Capital Flows, Wealth Effects and Procyclical Monetary Policy

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Abstract

This is an empirical study of the relations between global volatility, portfolio flows to emerging markets and their impact on the receiving economy. Using data from South Africa, the paper finds empirical evidence that global volatility has no predictable effect on cross-border flow of capital in the share market, but there is a predictable impact on cross-border flows in the bond market. Higher volatility leads to net selling of emerging market bonds by non-residents. This is because the relative demand for emerging market bonds has shifted from the global investor to the home biased domestic investor in the emerging market. The implications of our hypothesis is that bond prices will not be affected, but share prices will drop since both residents and non-residents will demand less of these assets. This gives a negative wealth effect combined with a weaker exchange rate due to the outflow in the bond market. The depreciation feeds further into inflation in the short term. This suggests that an inflation targeting monetary policy regime will exaggerate the wealth effects of such flows.

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1 Introduction and Hypothesis

This is an empirical investigation of capital flows into emerging markets (*henceforth EM*), and their interrelation with global risk, monetary policy, exchange rates, credit and inflation. Using data on portfolio flows into South Africa, this paper will demonstrate how non-resident purchases of *EM* assets may induce macroeconomic dynamics that have not been fully recognized by the academic literature on the subject. The paper derives from the extensive recent literature on the important role of global risk (volatility), risk premia and risk aversion.

The arguments of this paper relies on a handful of stylized facts emanating from the existing literature. Firstly, we note the presence of so-called risk-on / risk-off capital flows. This refers to the tendency of investors to sell risky assets such as *EM* bonds and shares when volatility and risk aversion is high and investing the proceeds in safe haven government bonds (McCauley, 2012). Similarly, when volatility is low and / or risk appetite high, investors will sell safe haven assets and purchase more risky assets such as *EM* bonds and shares to achieve higher expected returns. Secondly, we note that volatility and the price of risk tends to be highly correlated across countries (Cappiello, Engle and Sheppard, 2003). When global (US) risk is high, it tends to be high in other globally integrated emerging market economies as well. Thirdly, we note the empirical evidence that investors tend to display a strong home bias (see for example French and Poterba (1991)). For emerging markets, such a home bias may be explained by traditions of capital controls, transaction costs and a potential information advantage.

Given these three stylized facts, our hypothesis goes as follows: Residents in the *EM* economy who invest with a certain home bias will respond to higher volatility by selling risky asset (domestic shares), and investing the proceeds in domestic safe assets (domestic government bonds). Thus, there is a reduced resident demand for shares and increased resident demand for bonds. Simultaneously, non-resident investors in the *EM*'s assets will respond to increased global volatility by reducing their holdings of *EM* bonds and shares, investing the proceeds in developed market (safe haven) assets. Thus, non-residents will reduce demand for both *EM* bonds *and* shares.

Adding these forces together yields an outcome where increased global volatility leads to a net supply of emerging market shares by both residents and non-residents, having a strong negative impact on share prices. The direction of the net capital flow in the share market is uncertain, since both residents and non-residents aim to reduce their holdings of these assets. At the same time, emerging market residents will demand more emerging market bonds (as this is their safe haven), whilst global investors will sell more bonds to invest in *their global* safe haven assets. This implies a net outflow of capital in the bond market, where non-residents sell bonds to residents. The effect on bond prices is uncertain, given the asymmetric response of residents versus non-residents.

Based on these dynamics we have an outcome where share *prices* and bond *flows* in the emerging market will respond strongly to global risk. On the other hand, share *flows* and bond *prices* will not respond in a predictable manner. The interesting consequence is that fluctuations in global risk will have a disproportionately strong impact on the emerging market economy. An increase in volatility will lead to a drop in *EM* share prices and a net outflow of non-resident investments in the *EM* bonds. The drop in share prices has a negative wealth effect, whilst the outflow in the bond market will depreciate the *EM* currency. The weaker currency implies higher inflation which will restrict an inflation targeting central bank from responding with expansionary policy. This is in contrast to the developed markets, where there will be a net inflow in the bond market which will strengthen their currency and allow for more expansionary policy to counter their modestly negative wealth effects in their share markets. It is also in contrast to what would be the case without any non-resident involvement in *EM* capital markets. Were there no nonresident investors, the net increase in resident demand for bonds would increase bond prices and thus have a positive wealth effect on bond owners. The non-resident involvement effectively eliminates the positive wealth effects from the bond market, and exaggerates the negative wealth effect from the share market.[1] [2]

The implication of this hypothesis is that an inflation targeting monetary policy rule will have pro cyclical effects on the economy. It is well known that inflation targeting is not well suited to deal with negative supply shocks. The problem is that global volatility will in effect impose regular "supply like" shocks on the *EM* economy due to the dynamics laid out above. The negative wealth effects of global risk will come at the same time as currency depreciation and so called "cost push" inflation. If the central bank is forced to respond to this inflation with restrictive monetary policy it will only serve to exaggerate the initial wealth effects. We propose that nominal GDP targeting may be more favorable than inflation targeting with respect to these dynamics.

This paper will present empirical results that strongly support the hypothesis laid out above. The empirical focus will be on South Africa (but can easily be expanded to include other open emerging economies). The paper is organized as follows. Section 1.1 provides a brief introduction to the data on South African portfolio flows. Section 2 discusses the relevant literature. Section 3 explains the empirical methodology. Section 4 presents the results and draws stylized facts. Section 5 concludes with a brief discussion and a proposal for future research.

1.1 Capital Flows to South Africa

Foreign capital that enter 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. Portfolio flows 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. It is the portfolio flows that will be the focus of this paper.

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

[1]And *vice versa*: when volatility is low, the non-resident involvement will exaggerate the positive wealth effect of share prices and eliminate the negative wealth effect on bond prices

[2]This is not to say that capital flows are bad. Our hypothesis implies that they do add volatility to the *EM* economy, but they may also add overall demand for *EM* assets and thereby reduce the average cost of capital in these economies.

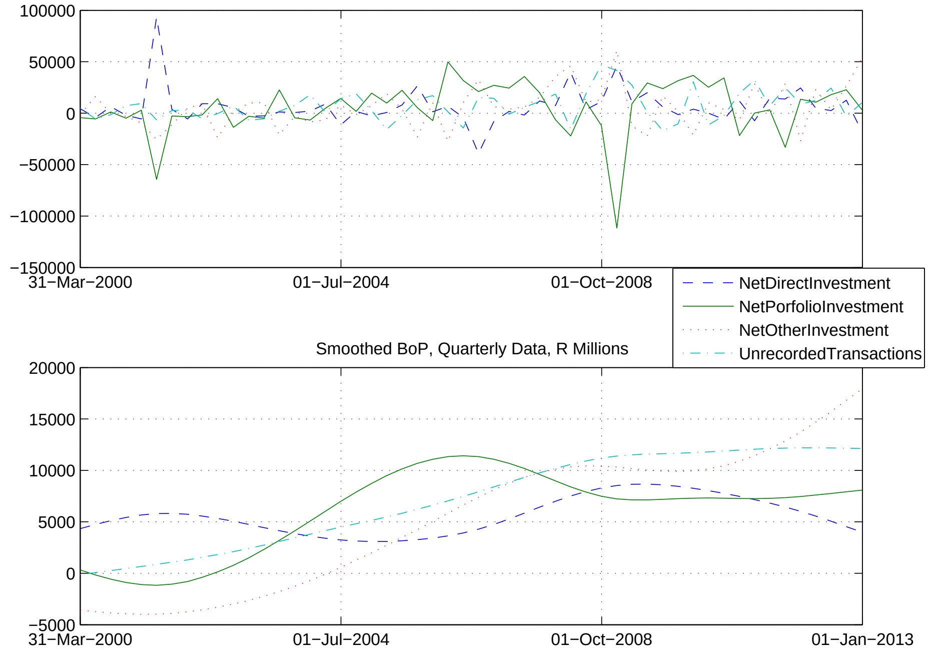

Figure 1: Quarterly Balance of Payment Figures - Actual (top) and Smoothed (bottom)

assets. The lower panel of figure 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 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 2 plots the different components of portfolio investments. It is clear from Table 1 (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.

Thus far we have singled out portfolio inflows to South African public authorities and the private sector as important driver of 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. The left hand panel plots the two series from 1994 to 2013, whilst the right hand panel plots the same series for a sub-sample from 2010 to 2013. Notably there has been a pronounced shift from equities to bonds beginning in late 2009. (This shift corresponds to the shift observed in figure 2.)

Non-resident purchases of South African bonds between January 2000 and October 2012 added up to a total net purchase of 148 billion rands. The same number for shares added to 291 billion rands. The standard deviation of monthly bond purchases was 6.8 billion rands, whilst the standard

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

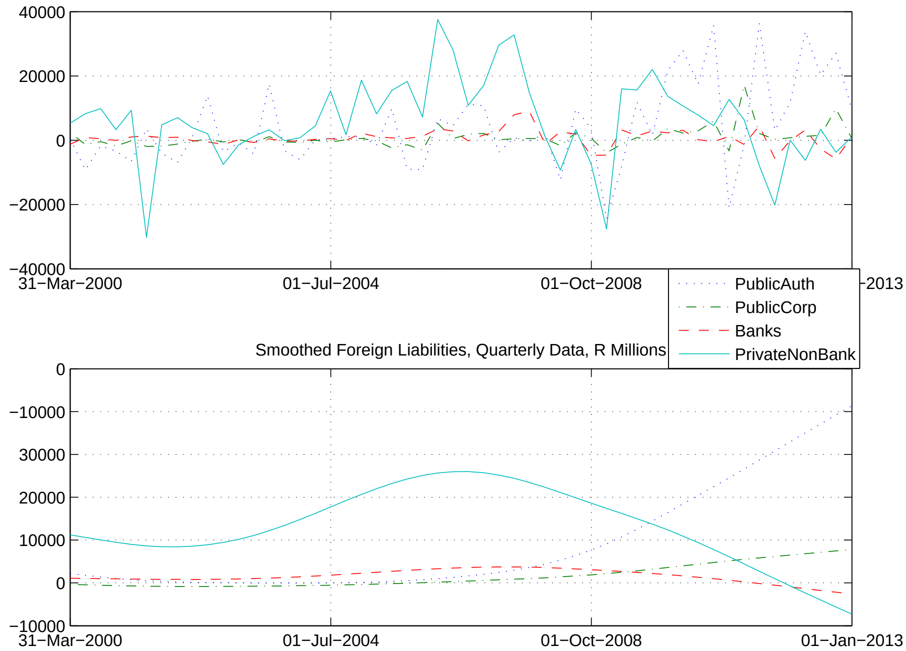

Figure 2: Quarterly Portfolio Inflows - Actual (top) and Smoothed (bottom)

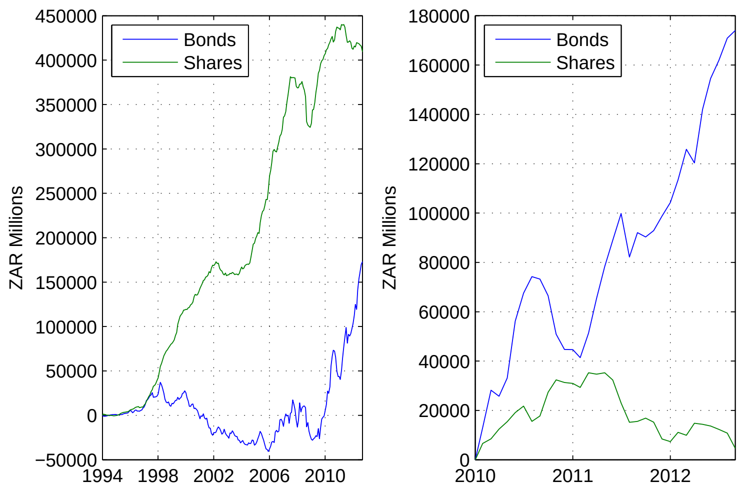

Figure 3: Cumulative purchases of South African bonds and shares by non-residents since May 1993 (left) and since February 2010 (right)

deviation of monthly share purchases was 5.1 billion rands. The standard deviation of the sum of net share and bond purchases for each month is 17.4 billion rands. The current account deficit for 2011 was approximately 100 billion rand, thus approximately 8 billion per month. In other words, the monthly volatility of share and bond purchases is approximately twice the value of the monthly current account deficit. There seems to be good reasons to suspect that this volatility has the potential to contribute significantly to volatility in the South African economy. 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.

Flows recorded as Direct Investment (as opposed to Portfolio Flows) on the balance of payments are generally perceived to be of a longer term nature and thus also less volatile. However,

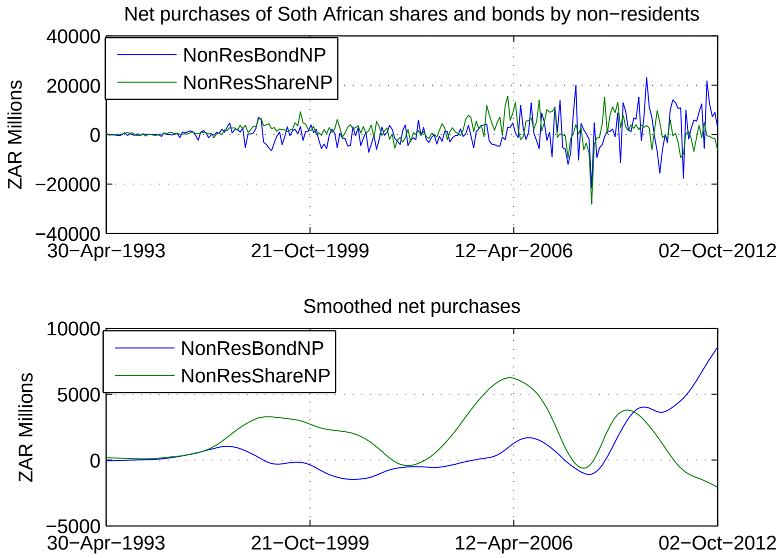

Figure 4: Net monthly purchases of South African bonds and shares by non-residents since May 1993, actual (upper) and smoothed by HP-Filter (lambda=129000) (lower)

one potentially important component of these direct investments is cross-border inter-bank lending, which may be susceptible to short term fluctuations. In fact, we see that the magnitude and volatility of flow of foreign funds onto South African banks' balance sheets is of a similar magnitude to that of net non-resident bond purchases. The cumulative change in foreign liabilities of South African private banking institutions added to 263.6 billion rand between January 2000 and September 2012 (see Figure 5). The standard deviation of the change in these foreign liabilities was 19.9 billion rand. Note that more than half of this inflow happened in the course of one month, September 2008 (the month of the Lehman Brothers collapse), when the balance increased by 150 billion rands.

An investigation of the BA900 forms reported to the South African Reserve Bank by all banking institutions in South Africa show that this sharp increase in September 2008 is caused by derivatives on the bank's balance sheets. These derivatives do not reflect typical behavior, and thus we plot an approximation of foreign liabilities excluding derivatives in the green solid line. This proxy is the sum of foreign currency deposits, loans received under repurchase agreements with foreigners, and other foreign currency funding. Between January 2000 and October 2012, the cumulated change in these foreign liabilities excluding derivatives (green solid line in figure 5) was 162 billion rand, and the standard deviation of the monthly change in these liabilities was 6.6 billion rand. This is very similar to the 148 billion rand cumulative bond non-resident purchases with a monthly standard deviation of 6.8 billion rand.

The above review suggests there are three important sources of volatility in short term capital flows to South Africa; (1) cross border inter-bank borrowing, (2) non-resident purchases of South African bonds and (3) non-resident purchases of South African shares. All three have roughly similar magnitudes and standard deviation. In the following section we will review the current literature on portfolio flows and cross-border bank flows in order to understand what one may expect regarding the dynamics of these flows. We will then proceed to demonstrate how only bond purchases by non-resident appear to have a consistent relationship to global risk factors in the case of South Africa.

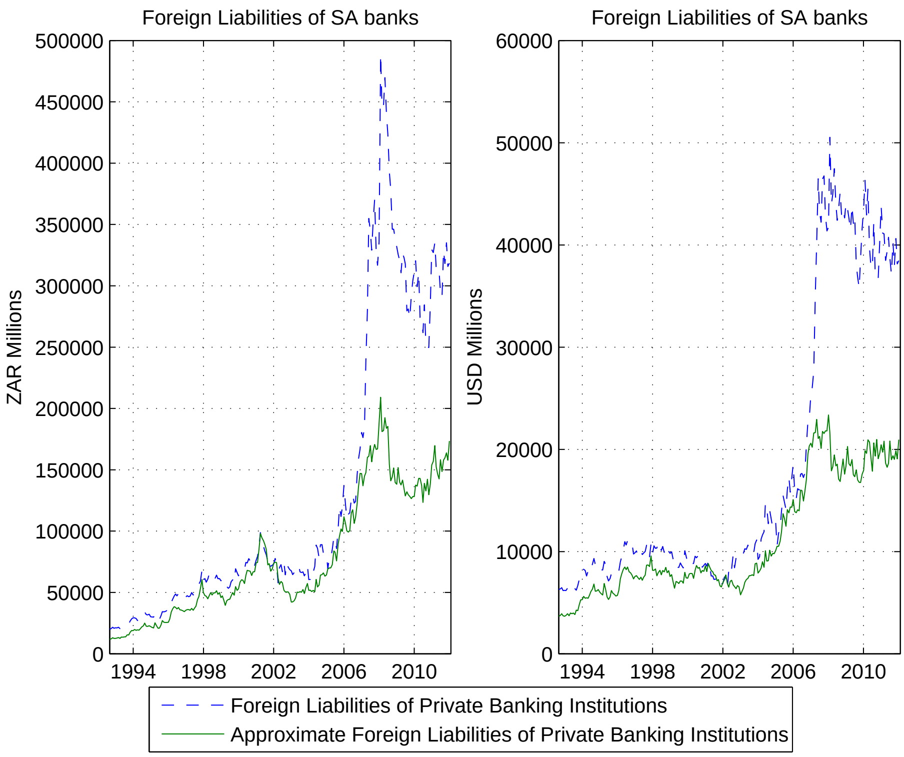

Figure 5: Foreign liabilities of South African banks, denominated in rands (left) and US dollars (right). The green solid line excludes derivatives.

2 Literature Review

Cross-border banking and capital flows have been the focus of academic research and debate for a long time. See for example, IMF (2012), Brookings Institution (2012), Allen, Beck, Carletti, Lane, Schoenmaker and Wagner (2011) for policy oriented debates, and Borio and Zhu (2008), Borio and Disyatat (2011), Bruno and Shin (2013b) and Bruno and Shin (2013a) for recent academic contributions.

The text book view of capital flows suggests that international financial markets are used to hedge risk to future consumption. Without trade, a country can only consume what it produces and is highly vulnerable to swings in production caused by unpredictable states of nature (Obstfeld and Rogoff, 2005). Through *intratemporal* trade a country trades assets for assets with another country to smooth their consumption under different stochastic states of nature at a future date. On the other hand, in *intertemporal* trade a country trades goods for assets (current consumption for future consumption) (see for example Obstfeld (2012)). Trading goods for assets would result in an entry on the country's current account, whereas a trade in assets for assets will not. This distinction has recently been drawn into the spotlight, most notably by Borio and Disyatat (2011) who argue that more research should focus on *gross* capital flows[4].

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). 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) [5]. 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 [6] [7].

2.1 The role of risk

In what the authors aptly describe as a "speculative" and "exploratory" analysis, 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). 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 bank flows [8].

Adrian and Shin (2009) study the role of financial intermediaries and risk in the transmission mechanism from monetary policy to credit supply. Banks have traditionally been dominant in supplying credit, but are now supplemented by market based institutions (financial intermediaries that raise funds in the money market to invest in longer term debt securities). Adrian and Shin

[4]Note the potentially confusing terminology: *gross inflows* equals *net non-resident purchases of domestic assets*, whilst *net inflows* refer to *net-nonresident purchases of domestic assets net of resident net purchases of foreign assets*.

[5]Other 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).

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

[7]The fact that the current account does not tell the full story, does not, however, mean that it has become irrelevant. Obstfeld (2012) 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 (2010)).

[8]See for example Adrian and Shin (2010),Adrian, Moench and Shin (2010),Adrian and Shin (2009),Danielsson, Shin and Zigrand (2011), Bruno and Shin (2013b) and Bruno and Shin (2013a).

(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).

Adrian and Shin (2010) demonstrate that market based banks tend to increase leverage when total assets increase. They point out that this must be caused by active leverage management, as an increase in asset prices would otherwise reduce leverage [9]. The positive correlation between assets and leverage may indicate 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) build a model which produces this outcome from profit maximizing behavior of banks. The model shows that banks maximize profits by keeping their *Value at Risk* (*henceforth* VaR) at a binding constraint where the probability of bankruptcy is constant. [10]

Importantly, Adrian and Shin (2009) demonstrate how higher asset prices and greater liquidity leads to increased risk appetite as the market based banks aim to increase *Value at Risk* to its binding limit. 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.

Based on these insights, Bruno and Shin (2013b) and construct a model of cross border financial flows. Bruno and Shin (2013a) 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 EMs [11], 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 build on the result from Adrian and Shin (2009) 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.

The EM borrowers take up debt in dollars to fund projects [12]. 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.

The model solution implies that a lower funding rate (e.g. from a cut in the US policy rate) will increase EM credit supply. This increase is fully funded by an increase in foreign borrowing (L) by the emerging market bank. By assumption, this will lead to appreciation of the exchange

[9] For example, as the price of a home increases the home owner will be less leveraged because her equity in the home increases by the same absolute amount as the home price itself, while debt remains unchanged.

[10] Commercial deposit based banks do not tend to have pro cyclical leverage. This is because deposits are rather stable and the banks can not actively increase leverage unless they turn to wholesale markets for funding. (Hahm, Shin and Shin (2012) show that a large increase in wholesale funding indicates a lending boom and increased vulnerability to financial crises.) The liabilities of an investment bank, on the other hand, are continuously marked to market and can be expanded or reduced at the will of the bank, typically through repurchase or reverse-repurchase agreements (*henceforth* repo). The high leverage of these institutions make their balance sheet highly sensitive to changes in the borrowing cost. This strengthens the pro-cyclical tendencies of asset and leverage growth, as rapid de-levering will push down asset prices which induces further de-levering(Adrian and Shin, 2009) (further explanations of how leverage accelerates falling asset prices can be found in Brunnermeier and Oehmke (2012) and Brunnermeier (2009)).

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

[12] The model thus 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.

rate which makes the local project (borrower) more valuable in dollar terms, and thus a lower default probability (Bruno and Shin, 2013b)(Bruno and Shin, 2013a). The reduced risk of default reduces the risk of the global bank's balance sheet, and the global bank must extend more credit to readjust its *Value at Risk* to the binding limit. This leads to further appreciation of the emerging market currency, even lower probability of default, and so on.

The above mentioned models are focused on cross border bank flows. These flows are only a fraction of the total short term capital flows into South Africa. Section 1.1 illustrated that non-resident purchases of bonds and shares respectively, both amounted to similar values as inter-bank borrowing. If the global investors in these assets follow a similar *Value at Risk* targeting rule as was described above, these investors will also purchase more of the high-risk high-return emerging market assets when general asset price volatility is low. We should again see a similar feedback loop, where these purchases push asset prices higher which reduces their *Value at Risk* and induces further purchases to readjust their *Value at Risk* to its target. This implies that global volatility will have direct impacts on cross border capital flows both between banks and in the capital markets. McCauley (2012) finds evidence that the variations in global asset price volatility are driving factors of portfolio flows into emerging market bonds and shares.

3 Data and the Empirical Estimation Procedure

3.1 Data

This paper is focused on portfolio flows consisting of non-resident purchases of South African bonds and shares. We aim to estimate the response of these flows to changes in global volatility and the further effect on the South African economy. To measure global risk we use the CBOE S& P 100 Volatility Index (VXO)[13]. Data on macroeconomic variables come from the South African Reserve Bank Quarterly Bulletin[14] and include monthly data on net non-resident purchases of South African bonds and shares respectively, the rand-US dollar exchange rate, credit supply and inflation[15]. The sample period is from February 1988 to February 2013.

3.2 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).

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 highly inaccurate and will ignore important changes to the relationship between the respective variables. We therefore choose to use a TVP-VAR framework which allows both coefficients to be time varying.

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 allow 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

[13] Available here (2013): `http://www.cboe.com/micro/buywrite/monthendpricehistory.xls`
[14] Available here (2013): `http://www.resbank.co.za/Publications/QuarterlyBulletins/Pages/DownloadInformationFromXLSXDataFiles.aspx`
[15] These variables are later referred to with the intuitive names: $BOND, SHARE, ZARUSD, CREDIT, INFLATION$.

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).

There are several algorithms that allow for both coefficients and the covariance matrix to be time varying. These algorithms have since been widely used in economics to estimate monetary policy models (see Koop and Korobilis (2010) for an overview). 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 with drifting parameters 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 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 dataset[16]. 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).

3.2.1 The Model

The paper uses the model specification from Primiceri (2005). This section provides a brief introduction to the model and we recommend that the reader refers to Primiceri (2005) for a more thorough derivation.

We have a state space model where the observation equation (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 includes the residuals from the corresponding structural VAR[17]. B_t includes all parameter 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.

$$y_t = c_t + B_{1,t} y_{t-1} + \cdots + B_{k,t} y_{t-k} + A_t \Sigma_t \epsilon_t \tag{1}$$

$$B_{i,t} = B_{i,t-1} + v_t \tag{2}$$

$$\alpha_t = \alpha_{t-1} + \xi_t \tag{3}$$

$$\log \sigma_t = \log \sigma_{t-1} + \eta_t \tag{4}$$

We impose the assumption that the error terms are independent (this is necessary in order to interpret the estimates as a structural model):

$$V = Var \begin{pmatrix} \epsilon_t \\ v_t \\ \xi_t \\ \eta_t \end{pmatrix} = \begin{pmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix} \tag{5}$$

Equation 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 imposing a prior assumption on the variance of this random walk we affect the probability distribution of this 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

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

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

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 imposes a random walk on 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 2. Equation 4 makes the variance of y_t a stochastic process, which implies that the true underlying variance (σ^2) is unobserved.

3.2.2 Estimation Procedure

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) [18]. 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 90 observations (we use monthly data, implying an OLS sample of 7.5 years). The time-varying parameters are then estimated over the remaining sample from 1995 to 2013. We follow the same rule of thumb as Primiceri (2005) in setting priors for the variance of parameter processes. Each block of these 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:

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

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:

$$\begin{aligned}
\text{Model 1}: y_t &= \begin{pmatrix} VXO_t & BOND_t & ZARUSD_t & CREDIT_t & INFLATION_t \end{pmatrix} \\
\text{Model 2}: y_t &= \begin{pmatrix} VXO_t & SHARE_t & ZARUSD_t & CREDIT_t & INFLATION_t \end{pmatrix}
\end{aligned}$$

where the ordering is such that the latter variables may respond to contemporaneous values of the former variables. Credit and inflation are ordered last simply because the contemporaneous data is not observable to market participants and will therefore not have an immediate impact on the former variables [19]. The exchange rate is allowed to respond simultaneously to changes in global risk (VXO) and net non-resident purchases of South African bonds and shares. The net non-resident purchases are allowed to respond simultaneously to global risk, but no other variables.

[18] The 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.koop/bayes_matlab_code_by_koop_and_korobilis.html`

[19] There is room to expand on this study by imposing further restrictions here. For example, one may make the VXO completely exogenous.

4 Results

This section reports the results of our estimations. We plot the impulse responses in the text and refer to the Appendix for plots of the posterior estimates of σ_i (Figures 9 and 10). Figure 6 plots the 6th, 12th and 24th impulse response (monthly periods) of each series to a shock in global risk (VXO) at each point in time across the entire sample. Figure 7 plots the same impulse responses for model 2, where bond purchases are replaced with share purchases. The crucial point to note is that the impulse response of non-resident net purchases of South African government bonds is consistently negative, implying that more global risk leads to net sales of bonds by non-residents. However, the results from model 2 shows that the impulse response of net share purchases by non-residents appears to be highly sporadic. This is exactly in line with the predictions of our hypothesis outlined in the introduction.

Focusing on Figure 6 one will notice that the impulse responses of bond flows cause further responses of the exchange rate, which again affects inflation. The exchange rate responds stronger when bonds respond stronger which appears to happen during times of higher volatility. The stronger exchange rate response further causes higher inflation in the short term (6 to 12 months), presumably due to higher import costs causing the so called "cost push" inflation. There is little if any significant effect on credit supply except for instances of exceptionally high volatility such as the global financial crisis. Therefore, there is little if any long term negative "demand pull" effects on inflation.

The sporadic impulse responses of net share purchases imply similarly sporadic responses of the exchange rate and inflation. This implies that the exchange rate does not respond to global volatility *per se*, but rather the capital flows that are caused by the volatility. The exchange rate and inflation responds in a predictable manner to the share flows (more share purchases causes rand strength which again causes lower inflation). However, due to the unpredictable nature of share flows in response to global risk, we cannot use is to predict the effect on the other variables.

Hence, it turns out that the bond market is where the important risk-on / risk-off flows take place. We argue that this is explained by the asymmetric demand for South African bonds between residents and non-residents as was explained in section 1. Higher global risk causes South African residents to demand less South African shares and more South African bonds to reduce the volatility of their portfolio. Simultaneously, international investors will demand less of both South African bonds and shares when volatility is high and demand more developed market assets. The sum of the two is that both residents and non-residents demand less South African shares, such that the share price goes down but we cannot predict the direction of the capital flow. In the bond market, the relative demand has shifted towards residents, such that non-residents will be net sellers to residents and cause a capital outflow from the bond market. This causes a predictable rand depreciation and consequently higher inflation in the short term.

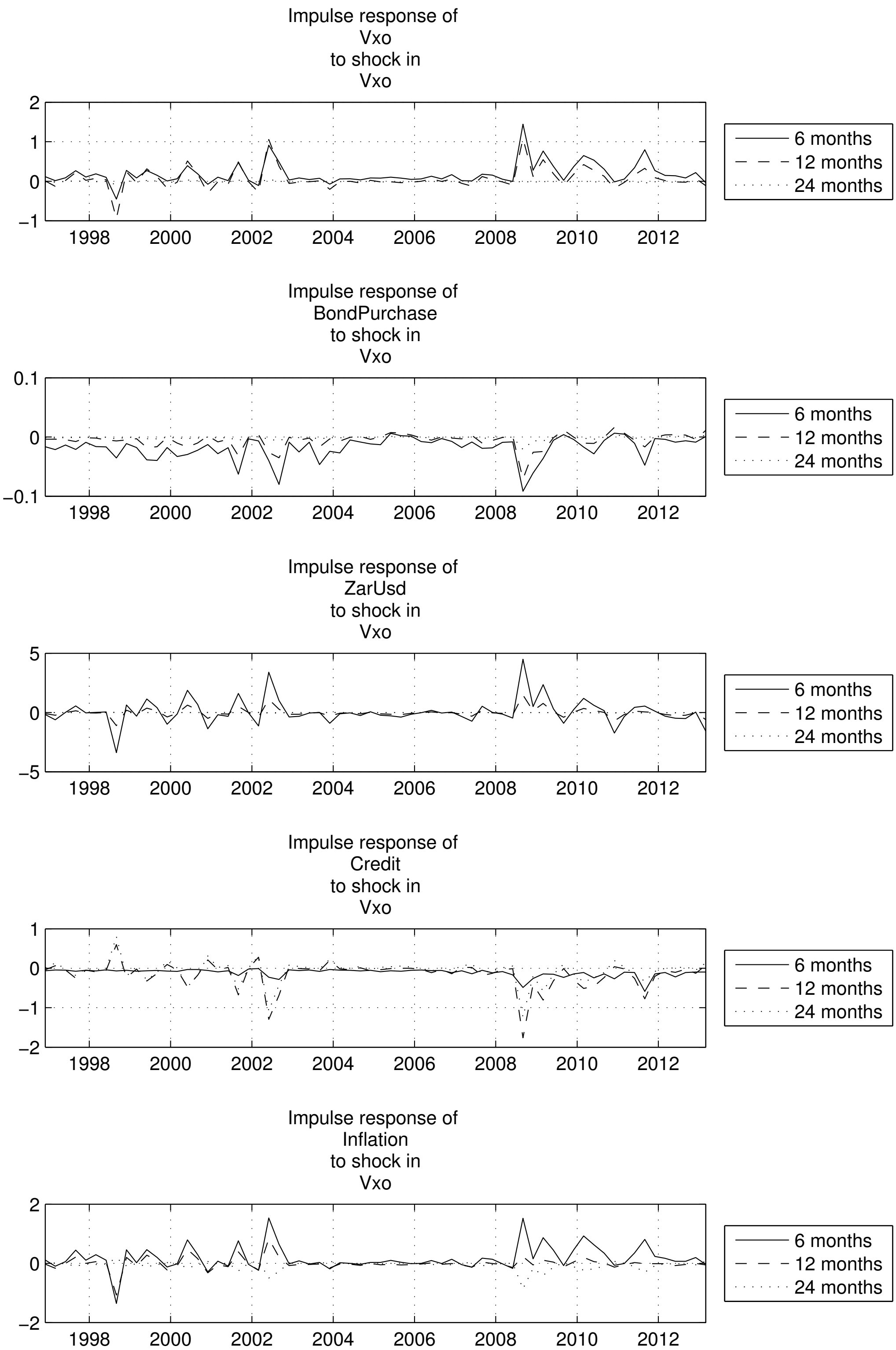

Figure 6: *Model 1* - Time varying impulse response after 6, 12 and 24 months from a shock to VXO.

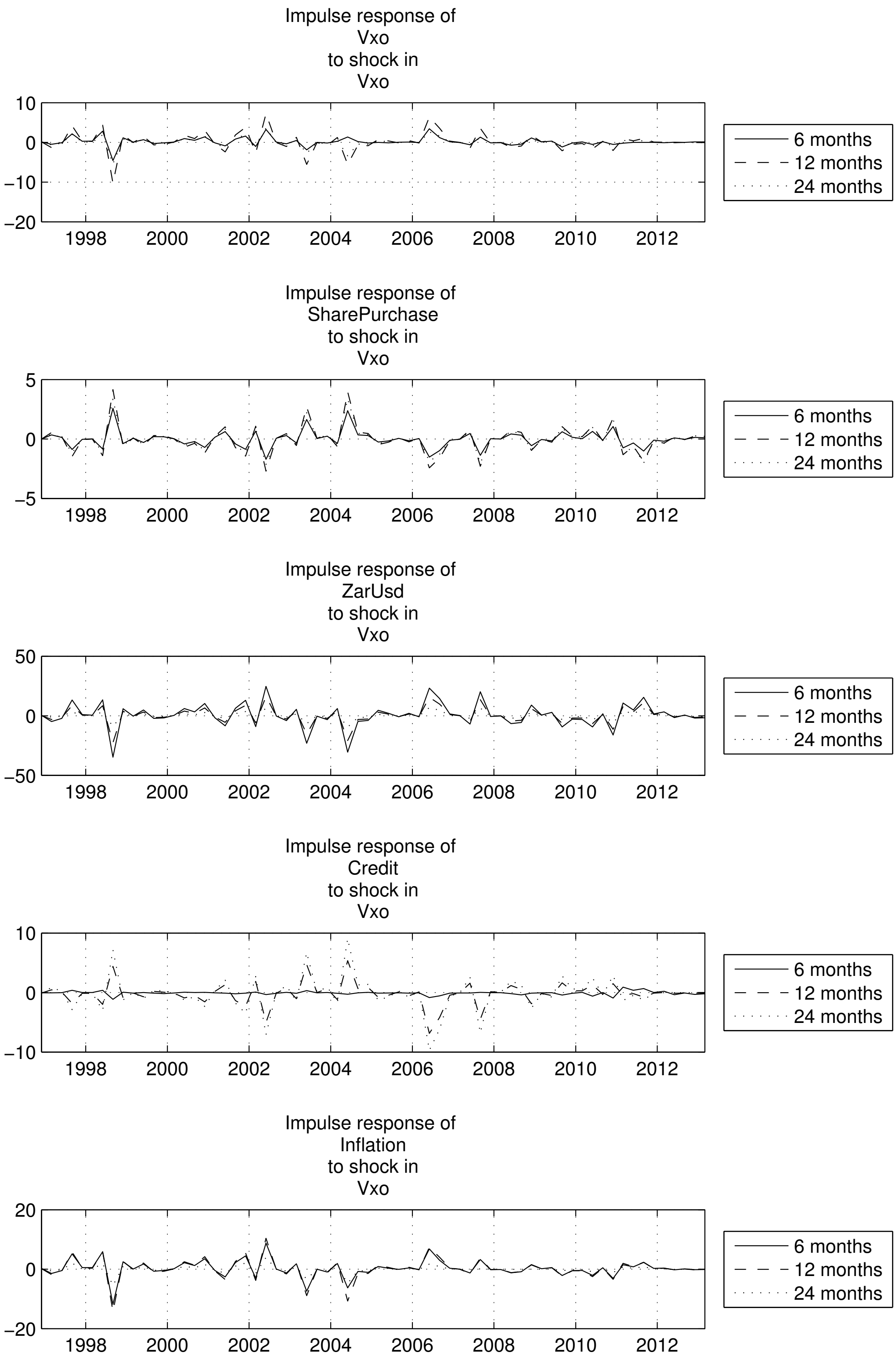

Figure 7: *Model 2* - Time varying impulse response after 6, 12 and 24 months from a shock to VXO.

5 Concluding Remarks

The paper has outlined the hypothesis that global risks has a predictable effect on emerging market share *prices* and bond *flows*. The results support the hypothesis and indicate that increased global risk will lead to net sales of South African bonds by non-residents (net purchases by residents). This causes a depreciation of the South African rand, which further causes higher inflation in the short term.

The implications of these findings are that an inflation targeting central bank will be pressured to implement restrictive monetary policy when global risk is high. This will exaggerate the potential negative wealth effects of the falling share prices. The transition mechanisms works as usual, first by increasing the discount rate and thus reducing share prices even further, causing more negative wealth effects. Secondly, it will affect the cost of borrowing and thereby credit demand and investment in productive capital as well as consumption. It may also be the case that the higher rates imposed by monetary policy are not sufficient to attract carry trades, as this occurs during a high risk environment when the global investor is unusually concerned with avoiding risks. The results support this notion as we see the impulse response of bond flows being non-linear in risk. That is, when risk is high, the bond flows respond stronger than usual (per unit of risk), indicating that risk becomes an overriding factor.

An inflation targeting central bank will of course not be forced to respond in this manner. A flexible inflation target allows for the so-called first round effects to pass through and will only respond to avoid second round effects caused by higher inflation expectations (Bernanke and Mishkin, 1997). The problem with this is that changes in global risk may happen relatively frequently and thereby causing frequent deviations from the inflation target. This has the potential to erode the credibility of the inflation target which is a crucial tool of the central bank.

It is not within the scope of this paper to determine the optimal policy response to such exogenous shocks to global risk. This will be an important line of research for South Africa an other emerging markets with similar structure and dynamics. One may for example imagine that a nominal GDP target is better suited to address such shocks as this will allow for temporarily higher inflation with a smaller negative impact on real GDP without loosing credibility of the target. Such targets have been recommended by for example Frankel and Chinn (1995).

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6 Appendix

	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 1: Correlation and standard deviation of changes in South Africa's foreign liabilities

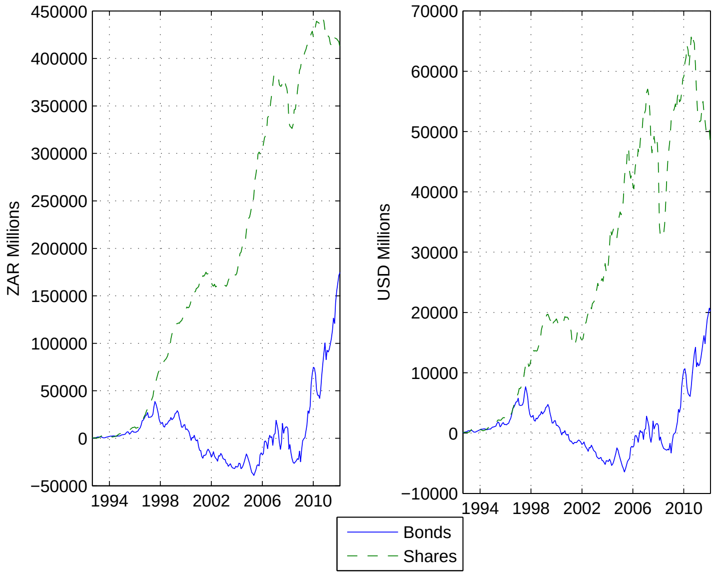

Figure 8: ZAR (left) and USD (right) denominated cumulative purchases of South African bonds and shares by non-residents since May 1993

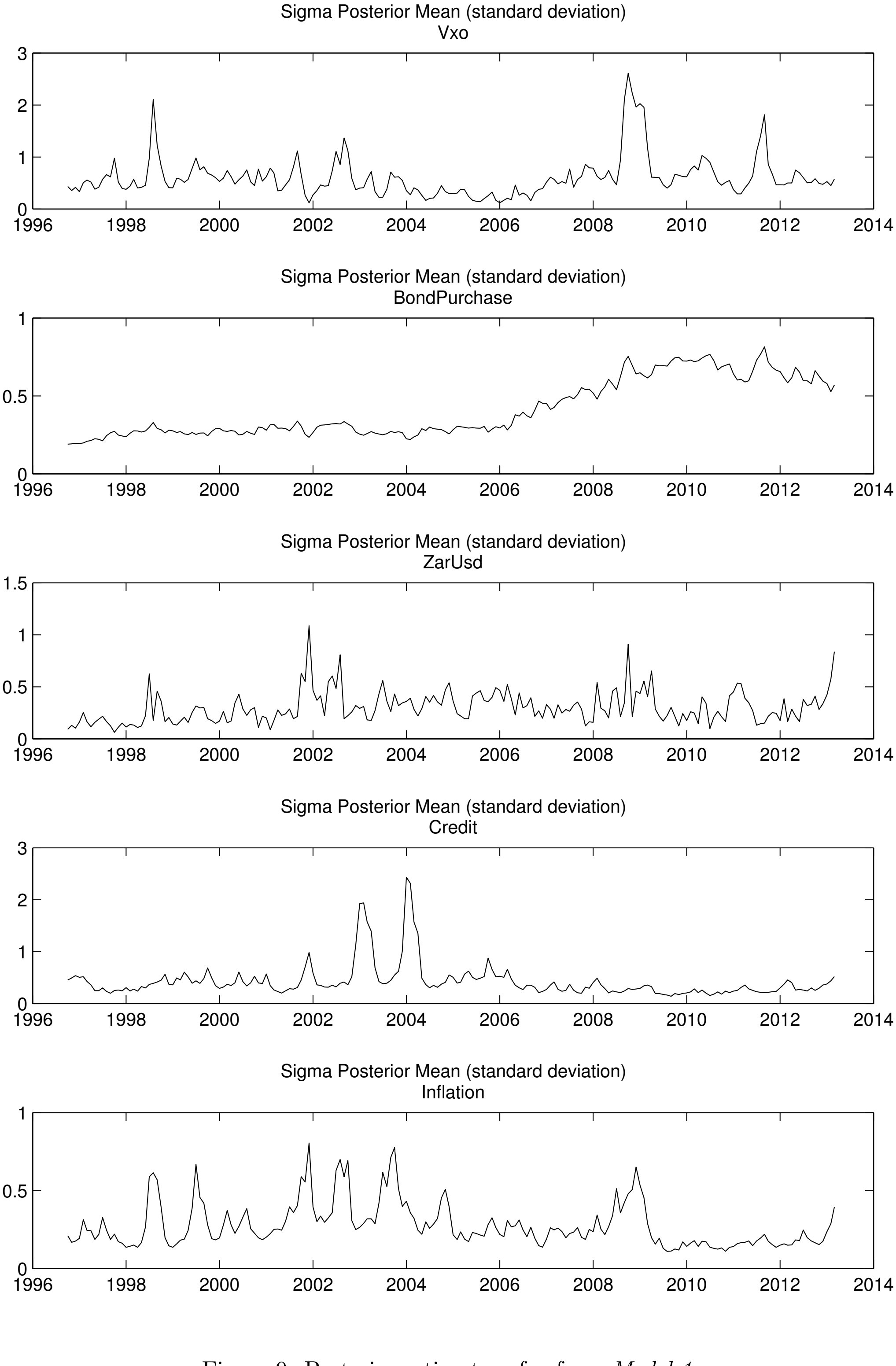

Figure 9: Posterior estimates of σ from *Model 1*.

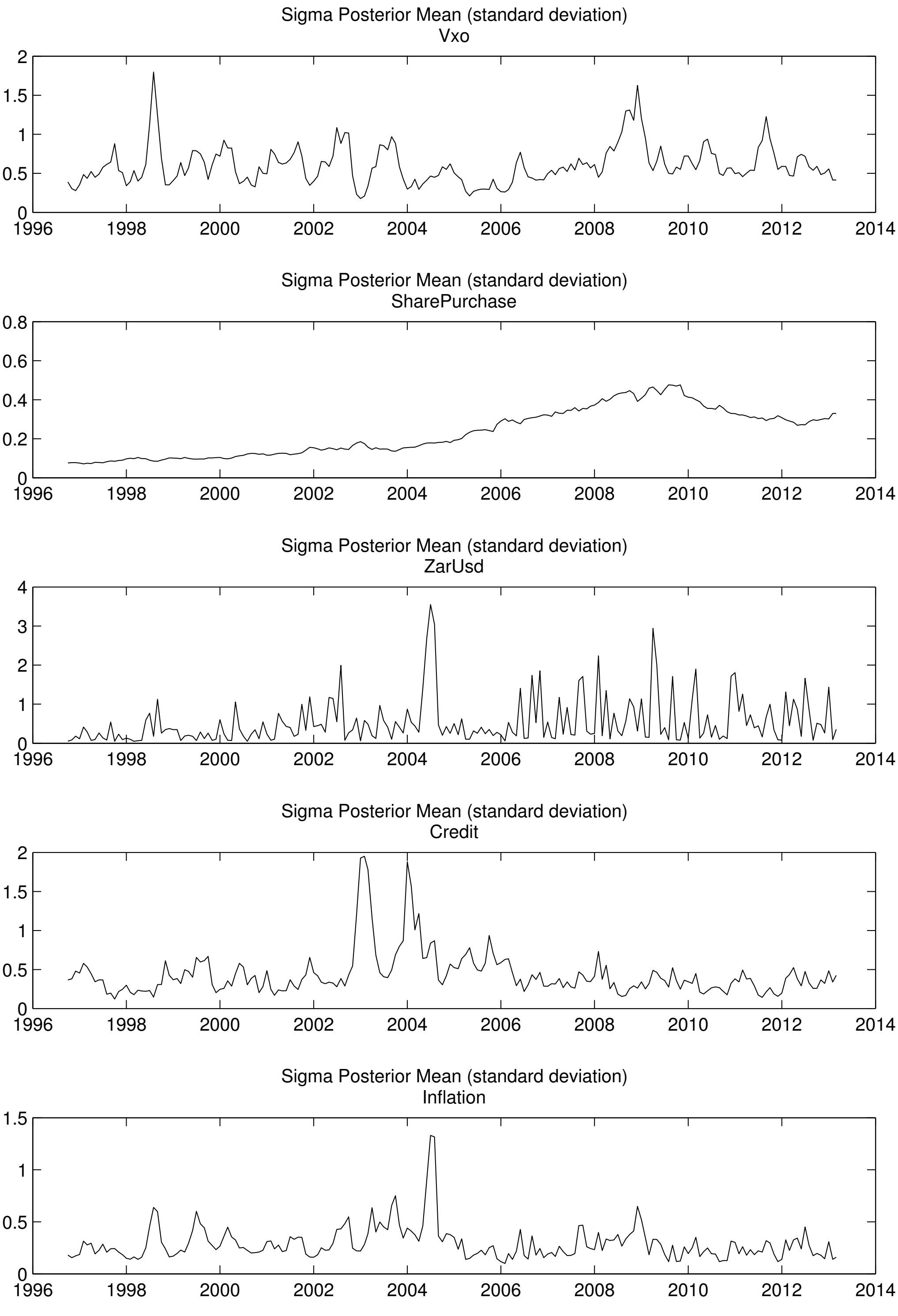

Figure 10: Posterior estimates of σ from *Model 2*.