to risk shocks to the *foreign* intermediary rather than on its own households. The downside is that risk shocks in the *foreign* economy can similarly be transferred to the *home* intermediary and further to the *home* household. This transmission was not significantly dampened by imposing a tighter leverage constraint on the *home* intermediary. It is possible that counter-cyclical adjustments to the risk penalty as recommended by Rey (2013) would be more effective in breaking the transmission channel.

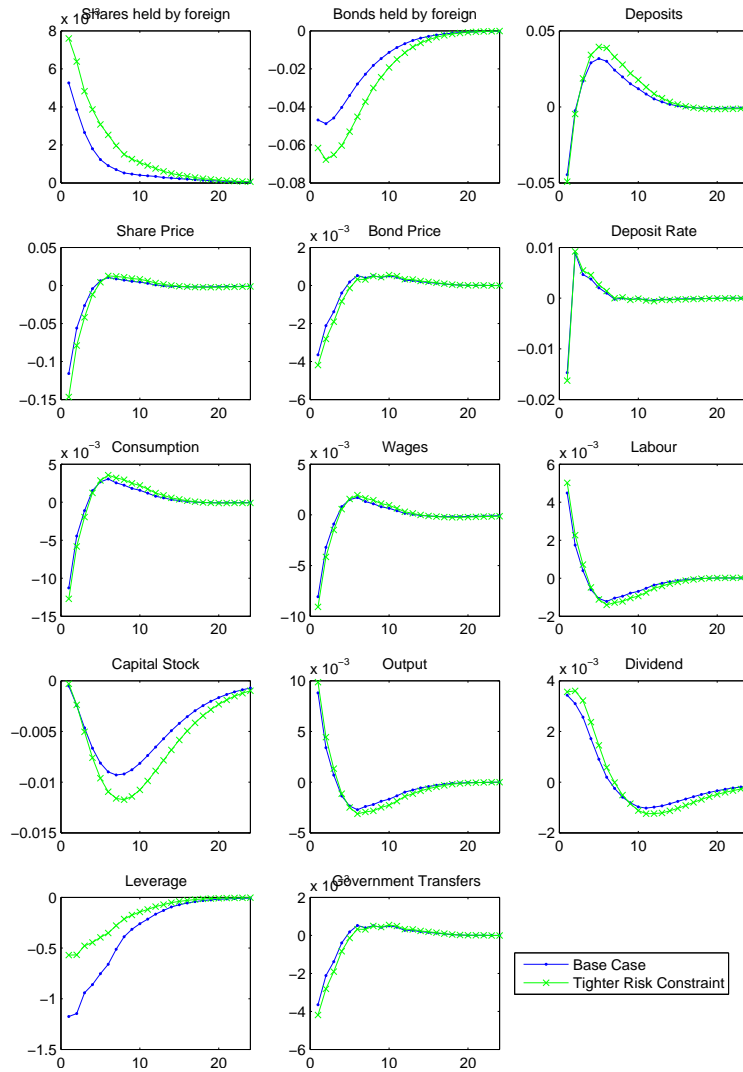


Figure 5-6: A shock to *home share risk* causes inflows in the share market and outflows in the bond market. The responses are stronger when the macroprudential policy is tighter.

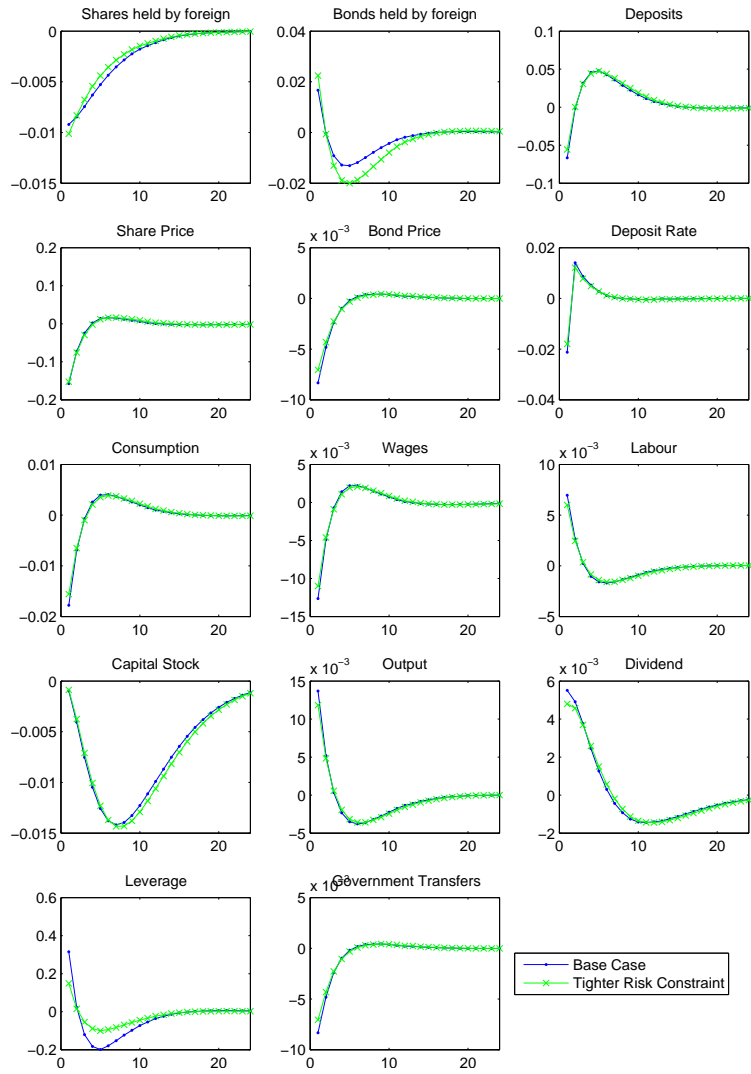


Figure 5-7: A shock to foreign share risk causes portfolio outflows. The effect of tighter macroprudential policy is minimal.

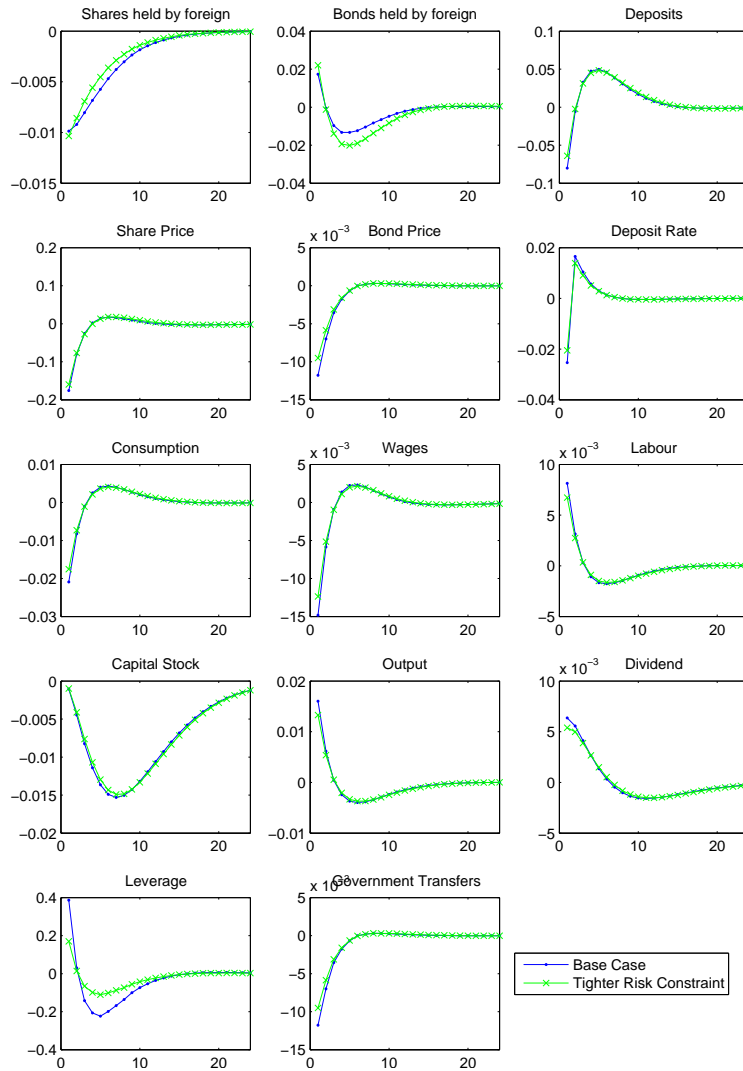


Figure 5-8: A shock to emerging market risk causes portfolio outflows. The effect of tighter macroprudential regulation is minimal.

5.4.4 Global policy makers have a great impact on emerging economies

Rey (2013) suggests there are four alternatives of policies that can deal with the fluctuations in credit caused by gross portfolio flows: (1) capital controls, (2) changing behaviour of the Federal Reserve and other global policy makers, (3) cyclical policies “limiting credit growth and leverage during the upturn of the cycle” and (4) structural policies “imposing stricter limits on leverage for all financial intermediaries” (Rey, 2013; p314). Rey recommends the latter two in addition to some capital controls. We saw above that our model does not find strong effects of a structural policy imposing limits on leverage. Our model does not have the capacity to study the effect of a cyclical leverage constraint. However, we do have the capacity to study the effect of changing behavior by global policy makers. In the following we show that the behavior of global policy makers can have a significant impact on portfolio flows and welfare effects in the recipient economy.

In a classic paper, Poole (1970) made the argument that the optimal choice of monetary policy instruments depends on the type of shocks the policy responds to. If the goal is stable output, Poole demonstrates that financial shocks (demand for money) are best absorbed by adjusting the quantity of money while keeping interest rates fixed. On the other hand, a shock to the real economy (demand for goods) is best absorbed by adjusting the interest rates while keeping the quantity of money fixed.

Poole’s results were based on a stochastic Hicksian IS-LM model of aggregate demand. But we see the echo of his findings in our more contemporary DSGE model of two economies where demand for goods and money is the outcome of utility optimising agents. To be specific, the impulse responses of *home* real economic variables such as consumption, labour and output are highly dependent on the policy framework in the *foreign* economy. Real shocks are best absorbed by adjusting prices, while financial shocks are best absorbed by adjusting quantities.

As an example of a financial shock, *Figure 5-9* plots the impulse responses to an

unexpected increase in the risk of *foreign* shares.⁹ Together, the impulse responses bring a clear message: One may use the supply of risk free bonds to almost completely absorb the risk shock. The alternative policy of fixing the supply of bonds and letting the rates adjust will see the risk shock causing larger adjustments to portfolios, asset returns, deposit rates, saving, consumption, labour and output. *Quantities absorb financial shocks.*

This policy works because the *foreign* financial intermediary can now reduce portfolio risk by raising deposits and purchasing risk free bonds rather than selling risky assets. There is no significant change in demand for *home* assets, and therefore no significant portfolio flow, and no response is required by the *home* intermediary. The *home* intermediary's demand for deposit liabilities is unchanged and the *home* real economy is unaffected. The same holds for shocks to other financial variables, as illustrated in the impulse responses reported in section B.3 in the Appendix. The credit response to a shock in risk was avoided, not by addressing the transmission channel in the home economy, but because the global policy maker absorbed the shock before it was transmitted to the *home* intermediary.

Poole's story persists when we shock a 'real' variable in the *foreign* economy. In *figure 5-10* we simulate the impulse responses to a shock in the income of the *foreign* household. In the model where global bond rates are fixed and the global bond supply is perfectly elastic, the shock causes large adjustments to the *home* households savings, consumption, labour, wages, and output. If instead the global bond supply is fixed and the rates adjust to demand, we see smaller portfolio flows, less adjustment in asset prices and less adjustment in the real economy. *Prices absorb real shocks.*

First the higher foreign household income raises the supply of deposits, and this will cause the foreign intermediary to demand more assets. To purchase risky high yielding assets then financial intermediary is required to also purchase a certain

⁹The (blue) lines marked with dots plot the responses from a model where the global policy maker keeps the supply of risk free bonds fixed while allowing the rate to adjust freely to demand. The (green) lines marked with 'x'-es plot the impulse responses from a model where the global policy maker keeps the rate of return on their risk free bonds fixed, while allowing the supply of bonds to freely adjust to demand.

amount of global risk free bonds. The demand for bonds leads to higher bond prices and lower bond rates. The lower bond rates makes the position more costly as it is funded by deposits with relatively higher rates. The intermediary's demand for deposits therefore falls, providing a further downward pressure on deposit rates.

Consequently, deposit rates will see a greater fall when bond rates are flexible than when they are fixed. The larger fall in deposit rates ensures a smaller increase in savings, reducing the transmission from the income shock to the financial sector. The price adjustment dampens the adjustment in balance sheet quantities. The net flow of deposits into the *foreign* financial sector is smaller, and the intermediary therefore has a smaller increase in demand for other assets, including shares and bonds issued in the *home* economy. The impact on the *home* asset prices, and therefore on the home intermediary, is reduced.¹⁰ Since the *home* intermediary is less affected there is no need make large adjustments to their demand for deposit liabilities from the *home* households. This keeps household savings, consumption and labour more or less stable. Overall, we see that the behavior of the foreign policy maker effectively stopped the transmission to the *home* economy by allowing *foreign* asset prices to absorb the shock to household income.

¹⁰In fact, the effect on *home* prices is negative. This is a bit of a fluke. Notice that when global risk free rates are fixed, the portfolio flow into shares pull their price up while dividends fall. Dividends fall due to the reduced supply of labour. The combination of higher prices and lower dividends imply significantly lower expected returns on shares. This is acceptable to the foreigner when risk free rates remain high which reduces the loss making spread between deposit rates and risk free rates. The small loss on reducing risk means less return is required on risky assets. However, in the policy regime where risk free rates fall due to fixed supply of risk free assets we see that this falling return on home shares does not outweigh the rising cost of reducing risk. In sum, the foreign intermediary actually demands less *home* shares. The increased supply of foreign savings is rather invested in foreign shares.

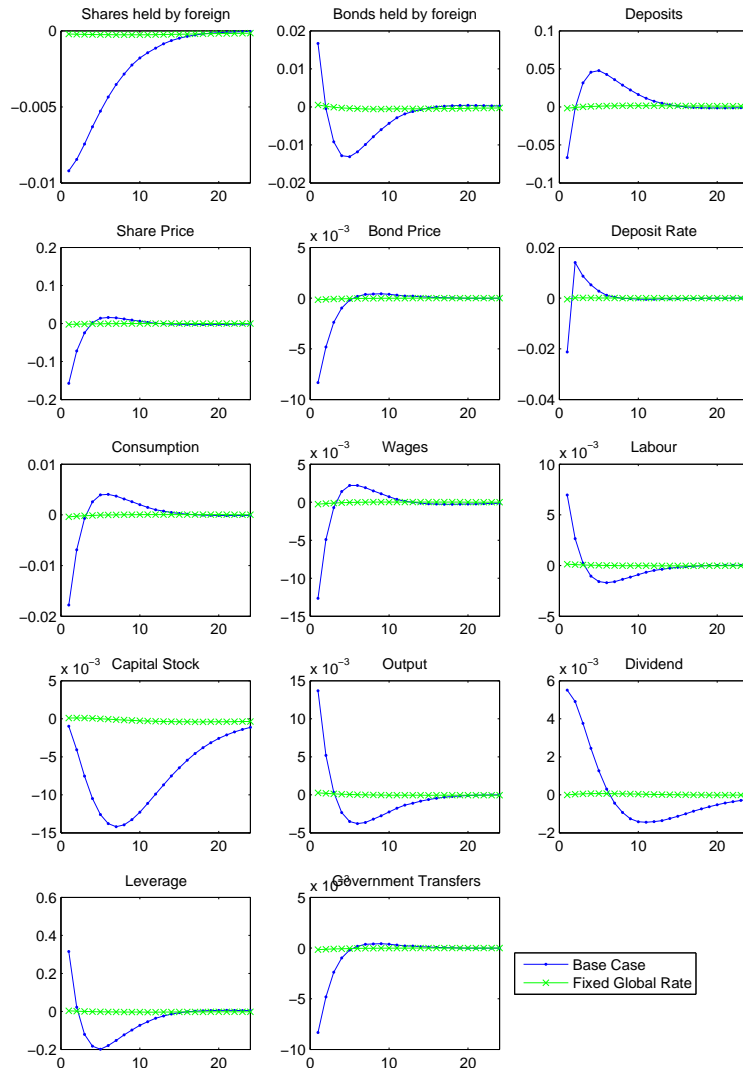


Figure 5-9: **Shock to foreign share risk** causes portfolio outflows. The shock is simulated in the base case model with fixed global risk free bond supply, and the ‘fixed rates’ model with fixed rates on global risk free bonds.

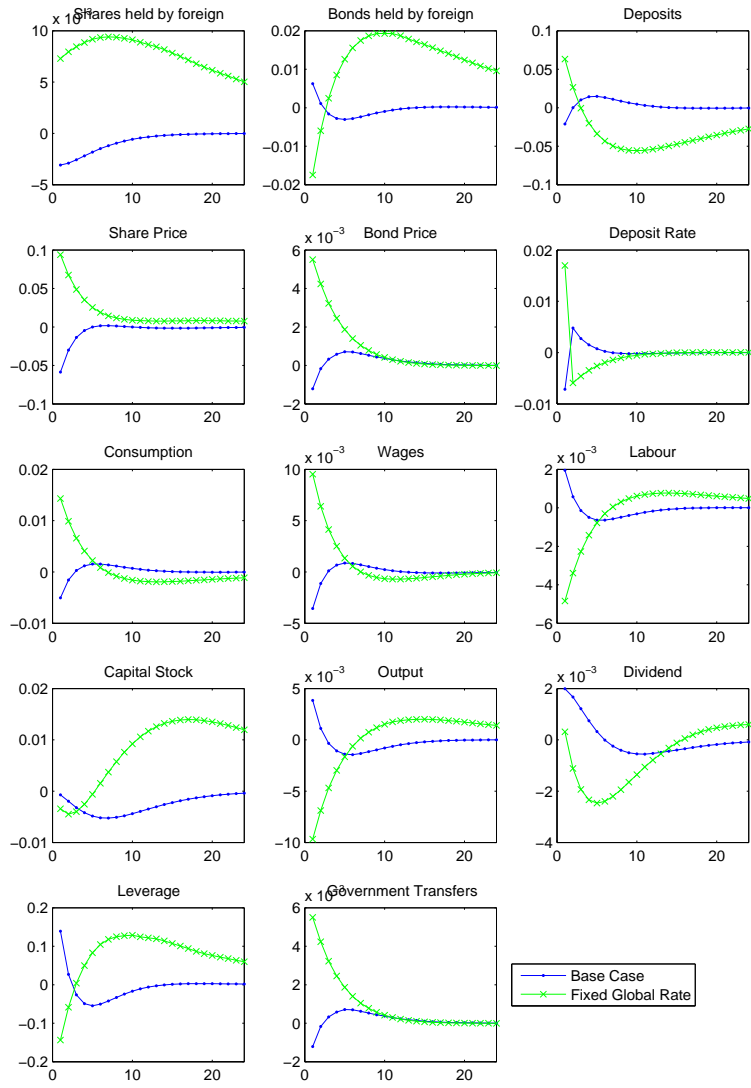


Figure 5-10: **Shock to foreign endowment** has mixed effects on portfolio outflows. The shock is simulated in the base case model with fixed global risk free bond supply, and the ‘fixed rates’ model with fixed rates on global risk free bonds.

Has recent global policy benefited emerging markets?

The behavior of foreign policy makers was shown to greatly affect the portfolio flows and welfare of recipient economies. This begs the question of whether recent global policy has benefited emerging economies. Our model is not even remotely equipped to fully answer the question, but we can analyse certain aspects of recent policy.

The dominant story in global financial markets since the financial crisis of 2008-2009 has been the large scale asset purchases (*Quantitative Easing*) by the US Federal Reserve. In 2008 there was a sudden large increase in risk of financial assets, causing a rush to reduce leverage. This, as the model suggests, caused a jump in demand for risk free assets. If the supply of risk free assets was fixed we would have seen a sharp drop in their rate of return. The drop in risk-free returns, as illustrated by the model, would cause greater volatility in the real economy as the delevering by banks would be more costly. The higher cost of reducing risk would be reflected in a sharper fall in demand for, and thus price of, risky assets.

In practice, however, the Federal Reserve provides an infinitely elastic supply of risk free assets to US banks in the form of reserve deposits. The rate of return on such deposits is fixed. Thus, despite the quantitative easing policies which in effect removed low-risk government bonds from circulation (the exact opposite of the model's recommendation), there was an infinitely elastic supply of other risk free assets. As the model predicts, these reserves have increased drastically throughout each round of quantitative easing. Removing the low-risk government bonds from circulation simply shifted banks demand towards their substitute, excess reserve deposits.

However, it is possible that the reserve deposits are not perfect substitutes for government bonds. If this is the case, it is possible that quantitative easing goes against the advice of our model by reducing the supply of the very asset they should increase supply of. The Federal Reserve's asset purchases were intended to push demand from low-risk assets toward higher risk assets. The idea is that higher central bank demand for risk free bonds will push down their discount rate, and therefore the discount rate applied to other assets will also fall (for example by maintaining a

constant risk premium). The idea is better explained by Woodford (2012) on page 244 of his paper presented at the 2012 Jackson Hole Economic Policy Symposium:

“It is often supposed that open-market purchases of securities by the central bank must inevitably affect the market prices of those securities (and hence other prices and quantities as well), through what is called a “portfolio-balance effect”: if the central bank holds less of certain assets and more of others, then the private sector is forced (as a requirement for equilibrium) to hold more of the former and less of the latter, and a change in the relative prices of the assets will almost always be required to induce the private parties to change the portfolios that they prefer. ”
(Woodford, 2012)

He further writes:

“But it is important to note that such “portfolio-balance effects” do not exist in a modern, general-equilibrium theory of asset prices in which assets are assumed to be valued for their state-contingent payoffs in different states of the world, and investors are assumed to correctly anticipate the consequences of their portfolio choices for their wealth in different future states - at least to the extent that financial markets are modeled as frictionless. ”

In our general equilibrium model presented here we do not make the latter assumption of frictionless markets. Financial markets are not frictionless and therefore asset prices may deviate from the present value of their expected state-contingent payoffs. We have imposed a risk adjusted leverage constraint on financial intermediaries, making demand for assets less than perfectly elastic, and we have introduced an exogenous cost of saving (deposits), making the supply of savings less than perfectly elastic. These frictions cause different price dynamics in response to a policy that reduces the supply of risk free assets. The lower supply of risk free bonds increases the price of the bonds, similar to the portfolio-balance hypothesis referred to

by Woodford (2012), but this higher price makes it more expensive to reduce risk by purchasing risk free assets. Instead the financial sector will reduce risk by demanding fewer risky assets. Asset purchases by the Federal Reserve were meant to increase all asset prices by pushing down the discount rate applied to future expected earnings. But in the model simulated here, the discount rate on other assets instead increases due to the higher risk premium. A somewhat related argument was presented in the same 2012 Jackson Hole presentation by Woodford (Woodford, 2012). On page 250 Woodford writes:

“First of all, even though purchases of long-term Treasuries could raise the price of (and so lower the yield on) Treasuries, this would not necessarily imply any reduction in *other* long term interest rates, since the increase in the price of Treasuries would reflect an increase in the **safety premium**, and not necessarily any increase in their price *apart from* the safety premium (and hence, not necessarily any reduction in the discount rate that the market uses to value future payments)” (Woodford, 2012) (italics in original, bold emphasis added).

The term ‘safety premium’ mentioned here was introduced by Krishnamurthy and Vissing-Jorgensen (2012) and refers to the fact that certain assets trade at a price beyond the present value of their expected future cash flow. Krishnamurthy and Vissing-Jorgensen (2012) find evidence that US Treasury bonds trade at a ‘safety premium’ due to their accepted status as collateral in repurchase transactions. This is not unlike the role the bonds serve in our model. In fact, one may view the leverage constraint as a collateral constraint: The more risk on the balance sheet, the more collateral is required per deposit liability.

The above argument by Woodford suggested that the higher price of risk free bonds in response to central bank purchases (lower bond supply) only reflects a higher ‘safety premium’. In our model, this effect is even greater. For the intermediary, the risk free bonds serve no other role than collateral. They earn lower returns than the cost of deposits, implying a loss on holding bonds. The spread between deposit

rates and bond rates reflect the ‘safety premium’. Without the collateral benefit, the intermediary would only hold bonds if they yield the same return as deposits (or more).

Now, quantitative easing, that is asset purchases funded by creating new reserves deposits, is impossible in our model since the model does not include an asset called ‘reserve deposits’.¹¹ However, should we introduce a new risk free asset called reserve deposits, with return equal to that of the risk free bond, there would be no demand for this asset unless it was allowed to be used as collateral similarly to bonds. Without collateral qualities, the reserve deposits are not a perfect substitutes for government risk free bonds. Thus, a shock that removes risk free bonds and replaces them with reserve deposits will not have the desired effects of reducing discount rates. The bond rates will decrease, but that is due to the scarcity of collateral-worthy assets. The discount rate, excluding the ‘safety premium’ will most likely increase, as it is now more costly to purchase risky assets due to the high cost of collateral.

Woodford (2012); Krishnamurthy and Vissing-Jorgensen (2012) suggested that quantitative easing may indeed have removed low-risk bonds that have values beyond their expected future cash flows. That is, the bonds have value as accepted collateral in repurchase transactions and therefore provide market liquidity. If the reserve deposits that replace the bonds do not carry these benefits, then they are not perfect substitutes for government bonds. According to our model, if reserve deposits do not have the collateral benefits, the optimal policy response would be to increase the supply of risk free government bonds to fully absorb the higher demand. Instead the supply has decreased due to central bank purchases. The higher prices achieved on government bonds reflect the reduced supply of collateral, not reduced supply of risk free cash flows. Thus, *ceteris paribus*, the discount rate excluding the ‘safety premium’ is unchanged.

¹¹We can of course simulate a negative shock to the supply of bonds in our model, but this will not reflect the effects of quantitative easing. If bond supply drops in our model, it is because the government issues fewer bonds and the burden of paying for this falls on the household. In response to their shrinking budget constraint, the household will save less, supplying less deposits to the intermediary, who in turn will have less funds to invest, thus demanding fewer assets, including fewer risk free bonds. In other words, reducing the supply of bonds will have the supply effect of higher prices, but through the household cause lower demand with a negative effect on prices.

In practice, everything does not remain equal when the federal reserve trades reserve deposits for government bonds. Empirical work by Rey (2013), Adrian and Shin (2009) and Bekaert et al. (2010) show that quantitative easing reduced both risk and risk aversion. This effect is important as it directly addresses the shock itself and therefore reduces the demand for risk free assets. With less demand for risk free assets, the falling supply of these assets do less damage. However, the persistent record high holdings of excess reserves by US banks indicate a still strong demand for risk free assets. Woodford's concern may still be relevant.

To conclude, our model is not suited to study the full impact of quantitative easing. However, it does reflect the argument by Woodford (2012) and Krishnamurthy and Vissing-Jorgensen (2012) that the policy reduces supply of important risk-free assets. However, quantitative easing has benefits not captured by our model, most importantly in reducing asset price volatility. In our model, risk shocks, such as the global financial crisis, can be absorbed using fiscal policy. The government can issue as many risk free bonds as is demanded to keep the rates on the bonds fixed. The government then transfers the proceeds from the bond issuance to the households. This maintains the demand for risky assets and thereby preempts the portfolio outflows.

5.5 Conclusion

Portfolio flows to emerging markets reflect the portfolio reallocation that arises when foreign asset demand changes *relative* to domestic asset demand. We saw that portfolio flows carry little, if any, information about *total* demand for financial assets. However, the direction of the portfolio flow is important because it is likely to affect demand for savings in the recipient economy. A portfolio inflow implies that the financial intermediary in the recipient economy sells assets to foreign agents. The transaction injects cash on the balance sheet of the recipient intermediary, thus reducing their demand for household savings, or equivalently increases their supply of credit. We see that the lower demand for savings pushes down interest rates in the recipient economy, causing less saving, more consumption and less labour, less output

and an associated current account deficit. The key link in the transmission channel is the financial intermediary's demand for savings or supply of credit.

While the direction of total portfolio flows has a predictable impact on demand for savings, the portfolio flow can be associated with different macroeconomic conditions. In the case of a domestic productivity shock, the domestic firm is expected to pay more dividends in the future, raising demand for shares from both domestic and foreign investors. The total demand for shares has increased, and the direction of the capital flow depends on whose demand increases more. In this case, domestic demand increases more than foreign demand because the higher productivity of labour increases the supply of savings, making it cheaper for the domestic intermediary to fund asset purchases. The portfolio outflow is associated with a domestic expansion with more output, more labour and more consumption.

On the contrary, a foreign risk shock will cause a portfolio outflow associated with lower total demand for assets. The domestic demand is unaffected as they have no exposure to foreign risks, but foreign demand for risky assets will fall. The foreign intermediary consequently sells assets to the domestic intermediary. The expansion of the domestic balance sheet must be funded by household deposits, therefore the demand for savings has increased. The risk shock, like the productivity shock, causes a portfolio outflow, but the risk shock is associated with falling consumption rather than rising consumption.

Despite the varying macroeconomic circumstances associated with portfolio flows, the transmission channel is always the same. Portfolio inflows will reduce demand for savings and therefore reduce the interest offered on deposits. The rate offered on deposits will further affect the household's decision to save, consume and work. A policy aimed at the transmission channel will in effect be one that reduces the volatility of demand for savings. In this paper we explored the power of macroprudential policy in this regard. The macroprudential policy imposes a risk adjusted leverage constraint on the intermediary. The more risk on the intermediary's balance sheet, the more risk free bonds must the intermediary hold in proportion to total liabilities. A permanently tighter macroprudential policy does not significantly affect

the response of the intermediary's demand for savings. Tighter macroprudential policy is therefore not successful in targeting the transmission channel, though we do see marginally higher welfare due to higher steady state consumption and less labour when the macroprudential policy is tight. It is possible that the policy would be more successful in reducing volatility if the leverage constraint becomes tighter in response to portfolio inflows. Such a countercyclical policy was not simulated here.

Macroprudential policy was aimed at the transmission channel from the flow to credit and saving. It is also relevant to study how global policy may respond to global shocks in a manner that deters portfolio flows from happening in the first place. We first saw that an increase in global risk will reduce global demand for risky assets, causing a portfolio flow away from emerging markets as the global investors sell assets to local investors. Our simulations suggest that any type of risk shock can be absorbed by an appropriate adjustment in the supply of foreign risk-free bonds. A perfectly elastic supply of these assets will immediately adjust to demand while keeping prices fixed. This enables banks to reduce their leverage without drastically reducing their demand for risky assets.

However, if the same policy of adjusting supply of risk free assets to demand was used in response to a shock in foreign income, we saw that this would exaggerate the real adjustments of the emerging economy. Instead, the real shock was best absorbed by keeping the quantity of bonds fixed and rather let the price of bonds adjust to demand. We concluded that the model hints at a policy rule similar to Poole's (1970) finding that financial shocks can be absorbed by quantities while real shocks can be absorbed by prices.

In summary, we can distinguish between two kinds of policies to deal with volatile portfolio flows. The first kind of policy aims to deter the shock from creating portfolio flows in the first place. The global policy maker could achieve this by letting the supply of bonds or the price of bonds to almost completely absorb the shock, leaving little change in global demand for emerging market assets. The second kind of policy aims at the transmission channel linking portfolio flows to the recipient economy. The key link in this transmission channel was the financial sector's demand for

savings. Macroprudential policy has previously been suggested as a tool that targets this transmission channel. Our simulations suggest that permanently tighter macroprudential policy will not have a meaningful effect on the transmission of portfolio flows to the real economy.

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Chapter 6

Concluding Remarks

In this PhD thesis we presented empirical and theoretical research on the relationship between risk, monetary policy, macroprudential policy, portfolio flows, savings and credit.

The literature typically focuses on changes in global asset demand when explaining portfolio flows to emerging markets. Here we have argued that some emphasis must also be placed on the *relative* demand for emerging market assets from global investors compared to local investors. The portfolio flows arise only if relative demand has changed. In Chapter 3 we first noticed the importance of *relative* asset demand when we found empirical evidence that bond flows are more affected by risk than share flows. At first glance, this result seems counter-intuitive since shares generally are more risky than bonds. We suggest that the explanation for the lacking response of share flows compared to bond flows lies in the responses relative demand. Both global investors and emerging market investors will reduce demand for emerging market shares when risk and risk aversion is high. The direction of share flows is therefore unpredictable. But local emerging market investors will increase demand for local emerging market bonds when risk and risk aversion is high. Global investors on the other hand, will reduce demand for emerging market bonds when risk and risk aversion is high. This leads foreigners to sell local emerging market bonds to local investors. A risk shock therefore causes strong bond flows and limited share flows.

In Chapter 5 we presented a two-country dynamic stochastic general equilibrium

model with risk constrained financial intermediaries and asymmetric capital controls. The model simulations confirm the observation made in Chapter 3: Risk shocks that affect both global and local emerging market investors will cause significant bond outflows from emerging markets. Share flows will not respond significantly. The reasons are as posited in Chapter 3. Simulations of other risk shocks that only affect global investors are found to cause large outflows from emerging market shares and modest outflows from emerging market bonds. In this case, the flow is dominated by changing global demand. Global investors reduce demand for shares more than bonds when global risk is higher, simply because shares add more risk to their portfolio.

In Chapter 4 we found empirical evidence that portfolio flows have a significant impact on credit extension in South Africa. We proposed a hypothesis that the transmission channel from portfolio flows to credit goes via banks' credit supply. The alternative hypothesis would be that the transmission channel goes through demand for credit. We identify the supply channel from the demand channel by studying the response of credit to unexpected cash injections on bank balance sheets under two different regimes. The regime is defined by the level of cash on balance sheets as a ratio of total assets. When the cash ratio is high, an increase in credit demand can quickly be met by banks simply by lending out their excess cash. Thus, if the demand channel is dominant, portfolio flows should have a greater impact on credit when the cash ratio is high.

The credit supply channel would imply a greater impact of flows on credit when the cash ratio is low. Banks are more likely to hold less cash when credit demand is high and the supply of savings is low, as they could earn higher returns on the cash by lending it out. A portfolio inflow implies that local fund managers sell local assets to foreigners. Parts of the proceeds from the sale may be deposited in local bank accounts, providing an unexpected cash injection on bank balance sheets. If banks hold no excess cash and there is unmet demand for credit in the economy, this cash will quickly be transformed to credit extension. If instead banks already have plenty of cash and there is little demand for credit, the unexpected cash injection is more likely to be used for paying off other non-core liabilities. We find evidence in support

of this channel. When the cash ratio is low, an unexpected increase in deposits from fund managers will cause a significant and long lasting increase in credit extension. In the case of South Africa, share flows have consistently caused portfolio managers to deposit more cash in South African banks. Therefore share flows have had a stronger effect on credit when the banks' cash ratio is low, implying a certain pro-cyclical impact of share flows on credit extension.

The lessons from Chapter 4 suggest that the credit supply channel is important. We incorporate this finding in the model presented in Chapter 5. We model the financial intermediary as a single agent incorporating all roles played by the different agents in a real world financial sector. That is, the financial intermediary in the model takes deposits like a bank, allocates capital to shares and bonds like a fund manager, trades in shares and bonds with foreign intermediaries like a fund manager and broker / dealer, etc. This role of the financial intermediary as an entire financial sector is clear if we look at portfolio flows: When the local fund manager sells assets to a foreign fund manager we have a portfolio inflow. This inflow directly inject cash in banks and the cash injection directly reduces the banks' demand for savings / supply of credit. Thus, the model incorporates the results we found in Chapter 4 where we found empirical evidence that portfolio inflows cause an injection of cash from fund managers to bank balance sheets. We further build the financial sector in the model to also incorporate the findings from the literature review where we saw that banks tend to target risk and leverage (Adrian and Shin, 2009). In our model, the risk targeting is the outcome of profit maximization combined with a macroprudential policy that imposes a risk adjusted leverage constraint on bank balance sheets.

We simulate the model with calibrations representing different policy regimes and find the tightness of macroprudential policy to have limited effects on the transmission channel. Instead, we find that global monetary and fiscal policy can have a great impact on the transmission of shocks to portfolio flows. Global risk shocks can almost fully be absorbed by keeping global interest rates fixed and allowing the supply of global government bonds to adjust freely with demand. Shocks to global income are not absorbed very well with this same policy. Instead, the income shock is best

absorbed by keeping the bond supply fixed and allowing interest rates to freely adjust with asset demand.

In total, this thesis has contributed to the current literature by providing new insights into the role of relative asset demand in determining portfolio flows and into the transmission of portfolio flows to credit extension. The dynamics between global shocks, portfolio flows and emerging market credit are highly complex and interrelated. We argued that a two-country structural model is a minimum requirement for properly understanding these dynamics. With this thesis we made some initial steps towards properly understanding the transmission of risk to portfolio flows and credit, but we leave plenty of room for future modelling improvements and further research. The success of this continuing research programme is in the interest of policy makers, financial practitioners and the households whose welfare is our ultimate objective.

Appendix A

Tables

A.1 Tables for Chapter 3

	VIX	Bonds	Shares	ZAR	SA 10y	US 10y	Spread
VIX	1.00	-0.24	-0.23	0.21	0.14	-0.07	0.18
Bonds	-0.24	1.00	0.26	-0.24	-0.23	0.00	-0.22
Shares	-0.23	0.26	1.00	-0.76	-0.13	0.13	-0.20
ZAR	0.21	-0.24	-0.76	1.00	0.30	-0.01	0.29
SA 10y	0.14	-0.23	-0.13	0.30	1.00	0.23	0.84
US 10y	-0.07	0.00	0.13	-0.01	0.23	1.00	-0.34
Spread	0.18	-0.22	-0.20	0.29	0.84	-0.34	1.00

Table A.1: Correlation matrix on differenced monthly data - bold print indicates significance at the 5% level

	PublicAuth	PublicCorp	Banks	PrivateNonBank
PublicAuth	1.00	0.48***	0.07	0.02
PublicCorp	0.48***	1.00	-0.13	0.13
Banks	0.07	-0.13	1.00	0.57***
PrivateNonBank	0.02	0.13	0.57***	1.00
Std. Deviation	10918	2706	2236	10911

Table A.2: Correlation and standard deviation of changes in South Africa's foreign liabilities

A.2 Tables for Chapter 4

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
(Intercept)	1.496	4.161	0.359	0.7198
ldmortgages	0.506	0.071	7.096	0.0000
lcashratio	129.028	158.497	0.814	0.4170
ldfinancials	0.065	0.033	1.942	0.0541
shareflow	2.385	0.747	3.191	0.0017
bondflow	0.245	0.494	0.496	0.6208
vix	-0.431	0.188	-2.293	0.0233
lbondyield	0.299	0.392	0.763	0.4466
lcashratio:shareflow	-84.334	27.736	-3.041	0.0028
lcashratio:bondflow	-9.148	17.343	-0.527	0.5987
vix ²	0.007	0.003	2.153	0.0330

Explained Variable: Change in mortgages

Number of observations: 153, Error degrees of freedom: 142

Root Mean Squared Error: 4.25

R-squared: 0.429, Adjusted R-Squared 0.389

F-statistic vs. constant model: 10.7, p-value = 2.28e-13

Table A.3: Results from a linear OLS regression explaining change in mortgages. The model includes interaction terms between portfolio flows and the cash ratio. Outliers are included.

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
(Intercept)	1.212	4.228	0.287	0.7747
ldmortgages	0.493	0.073	6.797	0.0000
lcashratio	84.305	163.934	0.514	0.6079
ldfinancials	0.064	0.034	1.894	0.0603
shareflow	2.368	0.756	3.133	0.0021
bondflow	0.255	0.496	0.515	0.6077
vix	-0.294	0.228	-1.293	0.1981
lbondyield	0.290	0.394	0.736	0.4631
lcashratio:shareflow	-78.388	28.446	-2.756	0.0066
lcashratio:bondflow	-10.821	18.066	-0.599	0.5502
shareflow:vix	-0.006	0.006	-1.065	0.2889
bondflow:vix	0.002	0.007	0.316	0.7528
vix ²	0.004	0.004	1.120	0.2645

Explained Variable: Change in mortgages

Number of observations: 153, Error degrees of freedom: 140

Root Mean Squared Error: 4.26

R-squared: 0.434, Adjusted R-Squared 0.386

F-statistic vs. constant model: 8.96, p-value = 1.41e-12

Table A.4: Results of OLS with interaction terms between portfolio flows and the cash ratio as well as portfolio flows and the VIX. We include square VIX to control for other non-linear effects of risk. Outliers are included.

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
'(Intercept)'	10.390	8.328	1.248	0.2142
'ldfinancials'	0.007	0.083	0.083	0.9342
'shareflow'	0.851	0.352	2.421	0.0167
'bondflow'	-0.455	0.344	-1.325	0.1871
'vix'	0.315	0.527	0.598	0.5506
'lbondyield'	-1.341	0.922	-1.455	0.1477
'shareflow:vix'	-0.033	0.014	-2.388	0.0182
'bondflow:vix'	0.036	0.015	2.302	0.0228
'vix ² '	-0.002191871	0.009373834	-0.23382867	0.815450086

Explained Variable: Change in deposits from financial institutions ex. banks

Number of observations: 153, Error degrees of freedom: 144

Root Mean Squared Error: 10.7

R-squared: 0.099, Adjusted R-Squared 0.049

F-statistic vs. constant model: 1.98, p-value = 0.0531

Table A.5: Results from a OLS regression explaining change in deposits by fund managers, pension funds and unit trusts. The model includes interaction terms between portfolio flows and the VIX and the squared VIX to account for non-linearities in the effect of risk. Outliers are included.

Explanatory Variables	Coefficient	Standard Error	tStat	pValue
'(Intercept)'	1.496	4.161	0.359	0.7198
'ldmortgages'	0.506	0.071	7.096	0.0000
'lcashratio'	129.028	158.497	0.814	0.4170
'ldfinancials'	0.065	0.033	1.942	0.0541
'shareflow'	2.385	0.747	3.191	0.0017
'bondflow'	0.245	0.494	0.496	0.6208
'lbondyield'	0.299	0.392	0.763	0.4466
'lcashratio:shareflow'	-84.334	27.736	-3.041	0.0028
'lcashratio:bondflow'	-9.148	17.343	-0.527	0.5987
'vix'	-0.431	0.188	-2.293	0.0233
'vix ² '	0.007	0.003	2.153	0.0330

Explained Variable: Change in mortgages

Number of observations: 142, Error degrees of freedom: 132

Root Mean Squared Error: 3.04

R-squared: 0.655, Adjusted R-Squared 0.632

F-statistic vs. constant model: 27.9, p-value = 1.57e-26

Table A.6: Results from a linear OLS regression explaining change in mortgages. The model includes interaction terms between portfolio flows and the cash ratio and. Outliers due to suspected data errors have been removed.

'Explanatory Variables'	'Coefficient'	'Standard Error'	'tStat'	DF	pValue
'(Intercept)'	0.864	1.337	0.646	696	0.5185
'NEDBANK '	0.000	0.348	0.000	696	1
'ABSA BANK '	0.000	0.348	0.000	696	1
'FIRSTRAND '	0.000	0.348	0.000	696	1
'THE STANDARD BANK '	0.000	0.348	0.000	696	1
'ldmortgages'	0.681	0.024	28.292	696	8.39E-118
'ldfinancials'	0.053	0.010	5.057	696	5.46E-07
'shareflow'	1.425	0.246	5.792	696	1.05E-08
'bondflow'	-0.581	0.163	-3.565	696	3.88E-04
'vix'	-0.345	0.058	-5.914	696	5.23E-09
'lbondyield'	0.539	0.151	3.565	696	3.88E-04
'lcashratio:shareflow'	-48.328	9.160	-5.276	696	1.76E-07
'lcashratio:bondflow'	19.762	5.697	3.469	696	5.55E-04
'vix ² '	0.006	0.001	5.650	696	2.34E-08

Explained Variable: Change in mortgages

Number of observations: 710

Root Mean Squared Error: 8.5841

R-squared: 0.65528, Adjusted R-Squared: 0.64884

Log-Likelihood: -1770.6669

Table A.7: Panel regression explaining change in mortgages. Outliers are excluded from the sample.

Appendix B

Figures

B.1 Figures for Chapter 3

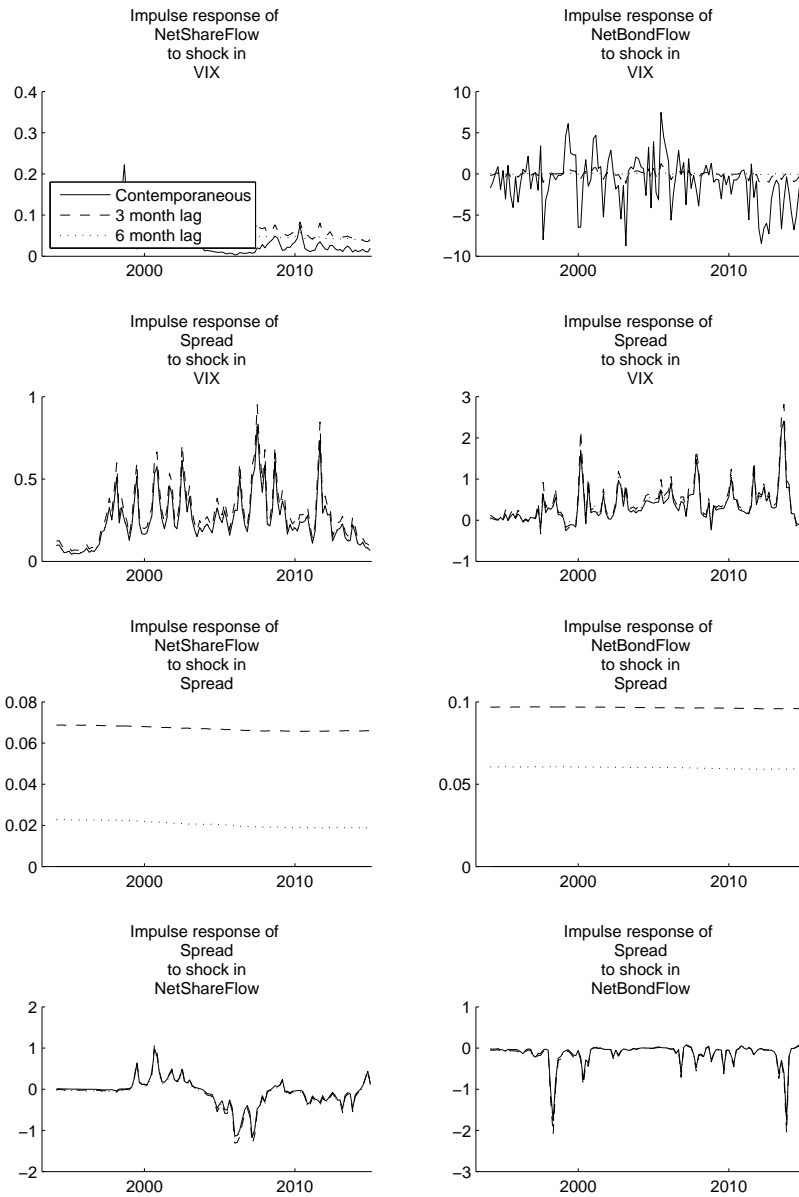


Figure B-1: Time varying impulse responses of *net* portfolio flows in the same month, after 3 months and after 6 months.

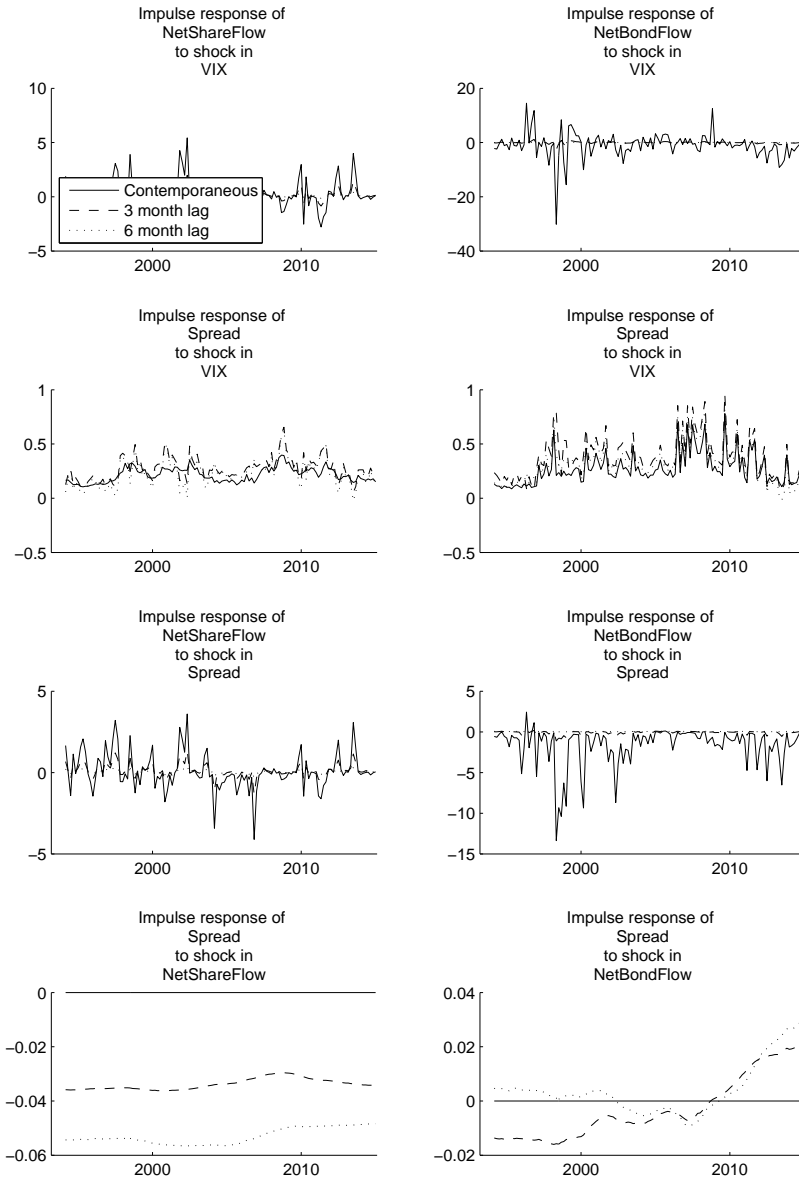


Figure B-2: Time varying impulse responses of *net* portfolio flows in the same month, after 3 months and after 6 months. The responses are estimated with the alternative ordering (VIX -> Spread -> Flow).

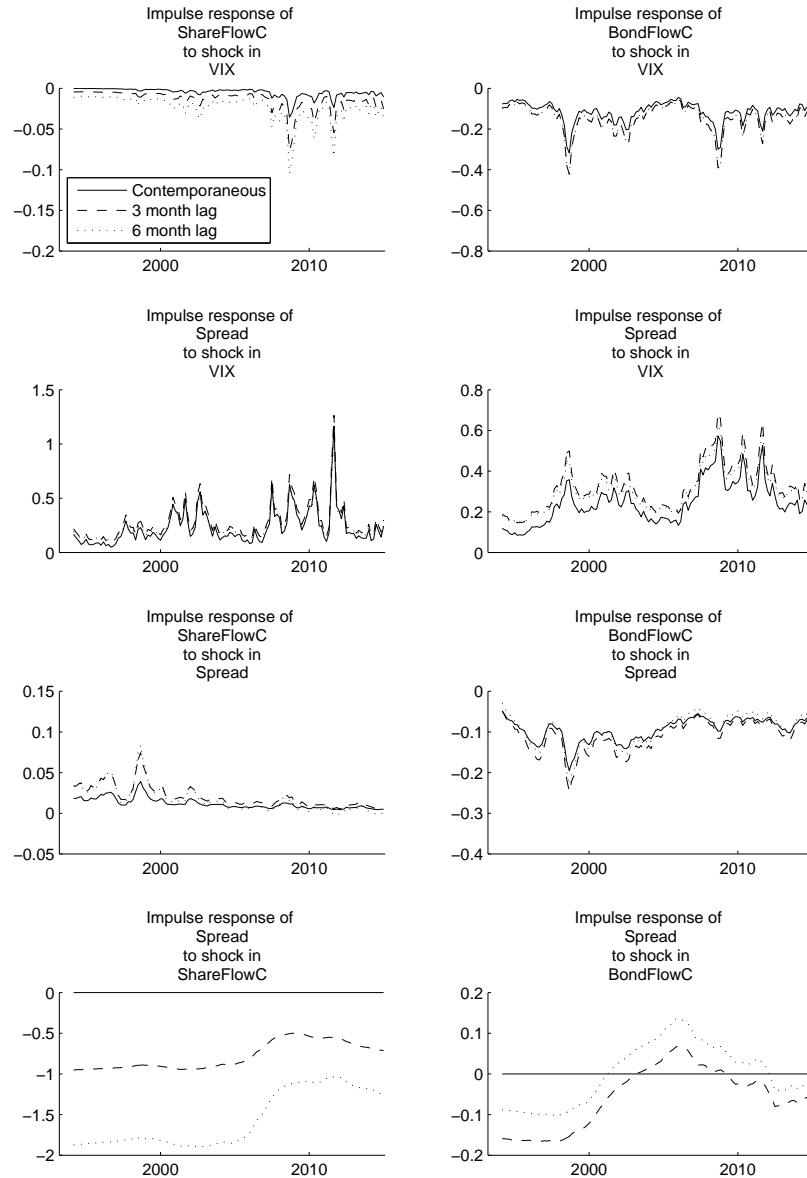


Figure B-3: Time varying impulse responses of *cumulative* flows in the same month, after 3 months and after 6 months. The responses are estimated with the alternative ordering (VIX -> Spread -> Flow).

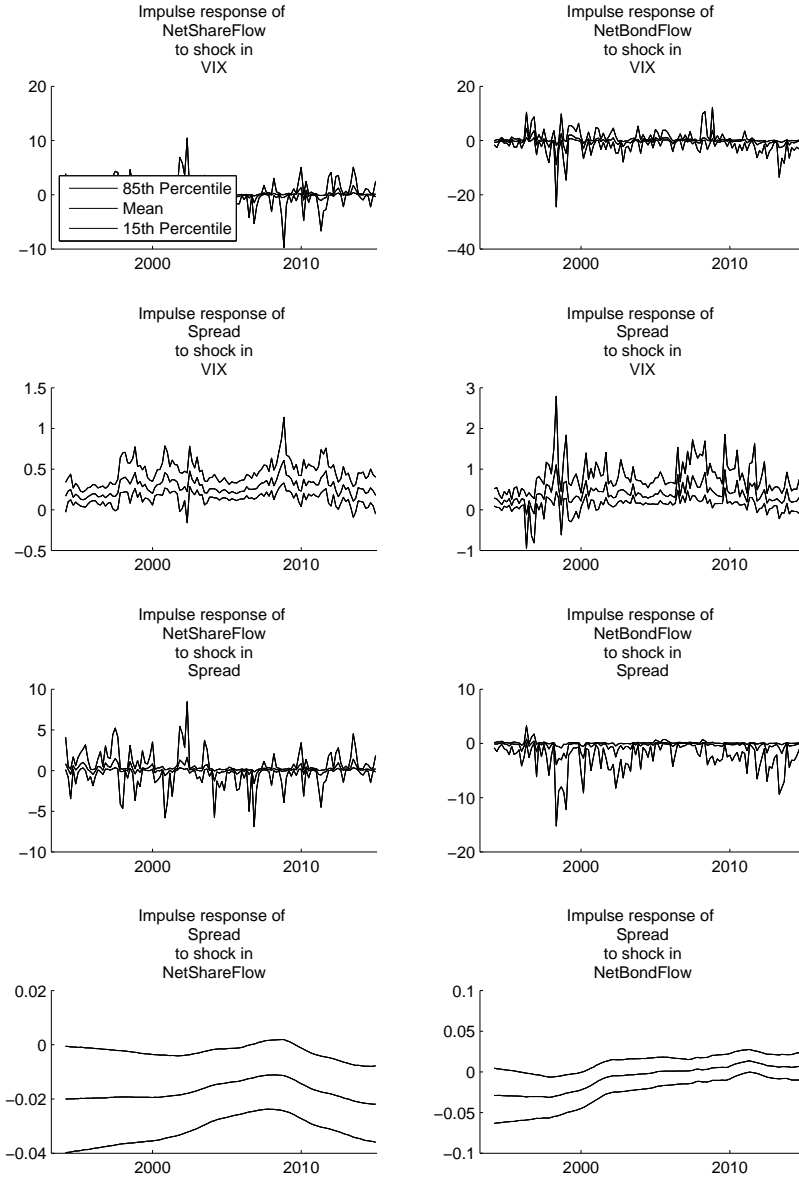


Figure B-4: Time varying impulse responses of *net* flows after one month with 15th and 85th percentiles. The responses are estimated with the alternative ordering (VIX -> Spread -> Flow).

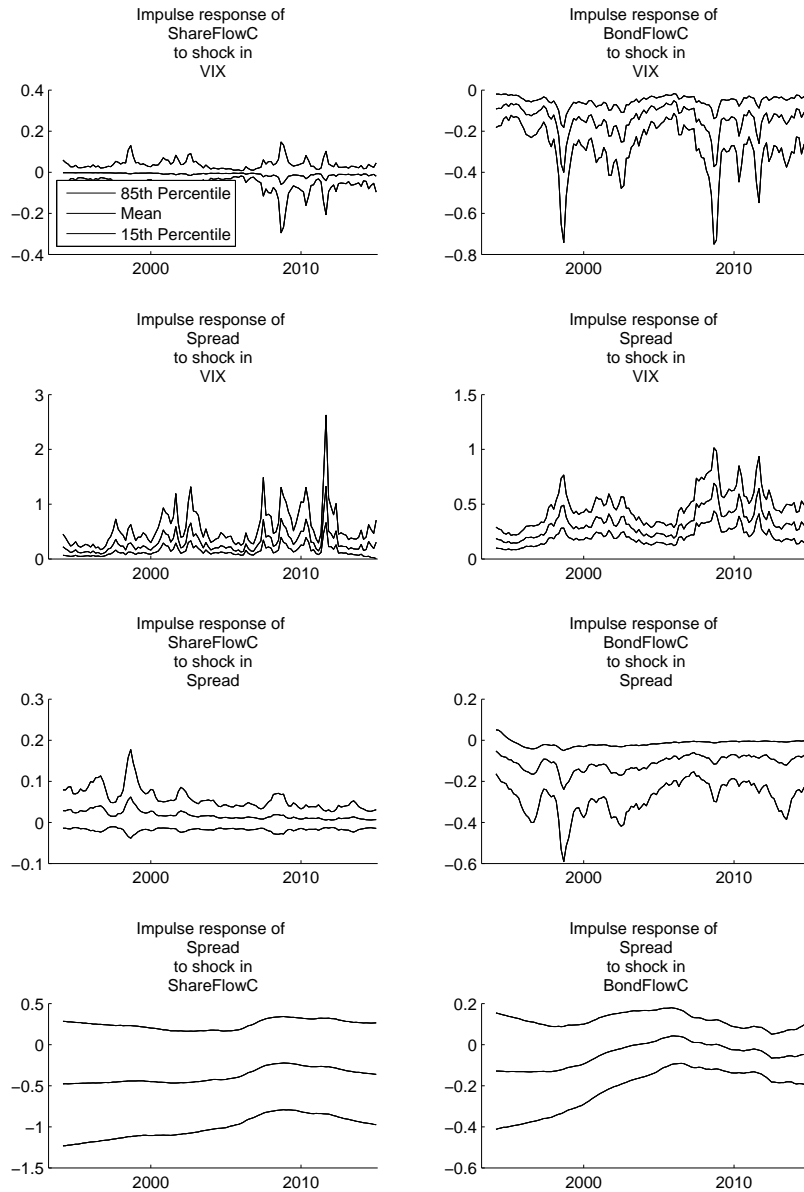


Figure B-5: Time varying impulse responses of *cumulative* flows after one month with 15th and 85th percentiles. The responses are estimated with the alternative ordering (VIX -> Spread -> Flow).

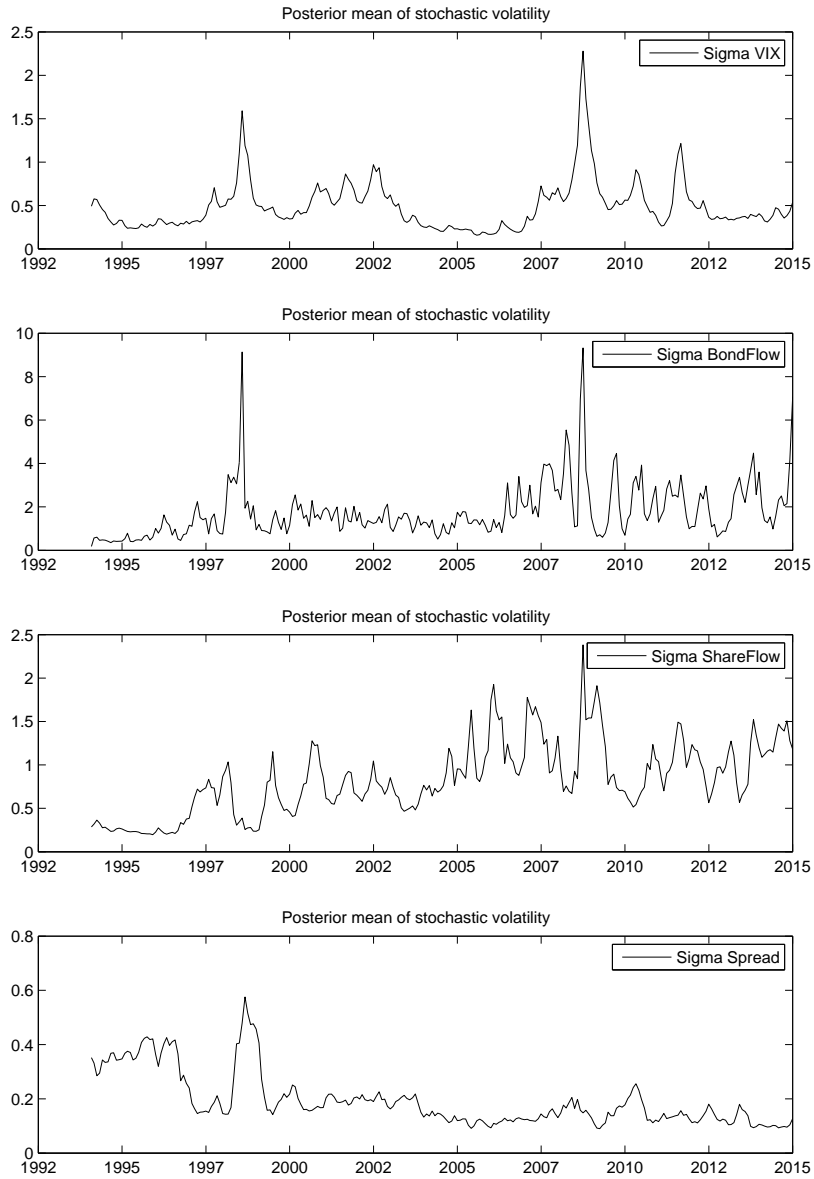


Figure B-6: Posterior estimates of the stochastic standard deviation of each variable.

B.2 Figures for Chapter 4

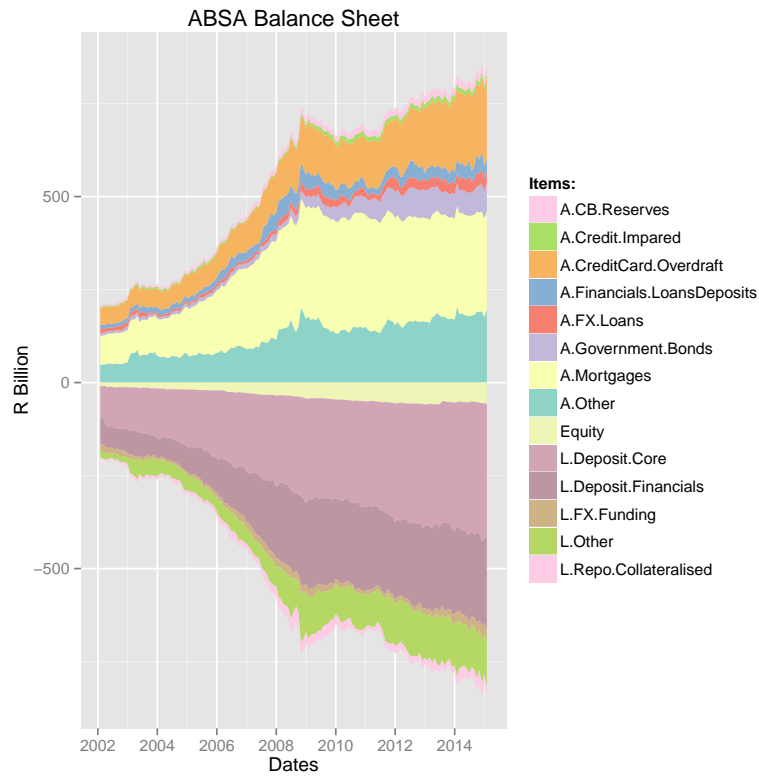


Figure B-7: Composition of ABSA's (now Barclays Africa) Balance Sheet

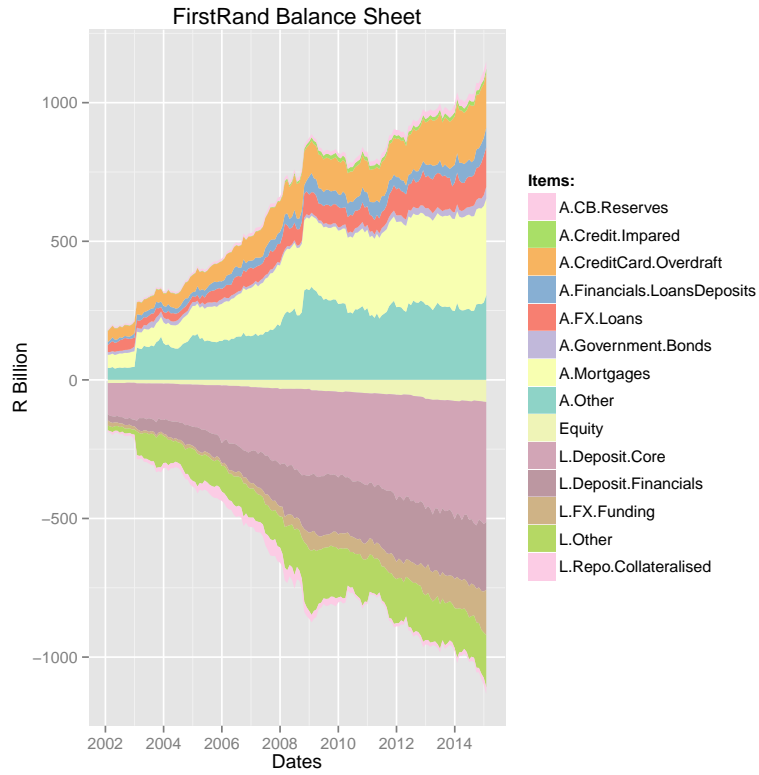


Figure B-8: Composition of Firstrand's Balance Sheet

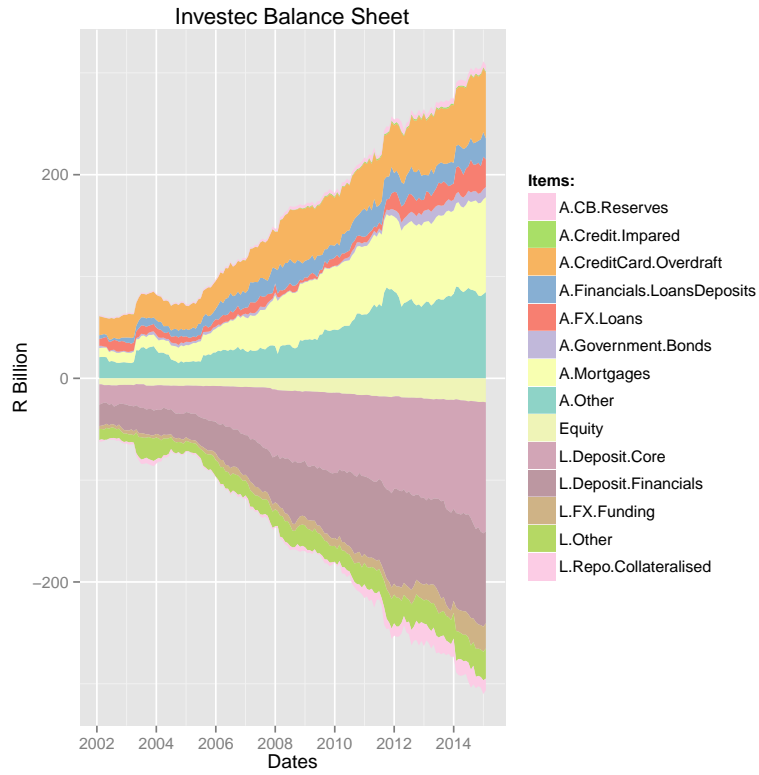


Figure B-9: Composition of Investec's Balance Sheet

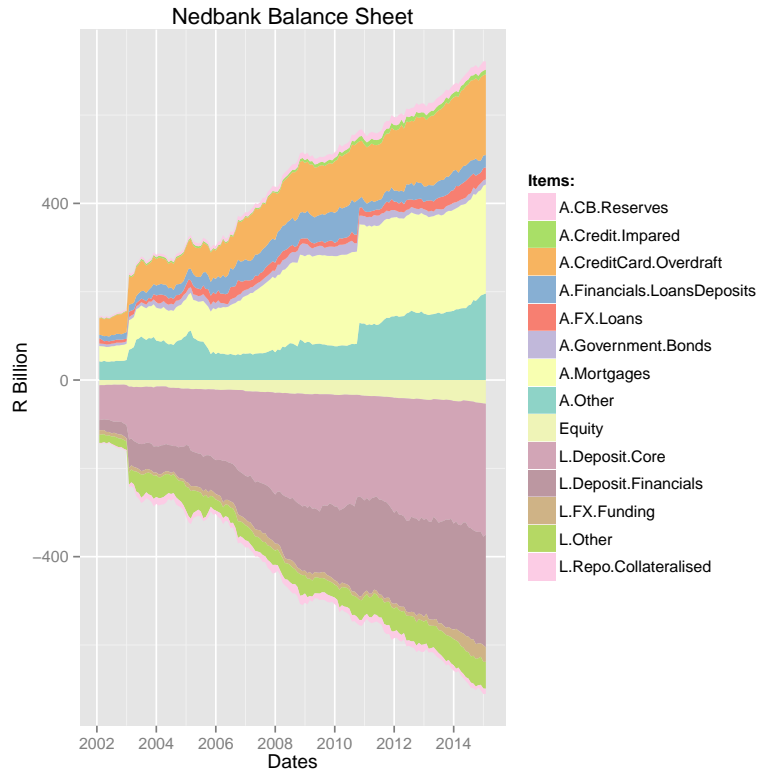


Figure B-10: Composition of Nedbank's Balance Sheet

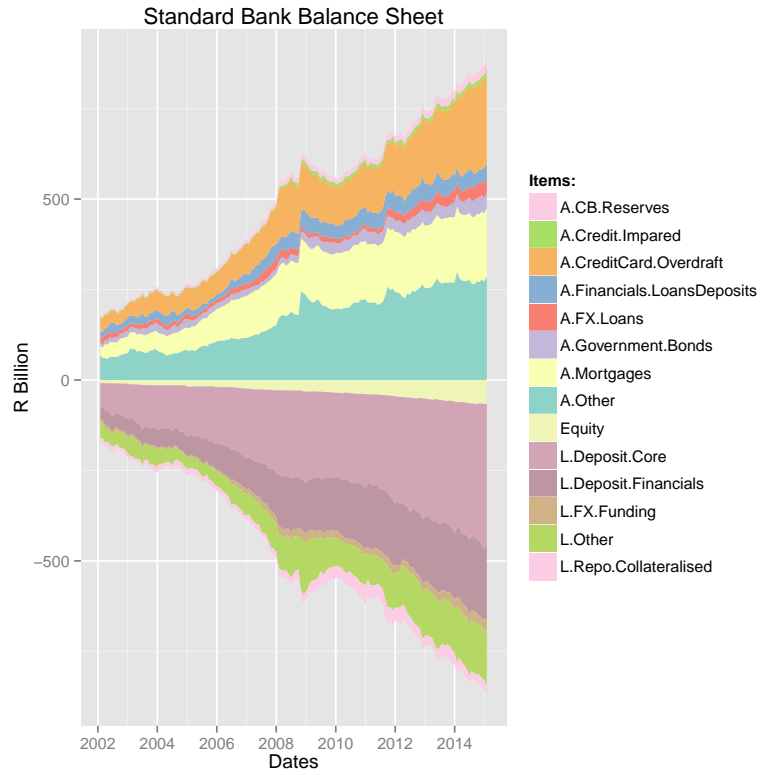


Figure B-11: Composition of Standard Bank's Balance Sheet

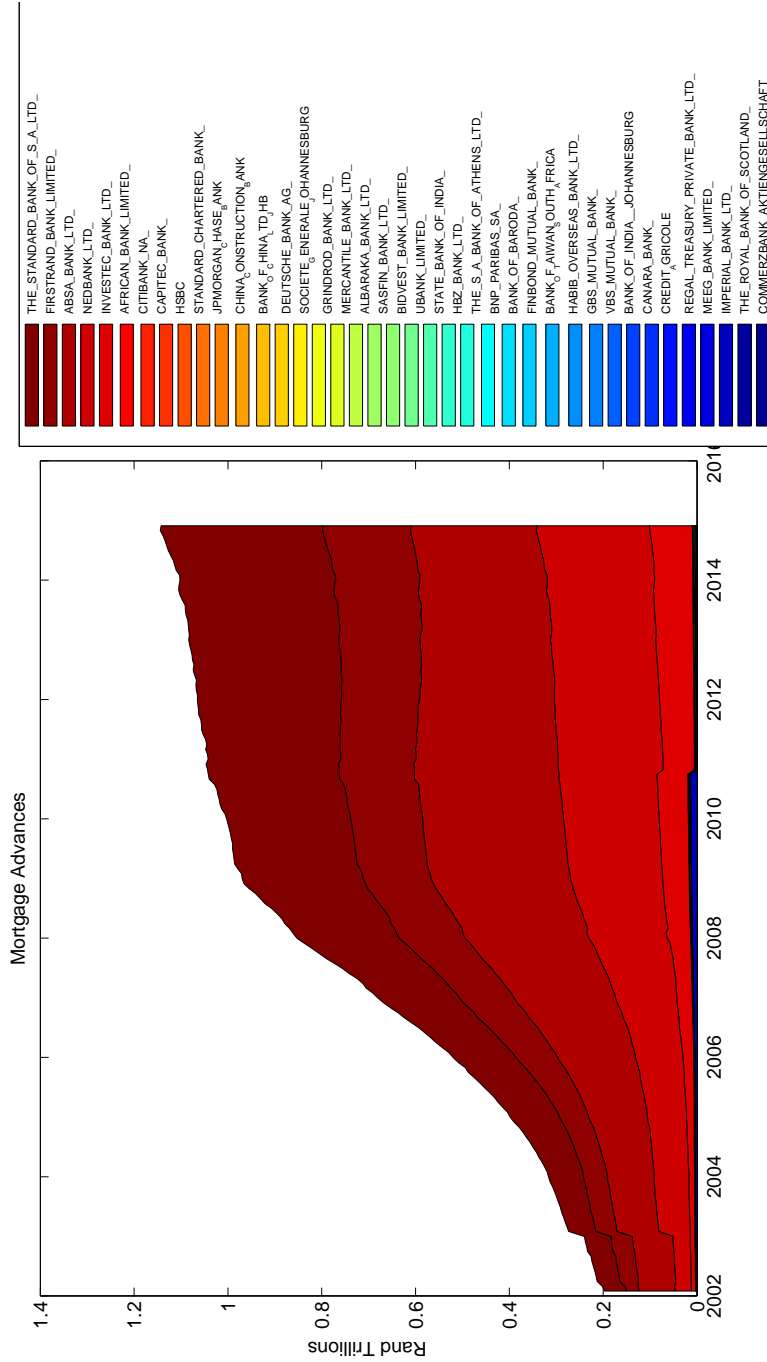


Figure B-12: Mortgage advances by South African banks. Rand Trillions.

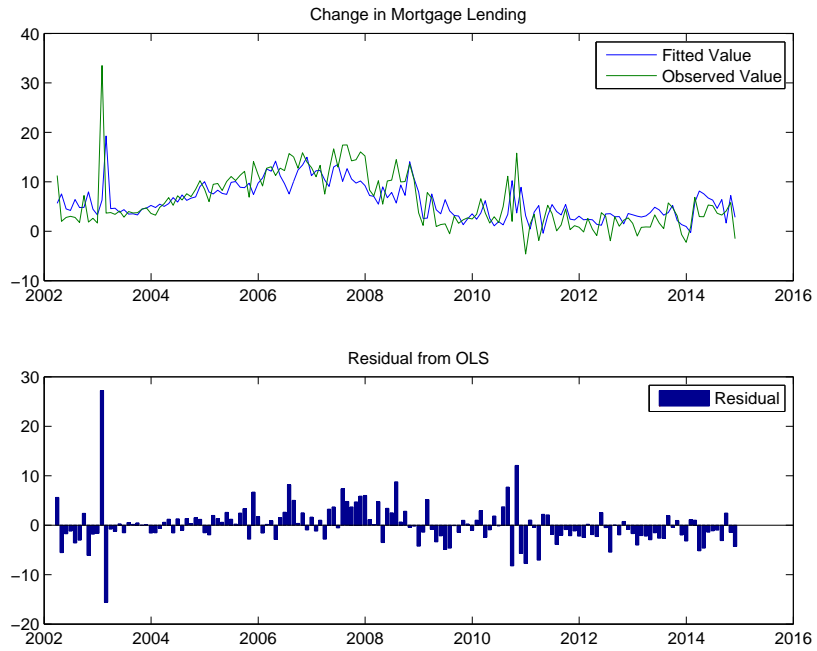


Figure B-13: OLS fitted values and residual from model explaining mortgages including interaction terms

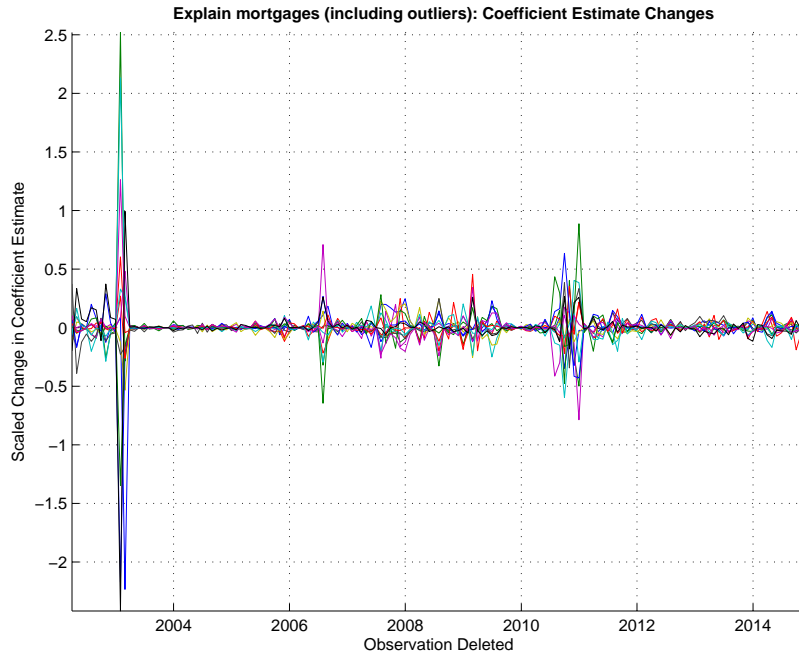


Figure B-14: The effect of each observation on the estimated coefficients after outliers have been removed. The remaining impactful observations are most likely driven by fundamentals and not data errors. Each point indicate the change in coefficients if the observation corresponding to that date was deleted from the sample.

B.3 Figures for Chapter 5

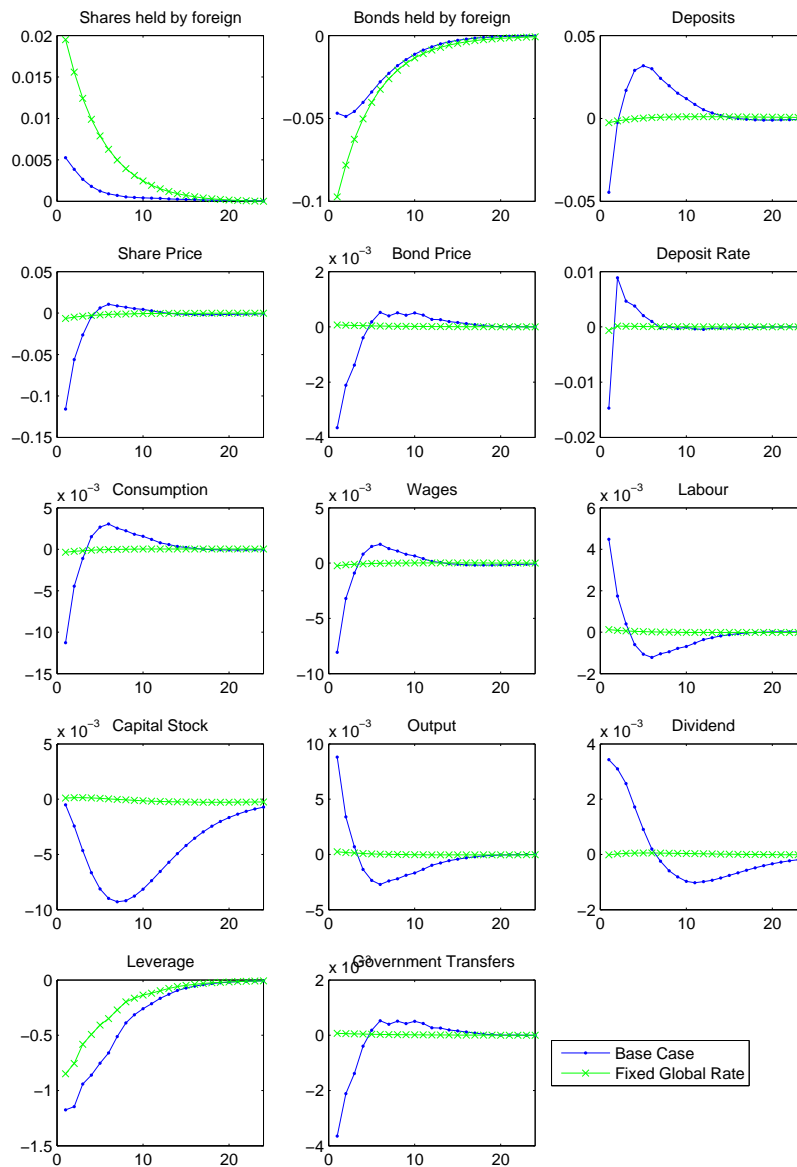


Figure B-15: **Shock to home share risk** causes portfolio outflows, less credit (more saving) and lower consumption.

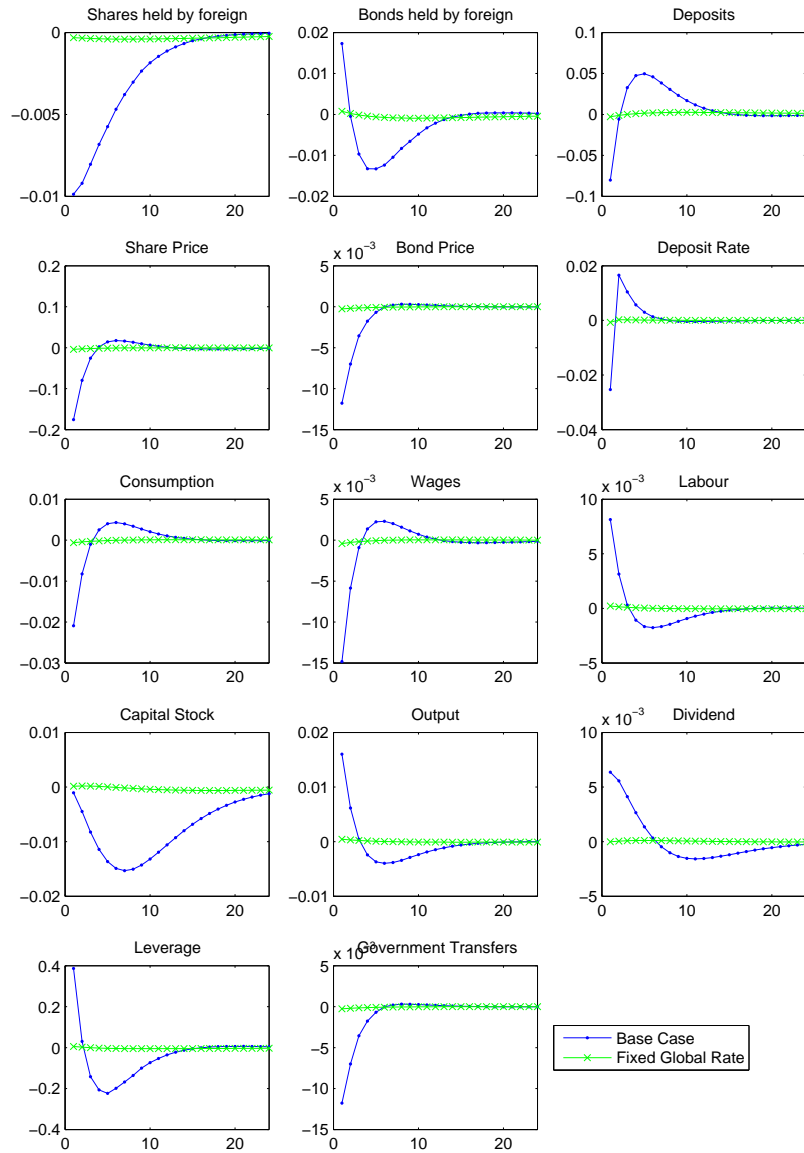


Figure B-16: **Shock to Emerging Market risk** causes portfolio outflows, less credit (more saving) and lower consumption.

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