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Are determinants of portfolio flows always the same? - South African results from a time varying parameter VAR model

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Are determinants of portfolio flows always the same? - South African results from a time varying parameter VAR model

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Abstract

The literature on determinants of cross-border capital flows has consistently assumed the determinants of such flows to be constant throughout the sample. This paper investigates 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 (measured by the CBOE Volatility Index, *henceforth* VIX). The results show that the time variation is highly significant and a constant parameter model will give biased estimates of the effects of risk on capital flows. The paper also gives important insights to South African policy makers and financial practitioners: Bond flows (non-resident purchases of South African bonds) have become more sensitive to the VIX after 2010. Share flows were particularly sensitive at the peak of the 2008 global financial crisis, but have at other times not responded in a statistically significant manner to changes in global risk. The relationships are estimated using a time varying parameter vector autoregressive (TVP VAR) model with stochastic volatility.

1 Introduction

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). This paper aims to contribute to the large literature studying the determinants of such flows by providing partial answers to the following questions: What explains the divergence between bond flows and share flows into South Africa and other emerging markets? Are the determinants of such flows always the same or do they change over time? We approach this problem by estimating the time varying effect of two factors that have been widely recognised as important drivers of cross-border portfolio flows: bond yields and global risk (as measured by the CBOE Volatility Index, *henceforth* VIX) [1] [2].

For the first time to our knowledge, we estimate a truly time varying model of bond and equity flows where the contemporaneous covariance matrix and the lagged coefficients are all time varying. This allows us to estimate the impact of shocks to each explanatory variable on portfolio flows to South Africa as they were at any particular month in our sample. We can thus plot 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 crucial feature in these relationships.

The findings of this research are significant on two levels. First, there is substantial time variation in the effect of both bond yields and global risk on the portfolio flows to South Africa.

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[1]The 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).

[2]See for example Calvo, Leiderman and Reinhart (1996); Taylor and Sarno (1997); Fratzscher (2011); McCauley (2012); Bruno and Shin (2013) and others; all discussed further in section 2.
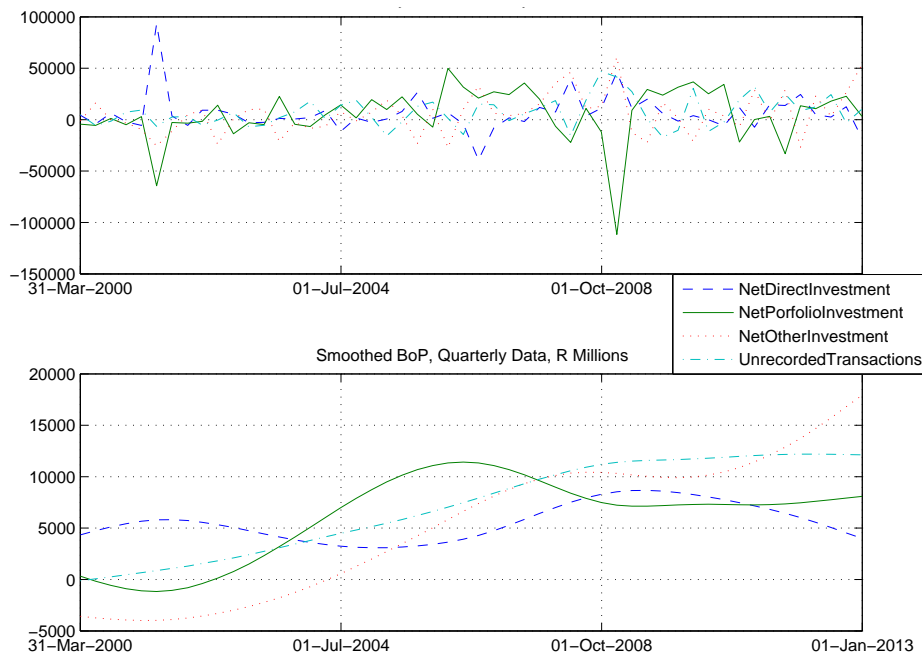
Figure 1: Quarterly Balance of Payment Figures - Actual (top) and Smoothed (bottom)

This time variation will induce a strong bias to coefficients estimated on a sample where the relationship is assumed to be constant. This will be particularly severe if the sample in question includes the global financial crisis of 2008.

Secondly, our results give important guidance to understand the dynamics of portfolio flows to South Africa. We learn that, contrary to what may be expected, global risk has had no impact on monthly bond or equity flows to South Africa in the period between 1998 and 2008. At the peak of the crisis however, global volatility and / or risk aversion appears to have caused large volumes of bond and share outflows. During the recovery from the crisis, share flows have remained unaffected by changes in the global risk, whilst bond flows have become more sensitive than they were even at the peak of the financial crisis. We speculate that this recent sensitivity is not caused by the risk itself, but rather by what causes changes in volatility: announcements about the unprecedented monetary policy interventions that have occurred over the same time period.

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. 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. 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 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

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[3]Clearly, sustained portfolio inflows also come with certain risks, for example sudden stops as argued by Calvo (1998)
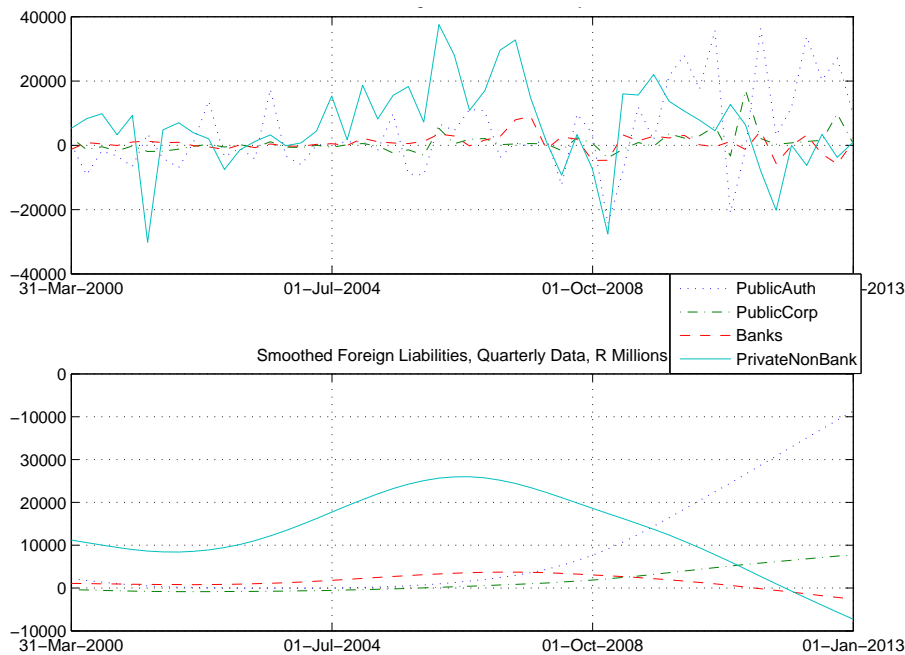
Figure 2: Quarterly Portfolio Inflows - Actual (top) and Smoothed (bottom)

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 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.

Thus far we have singled out portfolio inflows to South African public authorities and the private sector as an 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. 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 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 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 this volatility has 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. It is therefore crucial that policy makers strive to gain further understanding of what determines the foreign demand for South African financial assets.

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1.1.1 Some eyeballing

Our literature review (section 2) suggests that monetary policy, interest rates and global risk / risk appetite are important determinants of the volume and direction of cross border capital flows. The remaining figures of this introductory section will aid us in a simple eyeballing exercise to form some prior ideas of what relationships we may expect to find between these variables.

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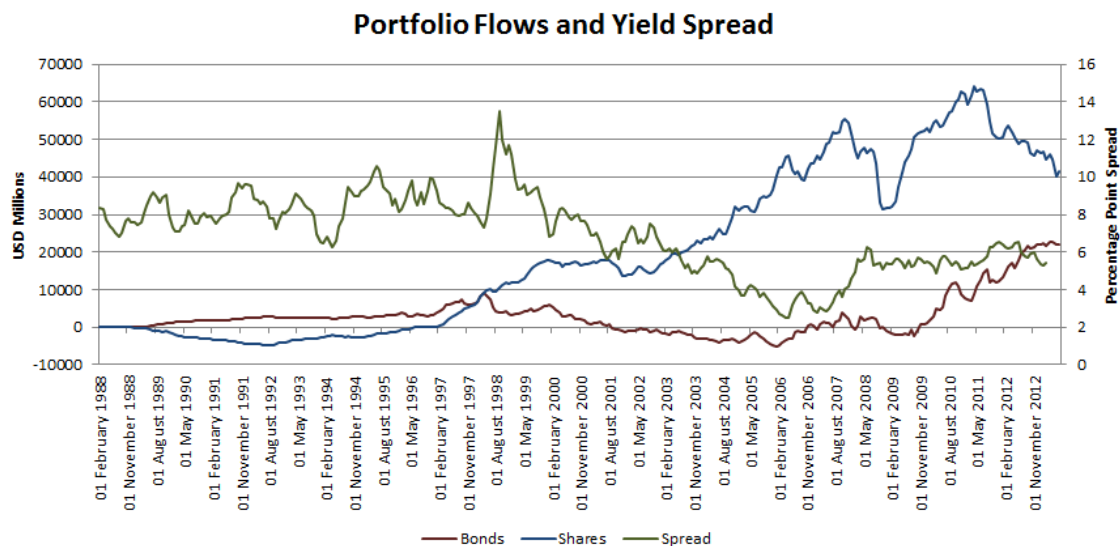

Figure 3: Cumulative portfolio flows (left axis) and the yield spread between 10 year South African and 10 year US Treasury bonds (right hand axis)
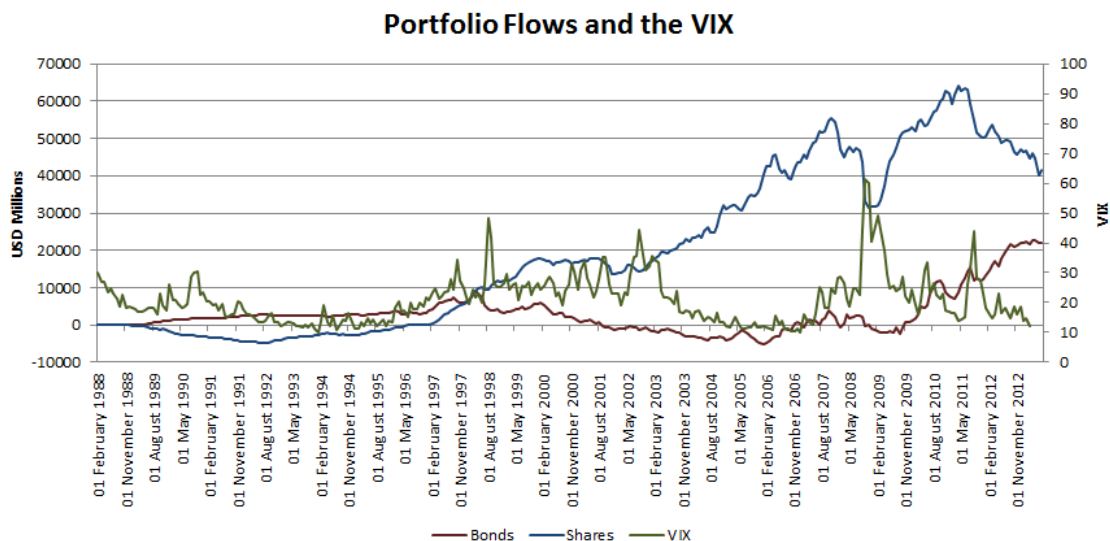

Figure 4: Cumulative portfolio flows (left axis) and VIX (right hand axis)

Once we move on to figure 5 we find a very clear relationship between the VIX and the yield spread. The Asian crisis and Russian default in 1998 caused a spike in risk (the VIX) at the same time as a spike in the yield on South African government bonds. From this point onwards the
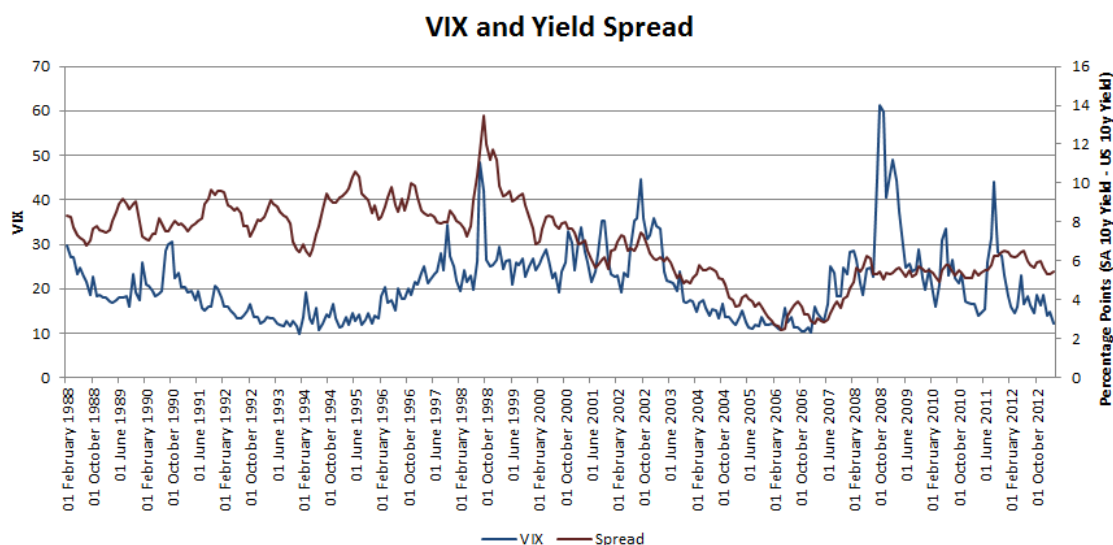
VIX and Yield Spread

Figure 5: Are the large inflows after 2008 explained by the fact that the spread remained high despite the falling risk

yield spread fell more or less in line with the VIX until their common trough in 2006 before both started climbing as we approached the financial crisis. Interestingly, the yield spread has remained rather stable since the onset of the crisis, whilst the VIX has been highly volatile before falling to levels well below average. It appears as if their relationship (if there indeed was one) broke at the onset of the financial crisis. We can hardly say more about this relationship without a more rigorous econometric analysis.

In figure 6 we point out the actual 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[4]. 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 and further that it may be difficult to distinguish the effects of each one variable on portfolio flows. The solution may be to compare the response of flows to the VIX before and after the financial crisis. These unconventional monetary policy measures were not present prior to 2008, and any relationship with the VIX prior to 2008 may therefore be more likely to be caused by the actual risk premium rather than the monetary policy of the US.

Figure 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 and again a more rigorous econometric analysis is necessary.

This brief review of the raw data suggests that there are indeed important relations between monetary policy, global risk / risk premia / risk appetite and the yield spread between South African long term government bonds and US long term government bonds. It is not immediately obvious from a superficial look at the data whether these variables are linked to capital flows into South Africa, but our expectation of such a relationship is supported by the vast literature on the subject. The next section will provide a rather selective review of this literature before the paper moves on to present the methodology used and the resulting estimates.

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[4]In the literature review we see that Adrian and Shin (2009) and Adrian and Shin (2010) construct a theoretical model that explains such a relationship and find empirical evidence in support of it
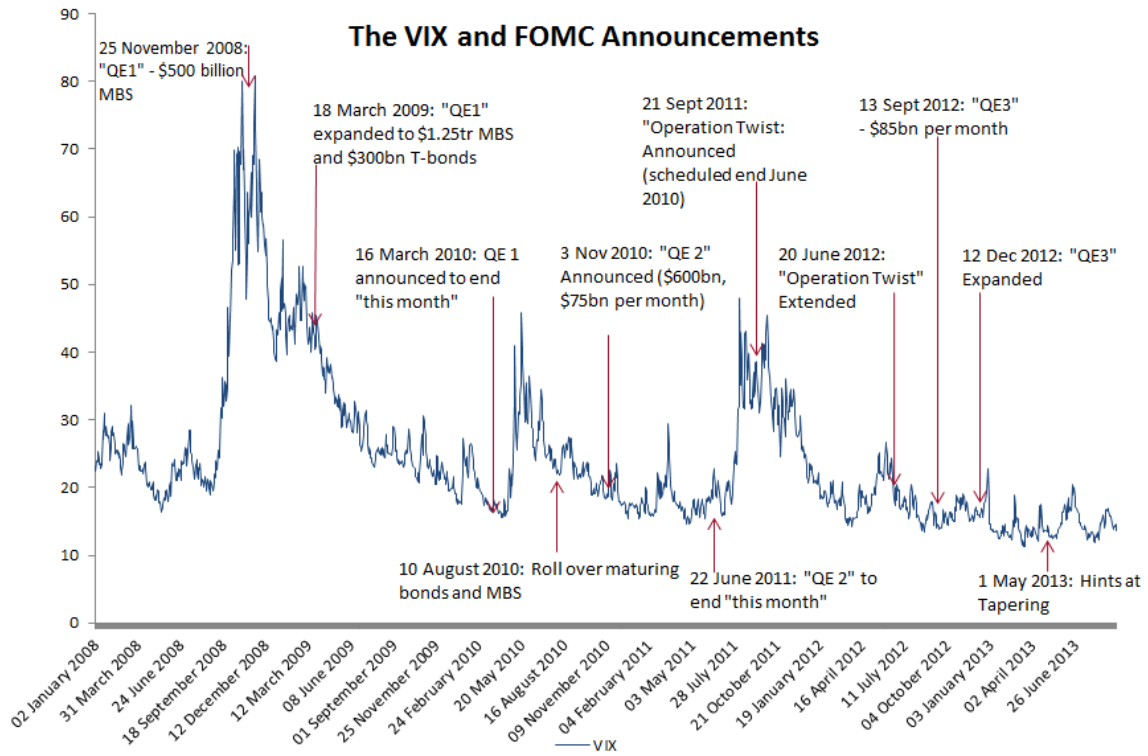
Figure 6: The VIX (left hand axis) and the yield spread between 10 year South African and 10 year US Treasury bonds (right hand axis)
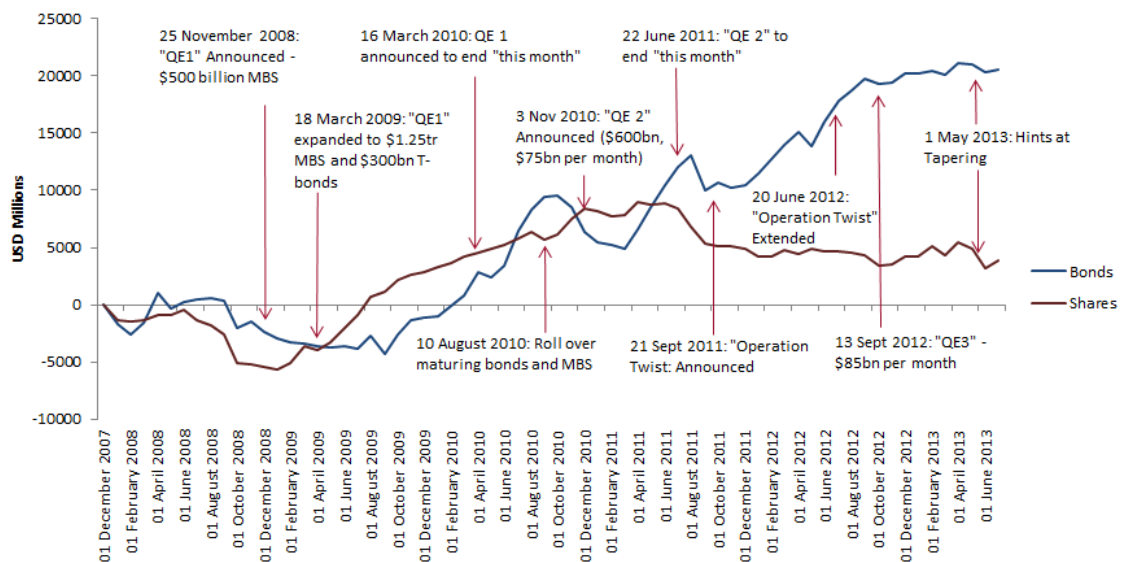

Figure 7: Cumulative portfolio flows since January 2008 and important US monetary policy announcements

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 (2012) and Bruno and Shin (2013) 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[5].

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) [6]. 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 [7] [8].

2.1 Models of risk, monetary policy and capital flows

In what the authors 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 [9].

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

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[5]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*.

[6]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).

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

[8]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 (2011)).

[9]See for example Adrian and Shin (2010),Adrian, Moench and Shin (2010),Adrian and Shin (2009),Danielsson, Shin and Zigrand (2011), Bruno and Shin (2012) and Adrian et al. (2010).

(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 [10]. 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. [11]

Importantly, 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. 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 (2012) and construct a model of cross border financial flows. Bruno and Shin (2013) 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 *EM*s [12], 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.

In this model, the *EM* borrowers take up debt in dollars to fund projects [13]. 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

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[10]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.

[11]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 (2011) 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)).

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

[13]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.

by the emerging market bank. By assumption, this will lead to appreciation of the exchange rate which makes the local project (borrower) more valuable in dollar terms, and thus a lower default probability (Bruno and Shin, 2012; Adrian et al., 2010). 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. [14] [15]

2.1.1 Empirical Literature

The theoretical literature discussed above is useful in deepening our understanding of how different structural factors interrelate and determine cross border capital flows. Lane and Milesi-Ferretti (2007b) provide a seminal empirical overview of the international balance sheets and their relation to capital flows. They demonstrate that such balance sheets differ significantly across countries, both in their allocation to different asset classes, maturity and liquidity. This implies that there are asymmetric exposures to different shocks and therefore such shocks will have different effects on portfolio flows in different countries. Such capital flows are caused by the rebalancing of international portfolios as the relative value of the assets within the portfolio is affected by shocks. This kind of portfolio rebalancing has also been studied by Hau and Rey (2006) who build a general equilibrium model where portfolio rebalancing causes a capital flow out of economies where asset prices are rising. They find strong empirical evidence in support of this model. [16] [17]

In this paper we are interested in understanding the importance of global and local factors as determinants of portfolio flows (where we distinguish between bond and equity flows) to South Africa. The following paragraphs give a brief overview of empirical research conducted on this very specific issue.

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 (which they gave the term "push factors" as opposed to domestic "pull 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. (See Calvo (2013) for a more recent discussion of this and other related papers). [18] [19]

There are several recent papers that have shown the importance of monetary policy (interest rates) as a driver of capital flows also in more recent times. For example, Taylor (2013) argue that monetary policy in the US tends to force other economies to follow suit with similar policy to

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[14]There are several papers that build general equilibrium models where leverage plays an important role. One important recent contribution to this literature is Mendoza (2010). In this model, leverage is growing with economic expansion, but once leverage reaches a threshold the collateral constraint becomes binding. This causes the cost of credit to increase and may force agents to liquidate assets used as collateral. If this liquidation leads to lower asset prices it may turn into a so called "debt deflation" scenario (ala Fisher (1933)) where the value of collateral falls relative to the book value of debt or revenue. This debt deflation may in turn cause large scale fire sales that spiral into further drops in the collateral value. This negative feedback loop gives rise to sudden stops in the model.

[15]There are several strands of literature modelling cross border capital flows (see for example Pavlova and Rigobon (2011) for a good review of this literature). One of the major puzzles in this literature is the documented presence of home bias in international portfolio allocation French and Poterba (1991). The macro finance literature has now come a long way to explain this puzzle, with important contributions from Obstfeld and Rogoff (2001), Kollmann (2006),Engel and Matsumoto (2006) and Coeurdacier and Gourinchas (2011).

[16]For other important empirical papers on the determinants of external positions (i.e. the stocks rather than the flows studied here), see for example Lane and Milesi-Ferretti (2007b,a); Lane and Shambaugh (2010); Gourinchas and Rey (2007); Herrero and Peria (2007).

[17]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).

[18]Chuhan, 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).

[19]Chai-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.

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. These findings are in strong support of the models developed by Adrian and Shin (2009); Bruno and Shin (2013) as discussed above. McCauley (2012) finds additional evidence that variations in global asset price volatility are driving factors of portfolio flows into emerging market bonds and shares.

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.

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 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.

3 Data and the Empirical Estimation Procedure

3.1 Data

This paper is focused on gross portfolio flows into South Africa, that is 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)[20]. Data on flows and yield on South African government bonds come from the South African Reserve Bank. US government bond yields are accessed from the US Federal Reserve Economic Data (FRED) [21]. The sample period is from February 1988 to February 2013. [22]

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).

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[20]Available here (2013): `http://www.cboe.com/micro/buywrite/monthendpricehistory.xls`
[21]Available here:`http://research.stlouisfed.org/fred2/`
[22]The variables are later referred to with the intuitive names: $BondFlow, ShareFlow, VIX, Spread.$

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 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[23]. 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[24]. 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.

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

[24]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: $u_t = A_t \Sigma_t \epsilon_t$

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

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

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

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

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 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) [25]. 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 120 observations (we use monthly data, implying an OLS sample of 10 years). The time-varying parameters are then estimated over the remaining sample from 1998 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:

$$B_0 \sim N(\hat{B}_{OLS}, (k+1) * Var(\hat{B}_{OLS}))$$

$$A_0 \sim N(\hat{A}_{OLS}, (k+1) * Var(\hat{A}_{OLS}))$$

$$\log\sigma_0 \sim N(\log\hat{\sigma}_{OLS}, I_n)$$

$$Q \sim IW(k_Q^2 * 90 * Var(\hat{B}_{OLS}), 90)$$

$$W \sim IW(k_W^2 * (k+1) * Var(\hat{B}_{OLS}), (k+1))$$

$$\underset{i=1:k}{S_i} \sim IW(k_S^2 * (i+1) * Var(\hat{B}_{OLS}), (i+1))$$

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[25] The model is estimated using Mathworks Matlab ®. Our code is based on code written by Koop20 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`

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:

$$\text{Model 1} : y_t = \begin{pmatrix} VXO_t & BondFlow_t & Spread_t \end{pmatrix}$$

$$\text{Model 2} : y_t = \begin{pmatrix} VXO_t & Spread_t & ShareFlow_t \end{pmatrix}$$

where the ordering is such that the latter variables may respond to contemporaneous values of the former variables.

4 Results

The most important contribution of this paper is the estimated effect of risk (measured by the VIX) on portfolio flows. We find that neither bond flows nor share flows have responded to shocks in the VIX prior to the global financial crisis of 2008. At the peak of the crisis, both share and bond flows appear to respond as expected with a negative sign. Figure 8 plots the impulse response of *bond flows* and the *soveriegn spread* 1 month after a shock occurs in the respective variables. Figure 9 plots the same impulse responses from the model with *share flows*. Impulse responses after longer lags are plotted in the appendix (see figures 11 and 12).

Interestingly, the most significant response, both in magnitude and statistical certainty, is found during the recovery from the crisis. During the past three years, 2010-2013, bond flows have been highly influenced by changes in the VIX, more so than by changes in the yield spread. We attribute this to the role of quantitative easing in the USA. Changes in the VIX during the financial crisis were presumably driven by severe risk aversion as well as market volatility. This drove both share and bond flows out of emerging markets.

During the recovery, however, changes in the VIX have been driven by two factors: announcements regarding quantitative easing and the sovereign (bond) crisis in Europe (see figure 6). Our results suggest that these shocks have been important determinants of bond flows, but not important for share flows.
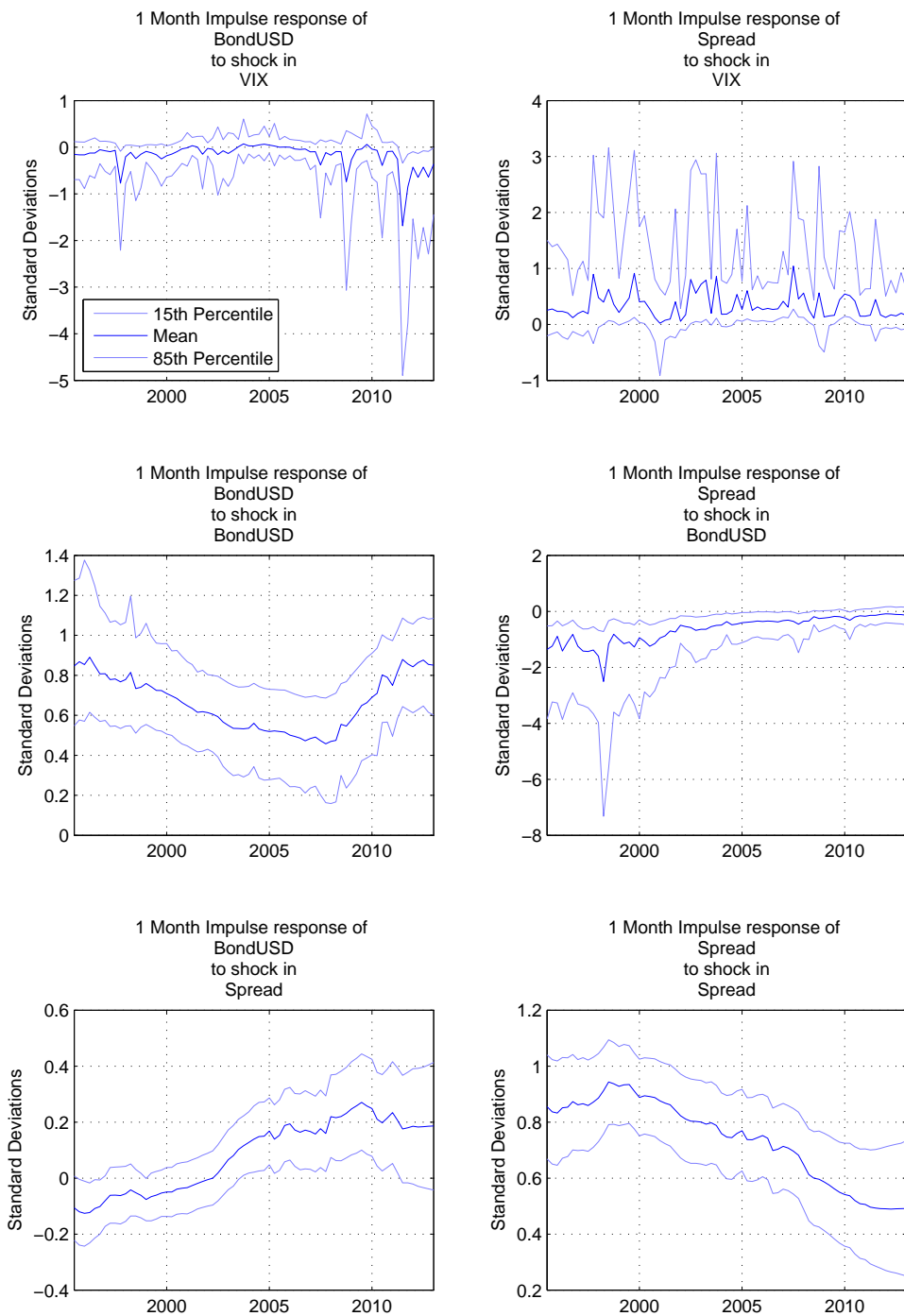
13

Figure 8: *Model 1* - Bond Flows: Time varying impulse response after 1 month from a standard deviation shock to the VXO (top), Bond Flows (middle) and Sovereign Yield Spread (bottom).
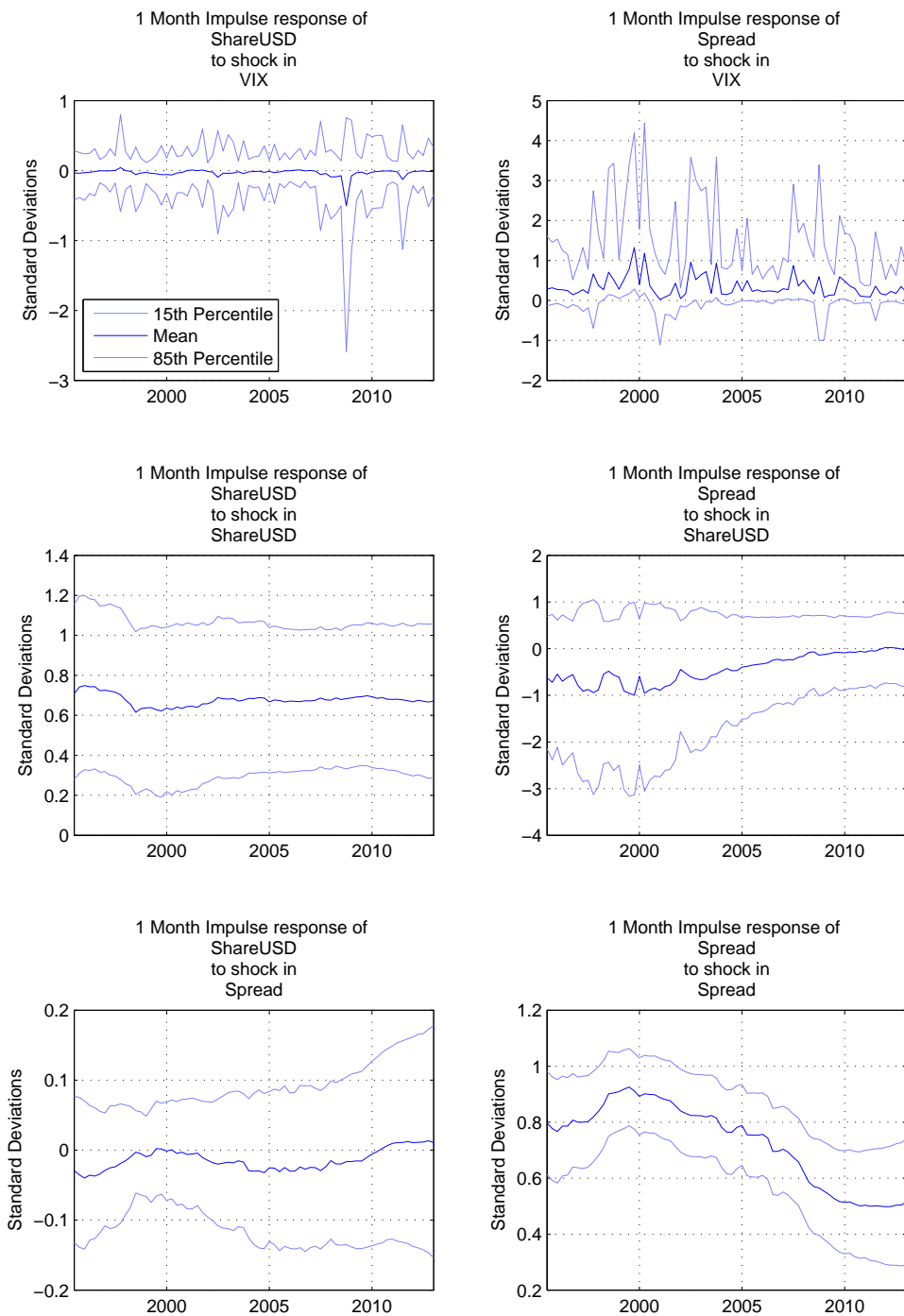
Figure 9: *Model 2* - Share Flows: Time varying impulse response after 1 month from a standard deviation shock to the VXO (top), Share Flows (middle) and Sovereign Yield Spread (bottom).

The lessons learned can be summarized as follows. Any model that assumes constant parameters throughout the sample period will produce highly biased estimates of the coefficient on risk if the sample includes the financial crisis. Risk has only been an important variable during and after the crisis. The importance of the sovereign spread in attracting bond flows to South Africa has also changed over time, and was more significant during the build-up to and at the peak of the financial crisis. During the recovery it appears that the yield spread has lost significance while risk (VIX) has become the dominant determinant.

The remaining panels in figures 8 and 9 tell a story that matches common understanding of financial markets. The sovereign spread has consistently, though to varying degree, responded to increased risk. This can be explained by a higher risk premium on emerging markets versus the US safe haven government bonds. Bond inflows to South Africa have consistently caused lower yields on South African bonds compared to US bonds as the flow increases demand for these assets. The response have become smaller over time, most likely due to an increasing value of the total outstanding South African government debt and possibly also due to higher liquidity of these bonds.

The temporarily negative impulse response of bond flows to shocks in the sovereign spread during the 1990s can possibly be explained by the high degree of South African specific risk and uncertainty at this time. This would imply a risk premium that was not caused by the VIX, and this higher risk premium would be accompanied by bond outflows as foreign investors aim to reduce this South African specific risk in their portfolio. At last, we note without further analysis that bond flows have become more persistent during the recent recovery, whilst the sovereign spread appears to have become less persistent.

4.0.3 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. Fratzscher (2011), however, finds local factors to become dominant during the recovery 2009-2010. Given this finding, it is interesting that we estimate the VIX to be even more important during the more recent recovery 2010-2013 than it was during the financial crisis. Notably, Fratzscher (2011) uses a sample from 2005 to 2010, and thus his results are not in direct conflict to our findings.

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 determinants[26]. 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. We don't find significant responses in share flows to changes in the VIX during this time.However, it is interesting that bond flows respond very sharply to the VIX during this time period. This diverging behavior of the two types of portfolio flows emphasises the importance of studying each flow separately.

5 Concluding Remarks

The paper has reviewed the literature on the determinants of cross border capital flows and highlighted a need to study the time variation of such relationships further. In particular we set out to answer two questions: What explains the divergence between bond flows and share flows into

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[26]Figure 10 in the appendix illustrates the significant time variation in the standard deviation of the variables included in our model.

South Africa and other emerging markets? Are the determinants of such flows always the same or do they change over time?

The research has provided partial answers, but much remains unknown. We found that the determinants of bond and share flows are not the same all the time. In fact, it appears that the VIX, a variable that is widely expected to be a significant driver of portfolio flows, has only been so during and after the financial crisis. In the case of share flows, the VIX was important at the peak of the crisis, but not at any other periods in our sample. This is quite remarkable, and implies that caution is of crucial importance when interpreting the impact of risk and risk aversion on capital flows. We note here that our results are found for monthly data and do not rule out short term day to day effects of the VIX.

It was mentioned in the opening paragraph that bond flows to emerging markets have been unusually high in the last four years, especially when compared to share flows. We do not have a conclusive answer as to why this is, but we found that bond flows have responded very strongly to changes in the VIX over this same time period. The VIX has indeed been falling rapidly throughout most of the period, possibly due to monetary policy actions in the US. The estimates imply that this falling level of the VIX is predicted to drive large amounts of bond flows into South Africa. However, the estimates are inconclusive as to whether this relation to the VIX is driven by an underlying relation to market volatility or to monetary policy actions.

In general, we have found that bond flows have in the last five years been driven by both the sovereign spread and the VIX while share flows do not respond to neither of the two. This suggests that share flows are determined by variables not included in this model, most likely more local so called "pull factors". Financial media frequently discusses the risk of portfolio outflows from emerging markets once pace of asset purchases by the US Federal Reserve is reduced. Our results suggest that this may indeed be a very real risk in the bond market, but not a significant risk in the share market.

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6 Appendix

	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 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 2: Correlation and standard deviation of changes in South Africa's foreign liabilities
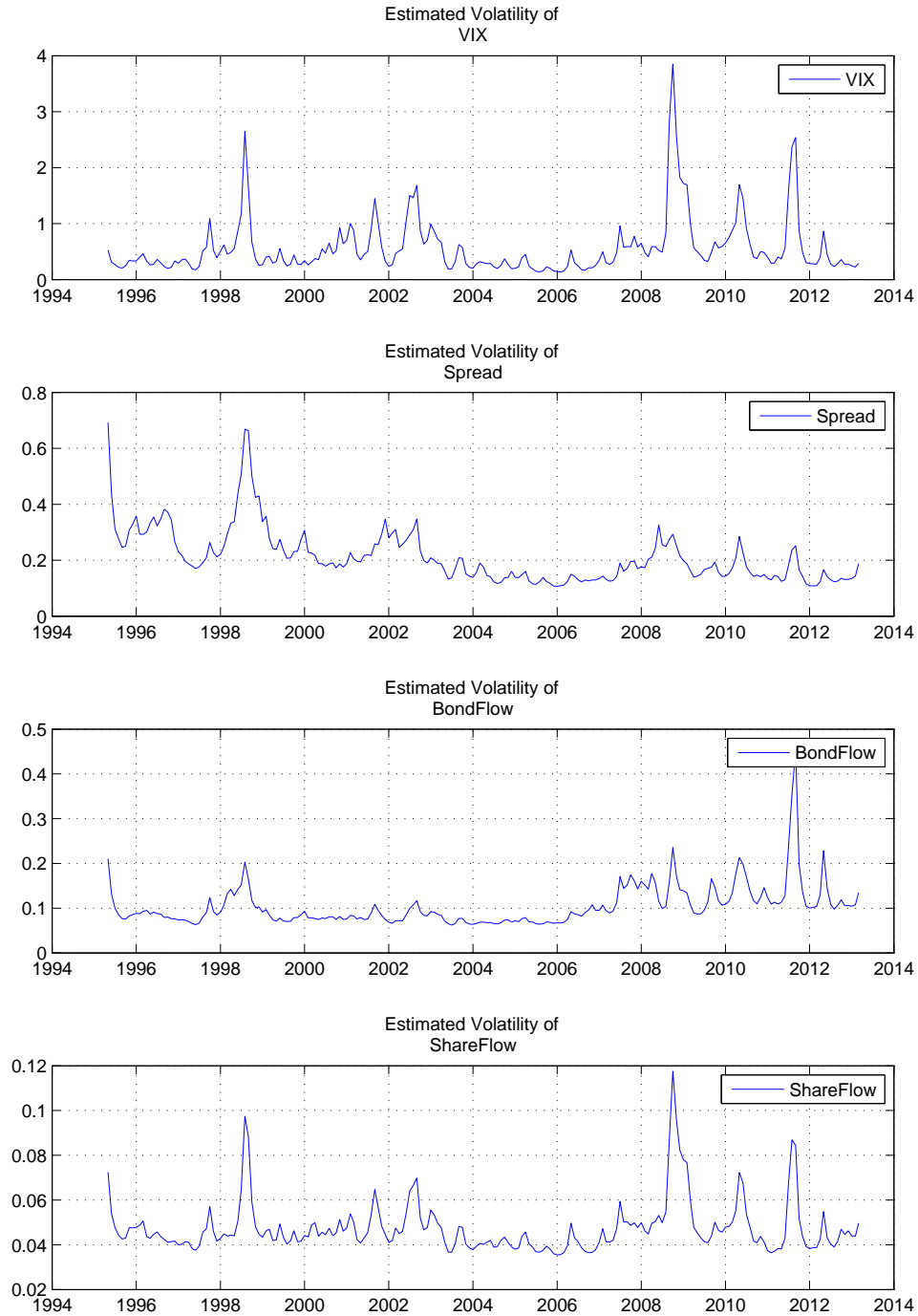
Figure 10: Posterior point estimates of the standard deviation of each variable. The results suggest significant heteroskedasticity and justify the use of stochastic volatility in the model.
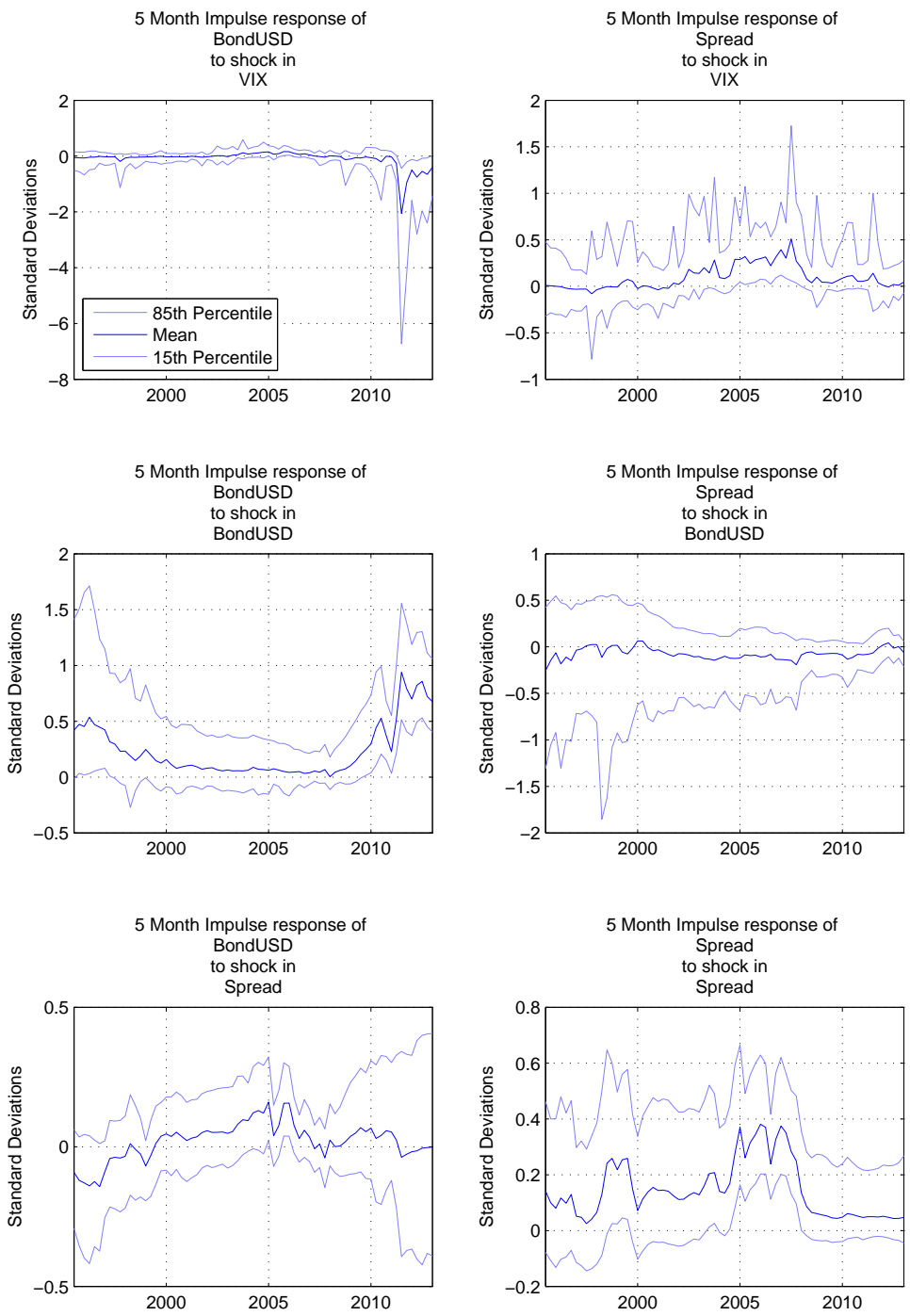
Figure 11: *Model 1* - Bond Flows: Time varying impulse response after 5 months from a standard deviation shock to the VXO (top), Bond Flows (middle) and Sovereign Yield Spread (bottom).
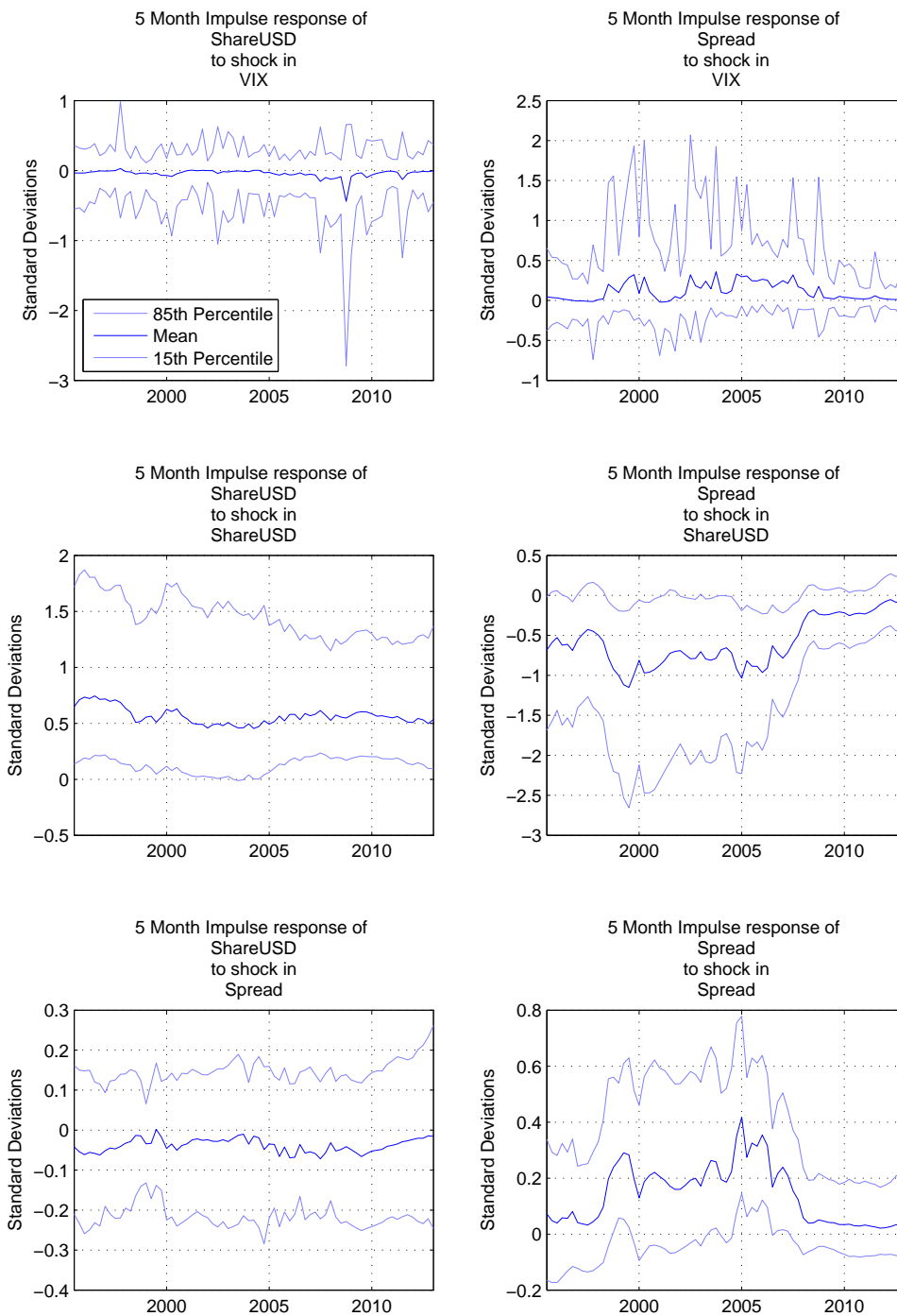
Figure 12: *Model 2* - Share Flows: Time varying impulse response after 5 months from a standard deviation shock to the VXO (top), Share Flows (middle) and Sovereign Yield Spread (bottom).