

# External Imbalances and the Valuation Channel

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Basil Thomas Whitehead

## **Abstract**

South Africa has been a net debtor of international capital since the South African Reserve Bank began measuring the international investment position in 1956. This surplus in the financial account has been partially used to finance the persistent current account deficit, which has given rise to a large negative net international financial position. The current practice for calculating the size of the financial account is to net off the size of the foreign assets and foreign liabilities, where use is made of the flow values at the date of transfer. In this paper we seek to incorporate the effects of changes in the values of these foreign assets and liabilities, which would ultimately effect the sustainability of an external imbalance. After we derive appropriate measures of the respective variables, we make use of a Bayesian structural vector autoregressive model that is able to capture stylised features that relate to the volatility of financial returns. We find that an increase in returns acts in a similar way to that of an improvement in the trade balance, which provides a more favourable external imbalance.

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# 1 Introduction

The sustainability of external imbalances is a primary concern for researchers and policy-makers involved in fields that relate to international finance, financial stability, international trade, global financial crises, the management of the balance of payments, exchange-rate stability, and sustainable global economic growth. This topic has largely been explored from a theoretical perspective, through the pioneering works of Obstfeld and Rogoff (1995) and more recently by Ghironi et al. (2007), Devereux and Sutherland (2010) and Tille (2008). In terms of the body of empirical research the vast majority of research in this area largely focuses on the sustainability of the large external imbalance in the United States of America. Gourinchas and Rey (2007a,b) are recent examples of such research that seeks to consider the role of returns that are derived on the net foreign asset portfolio as these may assist in balancing the external accounts. They show that fluctuations in asset prices and exchange rates lead to revisions of previous external positions, which are not accounted for in the income or financial accounts, and subsequently cause international wealth transfers. These findings suggest that the experienced systematic returns in advanced countries account for a substantial, and positive, variation in the dynamics of the net foreign asset portfolio (Gourinchas and Rey, 2007a). When looking further afield, the seminal cross-country studies of Lane and Milesi-Ferretti (2001, 2007a) illustrate that valuation effects are becoming increasingly prominent in both developed and emerging market economies due to substantial increases in international trade and financial globalisation.

This paper aims to investigate the role of returns that are earned on the South African net foreign asset portfolio to determine how this may affect the external sustainability of the current account deficit and the funding thereof. The case of South Africa is particularly interesting as it experienced historic periods of relative currency strength and stability when gold was treated as an important economic commodity. However, during the mid-1980s the political decisions of government resulted in a flight of capital, a dual currency system, sustained periods of capital controls and a debt moratorium (Mohamed and Finnoff, 2005). Following this period of significant political and economic instability, the external value of the currency has continued to depreciate, while the current account deficit that is funded by the financial account has persisted. Therefore, it is important to consider whether such an external imbalance in this particular emerging market economy is sustainable after accounting for both the trade and valuation channels.

Our results show that the valuation channel of adjustment has a positive influence on the South African external position, that is similar in scale to the effects of a positive change in net exports. In this case, a once off increase in returns results in an increase in the short-run net foreign asset position over the subsequent five quarters. Similarly, a once off increase in the change in net exports increases the net foreign asset position for approximately two years before returning to its trend. In each case, these increases have associated wealth transfers for the previously mentioned durations.

To the best knowledge of the author, this paper is unique for two reasons. There is a relative scarcity of recent published research into the gross external position of South Africa, none of which appears to consider valuation effects. Then secondly, there has been no attempt to explicitly account for the volatility

cycles that may arise from the risk adverse preference of the domestic agents for returns that exhibit low volatility (in the literature that pertains to either developed or emerging market economies). These cycles could lead to time varying interactions that we model accordingly. In addition, this paper also contributes to the literature by deriving a quarterly estimate of South Africa’s external position that largely follows the methodology of Lane and Milesi-Ferretti (2001, 2007a).

The paper proceeds as follows. Section two provides a theoretical framework that is used to illustrate how valuation effects, which arise from fluctuations in the real exchange rate and returns on the net foreign asset position, affect a country’s net foreign asset position. In addition, the preceding class of theories, broadly contained in “the intertemporal approach to the current account” of Obstfeld and Rogoff (1995), are discussed. Reasons for the popularity of this approach and a number of relevant empirical failings are also described in this section. Section three is dedicated towards pertinent measurement issues that relate to the external position, focusing on the financial account and the international investment position. Section four provides details relating to the international empirical literature relating to the prominence of valuation effects and the subsequent effects of these effects on external positions. Section five presents an overview of the motivations for domestic agents to invest abroad with respect to South African trade patterns, financial integration and the evolution of external adjustments.

Section six outlines the estimation procedure for a quarterly measure of South Africa’s international investment position, while section seven describes the results of this process. Section eight then contains the theoretic basis for the cyclical measures of the return on the net foreign asset position, changes in net exports and cyclical external imbalances. This data is then used in the estimation model, a Bayesian vector autoregression with stochastic volatility, to quantify the intertemporal effect of returns on the cyclical external imbalances. Section nine presents the estimation results pertaining to the three variables of interest. Section ten concludes.

## **2 Current account, international investment position and valuation effects**

To understand how revisions in the valuations of assets affect the economy a simple framework is proposed to consider the effects of exchange rate variations and asset price fluctuations on the change in the net external balance.

### **2.1 Accounting Identities**

Gourinchas and Rey (2014) refer to the systematic balance of payment deficits and surpluses held by many countries as global external imbalances. Two noteworthy cases are the United States of America, hereinafter referred to as the USA, which has a large current account deficit and China, which has a large current account surplus.

To determine whether a current account deficit is sustainable, a theoretic framework is proposed by Milesi-Ferretti (2008) and Lane and Milesi-Ferretti (2007b). This framework may also be used to illustrate how trade and valuation channels

arising from exchange rate fluctuations affect the net external balance. In subsection 2.2.3, we extend this framework to also consider the effects of changes in returns on the external asset and liability portfolios. To form a basis for evaluation Milesi-Ferretti (2008) consider a current account deficit to be sustainable if it does not yield an unbounded accumulation of net foreign liabilities. In other words, the net foreign asset position should not be continuously eroded over an indefinite period of time.

For the purposes of this discussion, the net foreign asset position,  $NA_t$ , is defined at the close of period  $t$ . This measure is derived from the difference between gross external assets and gross external liabilities, such that<sup>1</sup>

$$NA_t = A_t - L_t \quad . \quad (2.1)$$

The balance of payments accounting identity then defines the change in the net foreign assets as the sum of the current account,  $CA_t$ , capital gains on the net foreign asset position,  $KG_t$ , and capital account transfers that include net errors and omissions,  $E_t$ , during period  $t$ ,

$$NA_t - NA_{t-1} = CA_t + KG_t + E_t \quad . \quad (2.2)$$

The current account is given by the sum of the trade balance,  $TB_t$ , and the net investment income in period  $t$ , given by  $i_t^A A_{t-1} - i_t^L L_{t-1}$ . The nominal returns on external assets and external liabilities are denoted  $i^A$  and  $i^L$ , respectively.

$$CA_t = TB_t + i_t^A A_{t-1} - i_t^L L_{t-1} \quad (2.3)$$

We note that in equation (2.2) the capital gains on the net foreign asset position in period  $t$  would be comprised of capital gains on both the gross foreign asset and liability positions, denoted by  $KG_t^A$  and  $KG_t^L$  respectively. In the case of external assets, we define  $kg_t^A$  as the ratio of capital gains on external assets for the current period to the stock of external assets from the previous period, such that  $kg_t^A = KG_t^A/A_{t-1}$ . The same procedure is carried out for external liabilities, resulting in  $kg_t^L = KG_t^L/L_{t-1}$ . Given these expressions, the real rate of return for assets and liabilities is given by the sum of the nominal return and capital gains on assets and liabilities, respectively. Hence, after adjusting for the period's inflation,  $\pi_t$ ,

$$r_t^A = \frac{1 + i_t^A + kg_t^A}{1 + \pi_t} - 1 \quad (2.4)$$

$$r_t^L = \frac{1 + i_t^L + kg_t^L}{1 + \pi_t} - 1 \quad . \quad (2.5)$$

Equation (2.3) and the capital gains decomposition are substituted into (2.2), where all level variables are normalised by the gross domestic product,  $Y_t$ , where we subsequently make use of lower case letters to refer to normalised variables. Similarly, the growth rate in gross domestic product could then be expressed by  $y_t = Y_t/Y_{t-1} - 1$ . Next, the net foreign asset position is manipulated before rearranging equation (2.1) relative to GDP, such that  $l_{t-1} = na_{t-1} - a_{t-1}$  and

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<sup>1</sup>In this subsection we largely follow the derivation of Milesi-Ferretti (2008).

$$\begin{aligned}
\frac{NA_t - NA_{t-1}}{Y_t} &= (TB_t + i_t^A A_{t-1} - i_t^L L_{t-1} + kg_t^A A_{t-1} - kg_t^L L_{t-1} + E_t) / Y_t \\
na_t - \frac{na_{t-1}}{1 + y_t} &= tb_t + \frac{i_t^A + kg_t^A}{1 + y_t} a_{t-1} - \frac{i_t^L + kg_t^L}{1 + y_t} l_{t-1} + e_t \\
na_t - na_{t-1} &= tb_t + \frac{-y_t}{1 + y_t} na_{t-1} + \frac{i_t^A + kg_t^A}{1 + y_t} a_{t-1} - \frac{i_t^L + kg_t^L}{1 + y_t} l_{t-1} + e_t \\
&= tb_t + \frac{-y_t}{1 + y_t} na_{t-1} + \frac{i_t^A + kg_t^A}{1 + y_t} a_{t-1} - \frac{i_t^L + kg_t^L}{1 + y_t} (na_{t-1} - a_{t-1}) + e_t \\
&= tb_t + \frac{(i_t^L + kg_t^L) - y_t}{1 + y_t} na_{t-1} + \frac{(i_t^A + kg_t^A) - (i_t^L + kg_t^L)}{1 + y_t} a_{t-1} + e_t
\end{aligned}$$

The final equation transforms the nominal returns on assets and liabilities into their real equivalents,

$$na_t - na_{t-1} = tb_t + \frac{r_t^L - y_t}{1 + y_t} na_{t-1} + \frac{r_t^A - r_t^L}{1 + y_t} a_{t-1} + e_t \quad (2.6)$$

The three important components of equation (2.6) are the trade balance, the rate of return of net foreign liabilities less the growth rate of GDP and the difference between the rate of returns on gross external assets and liabilities. The trade channel operates through the first term,  $tb_t$  whereas the valuation channel operates through terms two and three, given by  $\frac{r_t^L - y_t}{1 + y_t} na_{t-1}$  and  $\frac{r_t^A - r_t^L}{1 + y_t} a_{t-1}$ , respectively. Each channel will be discussed separately in the following subsections. In addition, Devereux and Sutherland (2010) note that movements in the valuation channel are largely driven by changes in asset price and exchange rate dynamics, which cause the previous values of gross external positions to fluctuate. These changes are not reflected in the income account through returns received on assets,  $i_t^a$ , or returns paid on liabilities,  $i_t^L$ . Therefore, in the present framework, these changes in valuations are captured through the capital gains on external assets,  $kg_t^A$ , and external liabilities,  $kg_t^L$ , which in turn affect their respective real returns.

When the change in net foreign assets is positive, the economy experiences a capital inflow, which can be utilised to buy goods and services or finance further investment domestically (or abroad).

## 2.2 Effects of the exchange rate on the net external position

As previously mentioned, the real effective exchange rate can influence the change in net external assets through two channels, namely the trade channel, given by the first term  $tb_t$ , and the valuation channel that operates through the second and third terms (Milesi-Ferretti, 2008). For the purposes of this discussion, the fourth term is assumed to be insignificant, which is equivalent to stating that net errors and omissions and capital account transfers may be represented by a white noise process.

### 2.2.1 Trade channel: the exchange rate level

An exchange rate appreciation will result in a deterioration in the trade balance during the subsequent period. This would give rise to a negative change in the

net foreign assets during subsequent periods, all else being equal. The quantum of the change in the trade balance is proportional to the level of the exchange rate, which implies that the higher the appreciation the larger the reduction of the trade balance (Milesi-Ferretti, 2008). Hence, a once off appreciation in the real effective exchange rate can be seen as a permanent decrease in the trade balance.<sup>2</sup>

### 2.2.2 Valuation channel: the change in exchange rate

In a country where gross external liabilities are denominated in domestic currency, an exchange rate appreciation reduces a period's return on gross assets to a larger extent than it reduces a period's return on gross liabilities. It follows that the net foreign asset position deteriorates, as the third term coefficient in equation (2.6) is negative and the stock of external assets is always non-negative. External assets are dependent on the relative change in the exchange rate as opposed to the level of the exchange rate. For instance, if the exchange rate remains constant at any arbitrary level, this channel would vanish entirely (Lane and Milesi-Ferretti, 2007b).

Similarly, Tille (2008) notes that if a country is a net creditor, where external liabilities are generally dominated in terms of domestic currency and external assets are denominated in foreign currency, a depreciation will, all else being equal, lead to a higher return on the net foreign asset position. Therefore, the gross asset return resulting from such a depreciation is likely to be larger than the negative component of the external liabilities return and the country will benefit from such a depreciation.

### 2.2.3 Effects of changes in asset prices on the net external position

In this section, four assumptions are made to derive an expression for the impact of changes in asset prices on the net external position. Firstly, we abstract from the composition of the gross external assets and liabilities to provide an aggregate representation. Secondly, each position is considered as a portfolio with an associated net return, where the constituents are not known. Thirdly, the exchange rate is assumed to remain constant. Fourthly, it is assumed that trade is balanced and net errors, omissions and capital account transfers are insignificant, such that the first and last terms of equation (2.6) may be omitted. The preceding assumptions are relatively strong, however, they provide a tractable and intuitive framework from which to interpret the valuation effects arising from asset price fluctuations. If the assumptions were relaxed, accurate measures of each variable would be required in order to determine the effect on the net external position.

To complete this analysis we establish a number of different scenarios to consider the effects of changes in asset prices. The first case assumes that external positions are equal. The second case assumes that the home country is a net creditor, where net foreign assets are positive. The third case considers the converse, where the home country is a net debtor. In recent times South Africa

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<sup>2</sup>Historically “the intertemporal approach to the current account” as summarised in Obstfeld and Rogoff (1995) focuses on current account and trade balance dynamics as the primary mechanism of external adjustment. This broad class of theory is discussed in section (2.3).

and the USA have been responsible for negative net external asset positions and fall into the third case, whereas China experiences a positive net external asset position.

**Case 1:**  $na_{t-1} = 0$

Here only the third term remains. As the gross stock of external assets is always positive, the change in net foreign assets is determined by the sign of the returns differential,  $r_t^A - r_t^L$ . If the return on foreign assets exceeds that of external liabilities, the net foreign asset position improves. Similarly, if the return on external assets is less than the return on external liabilities the external position deteriorates.

**Case 2:**  $na_{t-1} > 0$

Two coefficients determine the change of the net foreign assets in this case. In this case, the change in net foreign assets depends on the signs of the difference of the returns on liabilities and the national growth rate, given by  $r_t^L - y_t$ , as well as the returns differential, given by  $r_t^A - r_t^L$ . As net foreign assets is given by  $na_{t-1} = a_{t-1} - l_{t-1}$  and gross liabilities are large and positive, this difference term is relatively small relative to either position. Therefore, if the returns and growth rate are such that  $r_t^A > r_t^L > y_t$ , both terms are positive and the change in net foreign assets will be positive and larger than in the previous case. If  $y_t > r_t^L > r_t^A$ , all terms are negative and so the net foreign asset position will deteriorate during the period. If  $r_t^A > y_t > r_t^L$ , the returns differential will be positive, while the second term is negative. This is one of four indeterminate cases where the sign of the change in the net foreign asset position is not immediately clear. The additional three indeterminate cases are given by  $y_t > r_t^A > r_t^L$ ,  $r_t^L > y_t > r_t^A$  and  $r_t^L > r_t^A > y_t$ .

**Case 3:**  $na_{t-1} < 0$

When the net foreign asset position is negative, the two previous cases where signs may be relatively clearly determined are now indeterminate. Additionally, the four previous indeterminate cases now take on well defined signs. If  $r_t^A > y_t > r_t^L$  or  $y_t > r_t^A > r_t^L$ , both terms are now positive, and so the net foreign asset position will improve during the period. If  $r_t^L > y_t > r_t^A$  or  $r_t^L > r_t^A > y_t$ , both terms are negative and so the net foreign asset position will be further eroded during the subsequent periods of time.

## 2.3 The Intertemporal Approach to the Current Account

As mentioned in section 2.2.1, “the intertemporal approach to the current account” that is described in Obstfeld and Rogoff (1995) presents one of the leading theories on external adjustment. The central prediction of this underlying model is that an economy should borrow through the current account whenever an economy’s current net income is below its permanent level, or whenever the return to domestic capital is higher than the cost of borrowing. Under these conditions, the amount of borrowing is determined by the fact that returns to capital even out over time and across the world when a no-ponzi constraint is applied to ensure that all external debts have to be repaid (Gourinchas and Rey, 2014). This amounts to imposing the constraint,

$$\lim_{k \rightarrow \infty} \left( \prod_{j=1}^k R_{t+j} \right) NA_{t+k} = 0 \quad . \quad (2.7)$$

Gourinchas and Rey (2014) illustrate this result with the following capital accumulation identity,

$$NA_t = R_t NA_{t-1} + NX_t \quad , \quad (2.8)$$

which states that the net foreign asset position at the close of period  $t$  is equal to the return on the previous position and the net exports during the period. Furthermore, one is then able to show that the change in the net foreign asset position is related to the sum of the current account and valuation effects,

$$\begin{aligned} NA_t - NA_{t-1} &= R_t NA_{t-1} + NX_t - NA_{t-1} \\ &= (R_t - 1)NA_{t-1} - NI_t + NI_t + NX_t \\ &= (R_t - 1)NA_{t-1} - NI_t + CA_t \\ &= VA_t + CA_t \quad . \end{aligned}$$

Iterating this equation forward, taking expectations and imposing the no-ponzi condition results in the discounted cash flow expression,

$$NA_t = -\mathbb{E}_t \left[ \sum_{i=1}^{\infty} \left[ \prod_{j=1}^i R_{t+j} \right]^{-1} NX_{t+i} \right] \quad . \quad (2.9)$$

where the net asset position is equal to the negative of the sum of discounted future trade flows. When it is expected that a country is going to experience a trade surplus in the future the net foreign asset position is negative. To reconcile this expression with the primitive case outlined in Obstfeld and Rogoff (1995), it is assumed that the only internationally traded assets are risk free government bonds yielding a constant rate of return  $R^f = 1 + r$ .<sup>3</sup> The previous equation is therefore given by,

$$NA_t = - \sum_{i=1}^{\infty} (1+r)^{-i} \mathbb{E}_t [NX_{t+i}] \quad . \quad (2.10)$$

Any movements in the net foreign asset position has to be driven by expected changes in future net exports such that an external adjustment can only occur through trade. It is stressed that this requires the assumption that only risk free bonds are traded internationally, which implies that there can be no capital gains or valuation effects. In equation (2.2), the capital gains term vanishes and, when net errors and omissions and capital account transfers are negligible, the current account coincides with the change in net foreign assets such that  $\Delta NA_t = CA_t$  (Gourinchas and Rey, 2014).

After making use of the assumption that representative consumers are infinite-horizon certainty equivalent agents, with a rate of time preference that coincides with the interest rate, net output is defined as the difference of output, government spending and investment.<sup>4</sup> Hence, we make use of the identity,  $Q_t = Y_t - G_t - I_t$ . The present value methodology of Campbell and Shiller (1987) may be used to form an expression for the permanent level of net output,  $\hat{Q}_t$ , which is given by the discounted expected cash flow expression,

$$\hat{Q}_t = r \sum_{s=t+1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t+1} \mathbb{E}_t [Q_s] \quad . \quad (2.11)$$

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<sup>3</sup>This simplification of the international portfolio structure is discussed in the following section.

<sup>4</sup>These representative agent assumptions stem from the permanent income hypothesis of Hall (1978).

Since the current account is the difference of net output and its permanent level, borrowing occurs when net output is below its permanent level and the country is a net lender whenever net output is above permanent net output. This allows for us to arrive at the result in Obstfeld and Rogoff (1995) where,

$$CA_t = Q_t - \hat{Q}_t = - \sum_{s=t+1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \mathbb{E}_t [\Delta Q_s] \quad . \quad (2.12)$$

### 2.3.1 Testing the intertemporal approach to the current account

Initial tests of this theory relied on time series regressions where the trade balance is the dependent variable and includes proxies for the temporary component of government spending, as well as either permanent or current government spending (Ahmed, 1986, 1987). These specifications are somewhat problematic as the majority of the explanatory power is attributed to measures of these terms. In addition, the permanent level of government spending is usually estimated with the aid of a filtering procedure. An additional concern, which relates to these regressions is that the coefficients often lack significance (Ahmed, 1986).

A more comprehensive test of this postulate has been proposed by Otto (1992), which essentially makes use of an extension to equation (2.12). To describe the test, consider the first-order vector autoregression model that includes terms for net income and the current account balance,

$$\begin{bmatrix} \Delta Q_t \\ CA_t \end{bmatrix} = \begin{bmatrix} \Psi_{11} & \Psi_{12} \\ \Psi_{21} & \Psi_{22} \end{bmatrix} \begin{bmatrix} \Delta Q_{t-1} \\ CA_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix}$$

Iterating this expression forward and taking expectations provides,

$$\mathbb{E}_t \begin{bmatrix} \Delta Q_{t+k} \\ CA_{t+k} \end{bmatrix} = \begin{bmatrix} \Psi_{11} & \Psi_{12} \\ \Psi_{21} & \Psi_{22} \end{bmatrix}^k \begin{bmatrix} \Delta Q_t \\ CA_t \end{bmatrix}$$

Given the relationship in equation (2.12), we can then estimate the current account balance  $CA_t$  with the use of the representation,

$$\begin{aligned} \widehat{CA}_t &= -[1 \quad 0] [(1+r)^{-1}\Psi] [\mathbf{I} - (1+r)^{-1}\Psi]^{-1} \begin{bmatrix} \Delta Q_t \\ CA_t \end{bmatrix} \\ &\equiv [\Phi_{\Delta Q} \quad \Phi_C] \begin{bmatrix} \Delta Q_t \\ CA_t \end{bmatrix} \end{aligned}$$

If the theory holds, the estimate of the current account should equal the observed series, i.e.  $[\Phi_{\Delta Q} \quad \Phi_C] = [0 \quad 1]$ . However, Otto (1992) finds that this is not the case. In addition, a second-order vector autoregression also fails to replicate the hypothesised prediction (Sheffrin and Woo, 1990).

Such external adjustment theories were particularly popular during the periods of relative autarky in financial markets, which is largely no longer the case, as was made evident by the recent global financial crisis. Here the assumption of risk free bonds, being the only internationally traded assets, does not appear to be a major limitation. However, not incorporating the complex portfolio structures observed is paramount to the failure of these theories. Under this assumption there is clearly no capital gains or losses on net riskless bonds and so there cannot be any valuation effects. This disparity is additionally illustrated

by the divergence of the current account and changes in the net asset position (Lane and Milesi-Ferretti, 2007a).

Additionally the data requirements are fairly low as balance of payments and national accounts data have been readily available for many decades at an appropriate frequency. This is in stark contrast to reliable estimates of external positions that are currently not published for many developing and emerging market economies.

### **3 Balance of payments and the international investment position**

To derive a measure for the net return on the assets and liabilities in the financial account and international investment position, it is necessary to review number of important measurement issues. As of December 2014, the South African Reserve Bank (2014b) publishes the balance of payments and international investment position according to the residence principle, which is described in the sixth edition of the IMF Balance of Payments and International Investment Position manual (International Monetary Fund, 2009; South African Reserve Bank, 2014b). When applying this methodology, external assets and liabilities and capital flows are defined as transactions or claims between non-residents or residents of a given country (Lane and Milesi-Ferretti, 2007a). A brief overview of each account precedes a detailed description of the financial account and the international investment position.

The current account measures the sum of the trade balance, factor income and transfer payments between residents and non-residents, the latter of which is typically small and is primarily dominated by current international assistance (International Monetary Fund, 2009). Imports of goods and services represent payment outflows, while exports result in pecuniary inflows. Factor income includes monetary transfers that are made in return for the provision of labour, financial assets or non-produced non-financial assets between residents and non-residents, and is largely comprised of dividend and loan income (International Monetary Fund, 2009). Note that this account does not capture the net capital gains that occur due to asset price fluctuations.

The capital account records transactions in non-produced non-financial assets and capital transfers (International Monetary Fund, 2009). The non-produced non-financial assets component of the capital account includes items such as the sale of licenses between residents and non-residents, whereas the capital transfers category includes financial aid and related items (International Monetary Fund, 2009). This account is typically small when compared to the current and financial accounts.

The financial account records the change of ownership of financial assets and liabilities. An inflow of capital is reflected by an increase in liabilities and a net outflow is a disposal of liabilities. Similarly, for assets, an outflow of capital occurs as a result of a net acquisition of assets and an inflow results from a net disposal of assets. It follows from the residence principle that external liabilities are claims of non-residents on assets in the resident country and external assets are claims of residents on assets in non-resident countries (International Monetary Fund, 2009).

The international investment position reports on the current stock of external assets and liabilities of the home country at the current market value. The financial account differs from the international investment position in several ways. It is a flow rather than stock, meaning that it does not include information pertaining to previous positions, but rather changes in asset holdings during each period. The international position refers to a position at a single point of time, whereas the financial account refers to transfers during a given period of time. The financial account makes use of net recording, where credits and debits are subtracted from one another, resulting in the period's change being recorded. In contrast, international investment position uses gross recording, where changes assets and liabilities are recorded separately International Monetary Fund (2009).

### 3.1 Financial account

As previously noted, the financial account records all flows of capital between the home country and the rest of the world. This account is broken down into five categories. The first of these reflect direct investment that includes all equity holdings with ownership above 10%, thus granting the holder voting rights (International Monetary Fund, 2009). Direct investment is further broken down into incurrences of external liabilities and acquisitions of external assets. The rationale for this classification is that international firms' advantage stems from their ability to distribute risk and production internationally, as well as making contributions in terms of marketing, management and technology. As a result, such assets are viewed as less risky (Avdjiev et al., 2014).

Secondly, portfolio investment contains flows in portfolio equity and debt securities, neither of which holds voting rights or a significant stake in the firm. This is further disaggregated into debt and equity transactions (International Monetary Fund, 2009). The third category is comprised of transactions of financial derivatives. The fourth category is termed other investment and primarily consists of bank and other loans. Fifthly, there is an account for transactions involving official reserve assets. This is largely comprised of foreign currency and gold reserves (South African Reserve Bank, 2016).

### 3.2 The international investment position

The net international investment position is defined as the difference between external assets and external liabilities and represents the country's net claim on the rest of the world (International Monetary Fund, 2009).

Each position of the international investment position is disaggregated into categories that are similar to those of the financial account, which include direct investment, portfolio debt and equity investment, financial derivatives, other investment and reserve assets. In order to reconcile the financial account and the international investment position, Gourinchas and Rey (2014) make use of a general law of motion, which governs the growth in each position or subcategory, as

$$PX_{t+1}^i = PX_t^i + FX_{t+1}^i + VX_{t+1}^i + OX_{t+1}^i \quad (3.1)$$

where  $PX_t^i$  is the position of asset  $i$  at the end of period  $t$ ,  $FX_{t+1}^i$  is the associated flow between the close of period  $t$  and the close of  $t+1$ ,  $VX_{t+1}^i$  denotes the gain or loss in valuation during the period, associated with asset or currency

fluctuations, and  $OX_{t+1}^i$  denotes other adjustments that may be required.<sup>5</sup>

The international investment position corresponds to the external assets,  $A_t$ , and external liabilities,  $L_t$ , described in the preceding theoretic overview. Similarly, the net international investment position corresponds to net assets term,  $NA_t$ .

### 3.3 Measurement issues

The measurement of the stock of the external positions and flows in capital and goods can be relatively challenging. When considering flows, the net errors and omissions category could reflect mismeasurement of the current account, financial account or both (Lane and Milesi-Ferretti, 2003). The measurement of this balance of payments component is typically problematic in the case of developing countries that experience unrecorded financial flows and capital flight (Lane and Milesi-Ferretti, 2007a). In South Africa the degree of capital flight was largest between 1980 and 2000 and is approximately 6.6% of annual GDP (Mohamed and Finnoff, 2005).

When measuring the external stock positions, especially external assets, financial accounts data and survey methods are commonly used to determine the value of an external position. In these cases, accurate estimation of each survey participant's positions is not always feasible and national coverage is often-times insufficient (Lane and Milesi-Ferretti, 2007a). Furthermore, the statistics on direct investment positions are typically problematic as these stock components are often not traded openly and are not purely comprised of equity. This results in direct investment positions that take on book values listed on company balance sheets, which may depart from the underlying market value. These statistics are also subject to infrequent revisions that are made by central banks. In addition, other adjustments that may result from ownership changes in equity transactions that are reclassified as direct investment holdings. Similar issues can occur from reclassifications of portfolio debt and other investment.

In Lane and Milesi-Ferretti's (2007a) cross-country study these mis-measurement concerns are apparent as the net foreign asset position for all countries is negative, which reflects a systematic global mis-measurement of current account and net foreign asset positions.

## 4 Trends and heterogeneity in the international investment position

A substantial amount of the research pertaining to global trends in the international investment position is attributed to the pioneering work of Lane and Milesi-Ferretti (2001, 2003, 2007a). The second iteration of the *External wealth of nations* includes a panel of 145 countries, which covers the bulk of all assets held worldwide (Lane and Milesi-Ferretti, 2007a). The broad research into the international investment position is primarily centered around the significant growth and importance of the international investment position, as well as differences in capital structure between countries.

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<sup>5</sup>For instance the debt reduction of a creditor could cause a decrease in external debt assets, whereas a domestic debt reduction could result in a decrease in external debt liabilities.

## 4.1 The growing importance of the valuation channel

A widely used measure of financial integration is given by the sum of external positions, normalised by real gross domestic product, such that  $M_t = (A_t + L_t)/G_t$ . Gourinchas and Rey (2014) note that this measure has grown substantially for developed economies from about 68% in 1980 to 438% in 2007. However, in developing and emerging market economies it has only increased from 35% to 73% over the same period. This may be attributed to the growth in the global marketplace, but it is not the single cause of the *de facto* surge in external balance sheets (Lane and Milesi-Ferretti, 2003). The reduction in transaction costs and increased access to international markets have allowed many economies the opportunity to share risk internationally. In addition, the total stock of assets and total liabilities are growing and so the growth in external positions cannot be fully attributed to diversification motives (Lane and Milesi-Ferretti, 2003).<sup>6</sup>

The magnitude of the external portfolios that are held by the residents of most countries allows for large wealth transfers internationally, given the fluctuations in asset prices and exchange rates (Lane and Milesi-Ferretti, 2007a). Furthermore, exchange rates play a dual role in determining capital flows and capital gains on existing asset stocks. Lane and Milesi-Ferretti (2007a) suggest that the importance of these valuation effects is proportional to the size of a country's balance sheet and that valuation effects typically imply larger short term volatility in the change in the net foreign assets, relative to the current account.

In their cross-country study, Lane and Milesi-Ferretti (2007a) make use of measures for the current account, capital account, net errors and omissions and changes in net foreign assets separately from 1982 to 2004. When abstracting from capital gains or losses, the change in net foreign assets should equal the sum of the current and capital accounts and net errors and omissions. If the converse held, then the change in net foreign assets should be approximately the sum of the current and capital accounts. Therefore, any difference between these measures may be attributed to identify valuation effects after accounting for errors and omissions. This exercise highlights the existence of large, positive valuation effects for countries such as the USA and the United Kingdom. Furthermore, South Africa fits into this category too, where the discrepancy between the cumulated current account and cumulative net foreign assets is not offset by net errors and omissions and capital account transfers (Lane and Milesi-Ferretti, 2007a). It is evident that South Africa is subject to large valuation effects from exchange rate and asset price fluctuations.

## 4.2 Compositional effect on returns

The composition of the gross external holdings can affect the net returns on foreign holdings. This stems largely from the different risk-return profiles of equity and debt-type securities. For example, US treasury bills are commonly held by external agents as a liquid hedging position or official reserve assets (Gourinchas and Rey, 2014). In addition, domestic agents in the USA typically invest in higher risk and return areas in foreign countries. This type of investment may take the form of portfolio equity and direct investment securities.

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<sup>6</sup>The growth in global markets have also contributed to substantial revisions in the value of external stocks.

This means that gross liabilities in the USA systematically experience a lower return than gross assets, often referred to as the ‘exorbitant privilege’. Due to the returns differential that stems from this asymmetric portfolio composition, the USA systematically earns a positive return on their net foreign asset portfolio (Gourinchas and Rey, 2007b, 2014).

This trend has been established for several developed countries that hold a larger proportion of external assets in equity than in debt (Lane and Milesi-Ferretti, 2007a). The converse is observed for external liabilities. In contrast, developing and emerging market economies have experienced steady growth in equity-type assets. Direct investment liabilities have increased to over three quarters of all equity liabilities in the sample drawn by Lane and Milesi-Ferretti (2007a). In addition, there has been a marked decline in the relative weight of debt assets in developing and emerging market economy external assets between 1970 and 2004, while official reserves have largely increased. This suggests that emerging markets are more prone to systematically recording negative or near zero excess returns on net foreign asset portfolios.

## 5 The South African Case

In addition to the global trends in international financial integration there have been significant macroeconomic policy decisions and developments that make South Africa’s international investment position unique and important.

This section will commence with an overview of motives behind residents international asset holdings and foreign agents domestic asset holdings. In what follows, the relevant macroeconomic history and the effects of the trend in financial integration, including important trade and investment relations, are considered. South Africa makes for a particularly interesting case study as it was subject to economic sanctions, during the later part of the 1980s and the early 1990s, which motivated policy interventions to stabilise the balance of payments. Thereafter, following dawn of the new democracy in 1994, South Africa experienced a strong inflow of foreign capital following the abolition of capital controls South Africa promoted international investment. This led to a large current account deficit and an increase in financial integration. At this current point in time there are now important trade and investment links between South Africa and the rest of the world, namely Brazil, Russia, India and China, hereinafter referred to as BRICS, the European Union, the USA and many other African countries. These trade patterns have led to several cross boarder asset holdings that differ from other emerging market economies, which are discussed below.

### 5.1 Motives for external investment

Large multinationals often have strategic advantages over domestic firms through their access to more efficient production methods, financing from parent companies and benefits from international marketing campaigns (Görg and Greenaway, 2004). Direct investment is commonly incentivised by emerging market economies, as the contribution of such an investment to the domestic economy may be more widely spread. Such incentives stem from tax benefits and a local example includes the motor industry import tariff incentives in South Africa. The Johannesburg Stock Exchange, hereinafter referred to as the JSE, is cur-

rently the 19<sup>th</sup> largest exchange measured by market capitalisation and the 5th largest emerging market stock exchange (Jefferis and Smith, 2005). It is the largest stock exchange in Africa, accounting for 80% of the listed stock market capitalisation on the continent (Jefferis and Smith, 2005).

Domestic agents in South Africa have two primary for investing abroad. Firstly, international assets may be used as a mechanism for international risk sharing and are may be used as a hedge against currency depreciation.. Destination markets for investment motivated by risk aversion tend to be safe assets in developed countries, such as US treasury bills or dollar based currency. Secondly, agents can earn a higher rate of return elsewhere, which a large driver of direct investment into the rest of Africa and Asia. For instance, this can be motivated by considering the Capital Asset Pricing Model with a international perspective, where the risk free rate corresponds to American or European bond returns (Sharpe, 1964). The central prediction suggests that risk can be mitigated following an adjustment in return through international diversification.

In this case the relative systematic risk of an asset is quantified in it's co-movement with the 'market portfolio'. For example, the risk return trade-off could be examined by considering the expected future value and volatility of returns. A similar risk return trade-off may be given by,

$$\mathbb{E}_t [r_{t+1}] = \alpha + \beta \sigma_t^2 \quad (5.1)$$

where  $\mathbb{E}_t [r_{t+1}]$  is the expected excess return on an asset and  $\sigma_t$  is the associated conditional variance. The literature suggests that the value for  $\alpha$  is usually small and  $\beta$  is typically negative, indicating that investors trade off expected returns for lower volatilities of returns (Campbell, 1987; Fama and Schwert, 1977; Glosten et al., 1993; Merton, 1980). Subsequently, agents considering whether to hold domestic or international assets may invest where risk adjusted returns are highest (Mohamed and Finnoff, 2005). As the JSE is characterised by a higher volatility of daily returns in comparison to the S&P 500, Dow Jones and London Stock Exchange, there is a motive to invest elsewhere (Salm and Schuppli, 2010).

## 5.2 Macroeconomic history

South Africa made use of a dual exchange rate system between 1961 and 1995 (Aron et al., 2010). This resulted in the introduction of the financial rand where the value of the currency was determined by demand and supply from foreign investors (Aron et al., 2010). The official Rand was then used for all other transactions, while an asset swap mechanism was introduced to allow domestic institutional investors an opportunity to diversify their portfolios internationally without putting pressure on the balance of payments (Rangasamy, 2014). Over this period, South Africa experienced a steady outflow of capital.

By 1995 South Africa had abolished nearly all capital controls, including the dual exchange rate system. Sovereign credit ratings were also introduced at this point in time, which provided a benchmark for other domestic debt (Aron et al., 2010; Rangasamy, 2014). These policy changes facilitated net portfolio inflows into South African financial markets over the subsequent decade.

Figure 5.1 presents the ratio of assets and liabilities to gross domestic product, as described in section 4.1, between 1985 and 2015. During the early period of

this sample, prior to 1995, it is evident that South Africa experienced a state of near autarky. However, financial integration has sharply increased after this period of time. In 2007 the ratio increased to 140%, which is nearly twice the emerging market economy average of 73% (Lane and Milesi-Ferretti, 2007a). However, this value is still lower than that of developed economies, which had an average of 438% at that point in time. This figure doubled over the following 5 years, after the financial crisis and during the period of quantitative easing in the developed world.

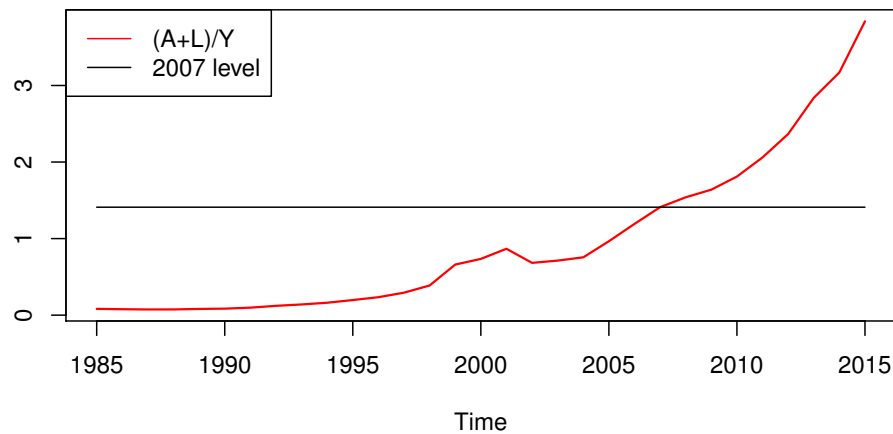


Figure 5.1: De facto measure of financial integration for South Africa: Ratio of assets and liabilities to real gross domestic product.

### 5.3 South Africa's International Investment Position

A breakdown of each position by composition, relative to annual gross domestic product, is illustrated in figure 5.2. This relates to the sample period between 1985 and 2015. It suggests that external assets have steadily increased over the sample period, from R33.6 billion to R6181.3 billion, which corresponds to an increase from 5% to 200% of gross domestic product in each period. Similarly, external liabilities have increased from R89,6 billion to R5544,3 billion, which translates to an increase from 5% to 180% of gross domestic product.

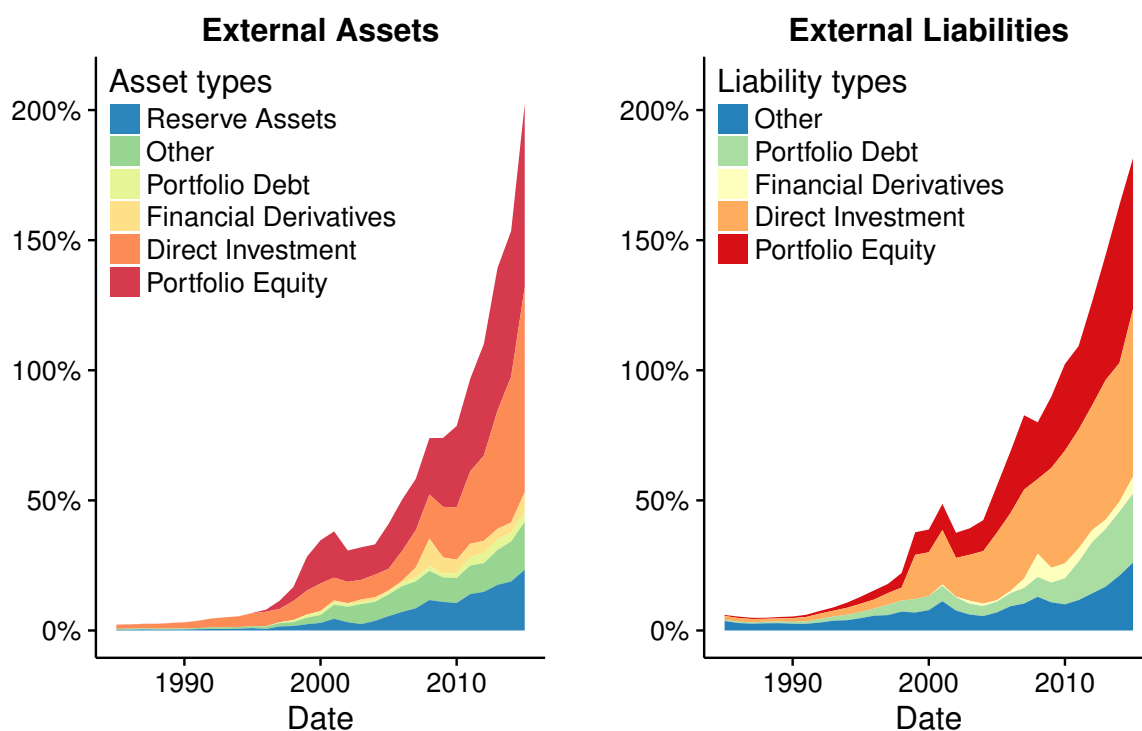


Figure 5.2: The composition of South Africa's International Investment Position as a percentage of real GDP

The largest constituent of gross liabilities is direct investment, constituting between 35% to 40% of all external liabilities between 2000 and 2015. Portfolio equity exhibits a similar trend to direct investment as a percentage of total liabilities, as it is bounded between 20% to 38% over the same period. The ratio of portfolio debt securities to total portfolio liabilities steadily declined from approximately 50% in 1990 to 17% in 2007, before climbing to 31% at the close of 2015. The above suggests that the emerging market economy trend identified by Lane (2016) is present in South African data, where the stock of portfolio debt liabilities is typically lower than the stock of direct investment liabilities. This is in direct contrast to developed economies, where debt plays a larger role than direct investment liabilities. The other investment category, which is primarily loans, has similarly expanded in magnitude, but has reduced as a proportion of external liabilities from approximately 61% to 14%.

Equity portfolio investment was largely non-existent until the full liberation of the balance of payments, when in 1997 it rose to 27% of gross external assets. However, during the first half of the sample, direct investment assets ranged from between 67% to 75% of all external assets. In the subsequent years, portfolio equity assets grew to the largest component of external assets. Portfolio debt is less than 5% of external assets for the full sample, whereas the other investment category is near 10% for most years. The above suggests that the case of South Africa diverges from that of the typical developing and emerging market economies when considering the asset structure (Lane, 2016; Lane and Milesi-Ferretti, 2007a). The remaining item, which relates to the stock of reserve assets has fluctuated slightly around a mean of 12% of total external assets.

These statistics may be used to measure the net international investment position, which is negative for the majority of the sample, bounded between  $-1\%$  and  $-20\%$  of output. The measure reports a positive value of  $20\%$  at the close of 2015.

## 5.4 Bilateral trade and investment relationships

As of December 2015, South Africa's largest creditors are the United Kingdom, USA, Netherlands, Luxembourg and China, with liabilities of  $31\%$ ,  $25\%$ ,  $11\%$ ,  $3\%$  and  $2\%$ , respectively. The largest debtors are the United Kingdom, China, USA, Luxembourg and Ireland with assets of  $26\%$ ,  $17\%$ ,  $14\%$ ,  $8\%$  and  $4\%$ , respectively (South African Reserve Bank, 2016). The composition, structure and sources of each bilateral position play important roles in understanding the structure of each position. The central focus are the risk and return profiles, which could influence the return on the net international investment position. Therefore, the bilateral positions of South Africa are detailed below.

### 5.4.1 Developed economies

In 1999, Anglo-American, Old Mutual and South African Breweries relisted on the London Stock Exchange, followed suit by Dimension Data, Investec and others (Fedderke and Liu, 2002). Direct investment and equity portfolio investment make up the bulk of South African liabilities, whereas equity portfolio assets constitute the majority of South African claims that are held in the United Kingdom (South African Reserve Bank, 2016). The liabilities position is consistent with the observed behaviour of financial agents from developed economies that seek to invest in riskier emerging markets to earn a higher rate of return (Lane, 2016). However, South Africa's external position is relatively symmetric, where equity and direct investment assets and liabilities constitute a similar proportion of each position. As a result, there is less investment in lower risk debt securities when comparison to similar economies.

Gross claims from the USA are almost entirely made up of portfolio equity investment, followed by government and public sector debt, while  $41\%$  of external assets that are held by South Africans in the USA are made up of reserve assets and the remainder are predominantly equity portfolio assets (South African Reserve Bank, 2016). When reserve assets are omitted, there is symmetry in the external position.

European financial hubs have substantial claims on South African assets through direct investment (largely from the Netherlands) or portfolio investment (largely from Luxembourg) (South African Reserve Bank, 2016). However, these financial centres invest more in government public sector debt, as a percentage of the total position, than the United Kingdom or USA.<sup>7</sup> Gross assets that are held by South Africans in Europe tend to be in the form of equity portfolio and direct investment assets, with small portfolio debt and other investment positions, as in the case of the Netherlands and Luxembourg (South African Reserve Bank, 2016).

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<sup>7</sup>There is an outlier in this case, which is Belgium's holding of R 211 billion in government debt (South African Reserve Bank, 2016).

### 5.4.2 Brazil, Russia, India and China

Given the recent emphasis on developing trade links between the so-called BRICS states, it is worth investigating the bilateral investment positions between South Africa and fellow members. In 1990, there was minimal trade between South Africa and the BRIC countries. However, by 2012 it has been suggested that 19% of all South African trade was comprised of transactions with other member nations (Gelb, 2014). Currently China is the largest destination for South African exports and the greatest source of imports. As well as holding the largest bilateral external position in the BRICS group, China is the fifth largest destination of South African direct investment (Gelb, 2014). In 2012 Naspers' share of the internet company Tencent made up 98% of all South African direct investment in China, while the Industrial and Commercial Bank of China purchased a 20% stake in Standard Bank South Africa, which constitutes about 85% of direct investment liabilities held by China during that year (Gelb, 2014).

India is responsible for the second largest bilateral trade with South Africa. It also has the second largest external position, with Tata's \$1.6bn investment in South Africa between 1994 and 2009 (Gelb, 2014). As of 2015 the gross asset position is approximately 2.5% of that of China, whereas the total liabilities is close to 10% of the Chinese position (South African Reserve Bank, 2016). Brazil and Russia have relatively small trade links with South Africa and the external positions have remained relatively insignificant (Gelb, 2014; South African Reserve Bank, 2016).

Gelb (2014) cautions that one should be aware of the relative inconsistencies between each set of bilateral positions recorded in each country's balance of payments. For the largest positions, such as those between the South African partnerships with China and India, the discrepancies as a percentage of the total positions decrease over time (Gelb, 2014).

### 5.4.3 Intra-Africa

As of 2015, financial transactions between South Africa and other African nations accounted for 3.5% of external liabilities and 8.4% of gross assets. The latter of which is largely comprised of direct investment assets (South African Reserve Bank, 2016). In addition, gross liabilities accounted for two thirds of the market value of direct investment assets in Africa. These have primarily been driven by the rapid expansion of South African firms into Africa. Historically, African investment has been dominated by large multinational firms from developed nations. By 2001 most intra-African direct investment was attributed to MTN, Sasol, Standard Bank South Africa and SABMiller (Boso et al., 2016). In subsequent years, however, there has been a rapid expansion primarily driven by financial and telecommunications services. South African firms, such as FNB, Telkom, Dimension Data, Massmart, Nampak and Shoprite have expanded rapidly into Africa, all with a presence in more than 12 other African countries (Boso et al., 2016). As of 2016, over 80 companies listed on the JSE have operations and direct investment positions in other African countries. This position does not occur on the liabilities front, with direct investment, portfolio and other investment liabilities having similar market values (South African Reserve Bank, 2016). On aggregate, South African firms are net creditors to the rest of Africa, largely driven by their direct investment positions.

The economic incentives for South African firms to expand into Africa have largely been driven by the subdued economic growth during recent periods of time, while other African countries, such as Kenya and Ethiopia, are expected to grow by well above 6% over the next four years (International Monetary Fund, 2016).

## 6 Constructing a quarterly estimate of the international investment position

This section describes the construction of quarterly estimates of external assets and liabilities that have been used to derive a measure for returns on these investments. Where in each case, stock estimates published on the international investment position are reconciled to the associated flows data. Stock estimates that are revalued periodically and the assumptions made pertaining to the composition of each portfolio are discussed individually. This methodology is preferred to the traditional interpolation methods, as it includes additional information that theoretically relate to each intermediate position, such as the quarterly flow date and stock pricing indices, whereas linear and cubic spline interpolation do not include any additional information.

South Africa publishes annual international investment position data dating back to 1956, quarterly intentional investment position data since 2014, and quarterly balance of payments data since 1985 (South African Reserve Bank, 2016). However, as valuation effects are predominantly driven by short run phenomena, a quarterly resolution and a substantial sample size is required to estimate the adjustments that arise through returns on external positions. Furthermore, given the capital controls, dual exchange rates and the near autarkic state of the South African economy prior to 1994, the data generating process may have been somewhat inconsistent. In light of this, this sample begins in the fourth quarter of 1985. In what follows we have largely applied the methodology outlined in Lane and Milesi-Ferretti (2001, 2007a) and Milesi-Ferretti (2008) to derive measures for the variables that are used in the subsequent model.

In order to derive quarterly stock estimates the previous law of motion given by equation (3.1) is modified to make use of the existing annual estimates. The annual external positions are substituted directly into the fourth quarter of each year as these estimates correspond to closing balances of each year. Subsequently, values are created for quarters one to three, using all available information. The valuation term is assumed to be proportional to the preceding period's stock and a valuation index, as well as the ratio of the mean of the closing prices of each flow, while the other adjustment term is assumed to be zero. Where there are no fluctuations in the asset's nominal price, the closing value is equal to the sum of the previous period's asset stock and the flow of the asset during the period, such that,

$$PX_{t+1}^i = PX_t^i + FX_{t+1}^i \quad . \quad (6.1)$$

When considering fluctuations in asset prices and exchange rates, the index is no longer constant, which causes revisions in the previous stock prices. If we assume that there is a price index  $I_t$  that captures the changes in prices of the asset under consideration. The valuation index,  $I_t$  is constant and equal to 1,

in the previous case. When relaxing this assumption, the law of motion is given by:

$$PX_{t+1}^i = \frac{I_{t+1}}{I_t} PX_t^i + \frac{I_{t+1}}{\bar{I}_{t+1}} FX_{t+1}^i \quad (6.2)$$

where  $I_t$  is the closing price of period  $t$  and  $\bar{I}_t$  is the mean price during period  $t$ . The valuation effect of the previous asset stock is therefore captured by the percentage change in the stock price multiplied by the previous position,

$$VX_{t+1} = \frac{I_{t+1} - I_t}{I_t} PX_t^i \quad (6.3)$$

whereas the valuation effect of the flow is similarly captured by revaluing the average price of the flow to the closing price. Lane and Milesi-Ferretti (2001, 2007a) applied this methodology when no regular stock estimates were available, making use of an initial stock estimate and iterating forward (or alternatively, they also make use of a recent estimate and iterating in reverse). However, the methodology is only applied for quarters one to three in each year as reliable stock estimates are available for each fourth quarter observation. As a direct result of this structure, measurement errors of flows and the associated indices are not carried throughout the whole period and divergence from official stock levels can only last for the interim interpolated values.

## 6.1 Mapping stocks to flows

Asset classes are dealt with individually in order to obtain as close an estimate as possible to reality. For instance, corporate debt and equity markets have differing dynamics and should not be treated in the same manner. Therefore, portfolio investment is disaggregated into debt and equity type securities. Tables 2 and 3 break down the South African balance of payments and international investment position into the similar subgroups of gross assets and liabilities.

Each stock of portfolio investment is separated into the sector type issuing the security, namely public corporations, banking sector and private non-banking sector, with the additional liability subcategory of general government. These categories are further subdivided into debt and equity type security holdings. All equity and debt securities are grouped in order to arrive at measures of total portfolio equity and portfolio debt holdings for external assets and liabilities. For portfolio investment flows in the financial account there are subcategories for net incurrence of external liabilities and net acquisition of external assets, which are broken down into subcategories for equity and investment fund shares and debt securities respectively. These four subcategories map directly to the four previously outlined aggregated stock variables. Direct investment assets and liabilities have direct mappings to the international investment position and, therefore, no aggregation or changes need to occur. Similarly, financial derivatives and other investment assets have straightforward mappings. Financial derivatives are not revalued as there is no clear way of adjusting historical stock values of derivatives to their current market values.<sup>8</sup> Reserve assets also have a direct mapping between the stock and flow values.

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<sup>8</sup>Lane and Milesi-Ferretti (2001, 2007a) make no valuation adjustments to the stocks of financial derivatives in any country and simply include stocks and cumulate flows when available.

The signs for flow data are based on outflows and inflows of capital where the former is denoted by a negative sign and the latter a positive (South African Reserve Bank, 2016). Therefore, an increase in the stock of external liabilities corresponds to a positive flow in the financial account, whereas an increase in the stock of external assets corresponds to a negative flow in the financial account (South African Reserve Bank, 2016).

## 6.2 Revaluation indices

In order to derive an accurate measure of the price of each position, one would need the same resolution data for each position. As this information is not available several assumptions need to be made to proxy the evolution of asset prices, which all stem from the assumption that a given price index accurately captures the price evolution underlying each portfolio. These assumptions are listed below in table 1, followed by a motivation of each choice as well as other considerations. These are the real effective exchange rate, the JSE all share index, a bilateral trade weighted index and the Morgan Stanley Capital International World index.

Table 1: Indices

Type	External assets	External liabilities
<b>Financial account</b>		
Direct investment	Bilateral trade weighted index	JSE All Share
Equity portfolio	Bilateral trade weighted index	JSE All Share
Debt portfolio	REER	Not adjusted
Financial derivatives	Not adjusted	Not adjusted
Other investment	REER	Not adjusted
Reserve assets	REER	Not applicable

### 6.2.1 Real effective exchange rate (REER)

Lane and Milesi-Ferretti (2007a) note that debt should be revalued based on the underlying currency composition of debt holdings. Therefore, all debt asset adjustments are in terms of South Africa's real effective exchange rate, which is measured against a basket of South Africa's 20 largest trading partners, adjusted for inflation differences (South African Reserve Bank, 2014a). Lane and Milesi-Ferretti (2008) illustrate that the composition of external portfolios is affected by bilateral factors, including trade linkages. Therefore, the use of the real effective exchange rate, as measured by the South African Reserve Bank, is appropriate for debt-type valuation adjustments. A real depreciation in the Rand implies an increase in the price of foreign debt assets, therefore, the debt revaluation should be proportional to the real exchange rate. External debt liabilities, given by the portfolio debt and other categories, are not adjusted as the majority of debt issued from South African agents is denominated in domestic currency.

### 6.2.2 JSE All Share Index

It is assumed that external equity portfolio and direct investment liabilities are invested with weights equal to that of the JSE All Share index. Therefore, an

increase in the JSE All Share Index corresponds to a proportional increase in the value of the stock of external equity based liabilities and a similar adjustment is made for a decrease in the value of the stock of external equity liabilities. On 24 June 2002 the official indices changed from the JSE Actuaries indices to the FTSE/JSE indices that are in use today. Daily historical data was backdated to 1995 using the current FTSE methodologies, whereas the monthly and quarterly mean indices were backdated to an earlier point. As the sample begins in 1985 the monthly series is used to create the mean and closing quarterly series.

This assumption is motivated by modern portfolio theory and appears acceptable when considering equity portfolio securities. However, this methodology may not be appropriate in the case of direct investment. If direct investment is largely comprised of greenfield investment, the dynamics of such firms may not be directly related to those listed on the stock market (Lane and Milesi-Ferretti, 2007a). Furthermore, the category includes liquid assets held by the firm, often in cash, and holdings will not be directly related to the JSE index. Methods for addressing these concerns are discussed below.

### **6.2.3 Morgan Stanley Capital International World index**

For emerging market economies Lane and Milesi-Ferretti (2001, 2007a) assume that each country invests its portfolio equity and direct investment asset holdings in a “world” portfolio with weights equal to the Morgan Stanley Capital International world index, hereinafter referred to as MSCI world index. The composition of the world index places a 60.1% weight on USA equity securities and a 6.65% weight in equity securities listed in the United Kingdom. These weights are substantially different from previously mentioned recent South African portfolio equity and direct investment asset holdings as well as bilateral trade relationships. For this reason, we create a trade weighted index that is described below.

### **6.2.4 Bilateral trade weighted index**

To overcome the shortcomings of the composition of the MSCI world index an additional index is created from stock market indices of the five major trade partners. This is motivated by the previously noted finding of Lane and Milesi-Ferretti (2008) that external positions are affected by bilateral trade linkages. The included regions are the United Kingdom, Euro area, USA, China and Japan and the FTSE, DAX, DOW Jones, Shanghai and Nikkei indices respectively. The German DAX index is the largest in Europe and is used as a proxy for all European indices. This is justified by the increasing bond and equity market integration since the formation of the common currency area (Bartram et al., 2007; Fratzscher, 2002). In each case we use the corresponding weight in the construction of the real effective exchange rate. The Shanghai index resumed operations after a lengthy closure in December 1990 and so the index is not available for the full sample. To overcome this issue the remaining four countries constitute the index between the fourth quarter of 1985 and the first quarter of 1991. After this period of time, the Shanghai index is included and the indices are rebalanced to align in the first quarter of 1991.

A comparison of the MSCI world index and the bilateral trade weighted index is illustrated in figure 6.1, where the bilateral trade index is adjusted to have the same initial value as the MSCI world index. From this result we note

that the trade weighted index appears to respond to most shocks observed in the MSCI World index.

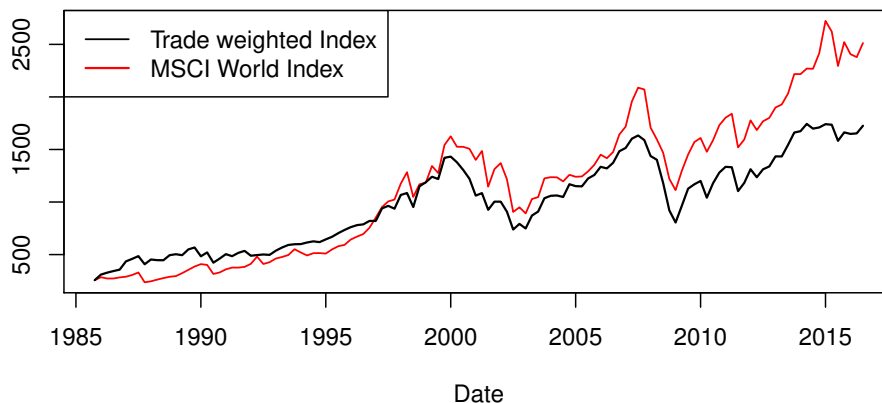


Figure 6.1: Comparison of MSCI World index and bilateral trade weighted index.

## 7 The final data

The model makes use of time series measures of external assets and liabilities, exports and imports of goods and services and net household wealth. In this section the estimation process and outcomes of the quarterly external assets and liabilities series are described. Thereafter, additional details of the external trade series and household wealth data are presented.

### 7.1 External assets and liabilities estimation

The interpolation methodology previously outlined is used to obtain initial estimates of each subcomponent of external assets and external liabilities. The resulting series are aggregated to form each aggregate position. Some large changes in positions are clearly visible, mostly between the third and fourth quarter of certain years, which is attributed to the difference between the final interpolated value and the annual stock estimate in the fourth quarter. This effect is largest for the direct investment class and affects external assets more than external liabilities.

These sharp increases may stem from the fact that the quarterly flows and revaluation terms (based on respective indices) may struggle to capture the dynamics in the annual stock estimates. Therefore the bulk of adjustment in certain years is reflected by the annual estimate. As previously stated, this problem is the largest for direct investment stocks. This category is substantially more difficult to value than portfolio and debt type assets as the asset is not openly traded and is often recorded at book value or partial market value (Lane and Milesi-Ferretti, 2007a; Patterson, 2004). In 2004 South Africa report partial market value estimates for direct investment positions, which are derived

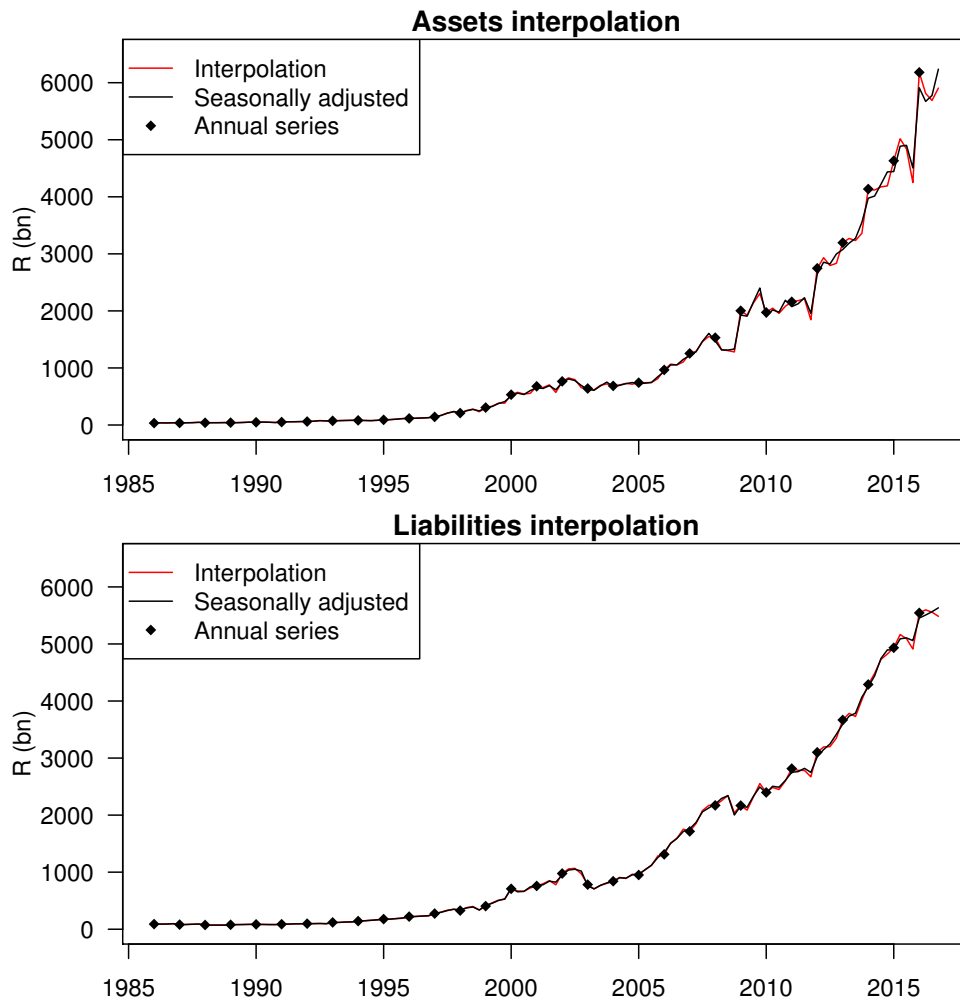


Figure 7.1: Final external position series - opening balances

from the book value data that is contained in balance sheets (Patterson, 2004). As previously mentioned Gelb (2014) compared the external positions between South Africa and other BRICS countries and found large discrepancies between each country's recordings of bilateral direct investment positions. As a result, these values could be subject to abnormally large revisions in order to compensate for the lack of complete market value estimates. For instance, the South African Reserve Bank have made substantial revisions of official data including GDP, consumption expenditure and personal disposable income statistics (Van Walbeek, 2006). Given the challenges that official reporting agencies face when seeking to derive accurate market value adjustments of direct investment stocks, it is understandable that this subcategory is subject to a similar caveat.

The extent of these revisions is potentially illustrated by the large increase in external assets between the opening balances in 2014 and 2015, which are

displayed in figure 7.1.<sup>9</sup> It is evident that the second quarter opening balance is higher than the first, meaning that the quarter’s flow and valuation adjustment resulted in a small increase in external assets. This is followed by minimal changes that arose during the second quarter, before a small decrease arose in the third. In contrast with these small changes, the fourth quarter estimate is substantially larger. Note also that the explicit jump only considers the difference between the fourth quarter opening estimate and the opening value of the annual series. If the underlying change between each year was relatively smooth, and the flow and price indices tracked this over the year, the bulk of the change would not fall into the last quarter and would be evenly distributed throughout the year. However, if the flow and index measures contained little information regarding the change in the annual estimate the final quarter difference would contain the majority of the correction. The result of this is that there is a sharp increase and large return in external assets during the fourth quarter. This is evident in the first two panes of figure 9.2, which illustrates the quarterly return series for each position.

An additional reason for the annual information not being included in the relevant flow and index information of each quarter is that the methodology proxies direct investment asset prices through publicly traded portfolio equity investment indices. Lane and Milesi-Ferretti (2007a) note that the two asset price dynamics could be divergent in certain cases, however, there is no clearly preferable alternative to this method.

In order to address fourth quarter return volatility, the series of direct investment assets is seasonally adjusted. This results in the new series not being identical to the annual series, with regards to the opening balance for each year. Furthermore, each aggregate position has been seasonally adjusted to purge similar artefacts from the remaining subcategories. The results are presented in figure 7.1, where the red dashed lines illustrate the unadjusted series, which also excludes the adjustment to direct investment. The black lines correspond to the series with the two adjustments that are described above. Note that the red line always passes through each dot of the annual series.

A pseudo bias measure is created to consider deviations from a smooth evolution between each annual estimate. Explicitly, this measure considers deviations from the linear interpolation between the annual estimate of each position and is normalised by the interpolated series. This is calculated for each final data series according to,

$$bias = \frac{1}{T} \sum_{s=1}^T \frac{Z_s - \bar{Z}_s}{\bar{Z}_s} \quad ,$$

where  $T$  is the number of observations. The external asset estimates have a bias of  $-1.5\%$ , whereas the external liabilities have a bias estimate of  $-0.6\%$ . Both of these values are fairly low in magnitude and the negative sign is illustrative of the sharp increases in certain final quarters, as the estimated series tends to lie below the linear interpolation. Hence, the seasonal adjustments are responsible for a near negligible contribution to the bias in each case. Therefore, the measure derived from this scheme would appear to have little systematic

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<sup>9</sup>As previously mentioned, the data was calculated using closing balances. Figure 7.1 is graphed using opening balances.

deviation from the annual series.

The standard deviation of the unadjusted assets and liabilities series, calculated as the square root of the square of each term in the sum, is approximately 0.09 and 0.08. It declines by 0.02 for each seasonally adjusted series.

## 7.2 External trade and household wealth data

The external trade component consists of nominal exports and imports of goods and services. Household net wealth is only publicly available directly at an annual frequency. However, the ratio of net wealth to disposable income are available at a quarterly frequency with seasonal adjustments. Subsequently the quarterly net household wealth is backed out by multiplying the two series. The respective codes for each series published in the South African Reserve Bank (2016) quarterly bulletin are provided in table 3.

## 8 Model specification

Stationary measures of the net foreign asset portfolio returns, differenced net exports and cyclical external imbalances (denoted by  $r_t$ ,  $\Delta nx_t$  and  $nxa_t$  respectively) are derived from external assets, external liabilities, nominal exports, nominal imports and household net wealth. These variables are then used in a Bayesian vector autoregressive model with stochastic volatility to generate impulse functions that are analysed.

### 8.1 Variable creation

External assets, external liabilities, nominal exports and nominal imports, denoted by  $Z = \{A, L, X, M\}$  respectively, are normalised with respect to household wealth. These variables are denoted by  $\hat{Z}_t = Z_t/W_t$  where  $W_t$  is the household wealth at the beginning of period  $t$ . Furthermore, long run trends of each variable, normalised by the long run household net wealth, are similarly denoted by  $\bar{Z}_t$ .

#### 8.1.1 Return on the NFA portfolio

The capital accumulation identity previously stated in equation (2.8) is rewritten in terms of an opening balance time convention, as opposed to the closing balance convention used in section 2.3.<sup>10</sup> The net foreign asset position is once again defined as the difference between external assets and liabilities,  $NA_t = A_t - L_t$ . Net exports, defined as the difference of the preceding period's exports of goods and services and imports of goods and services, is given by  $NX_t = X_t - M_t$ . Similarly, the net return,  $R_{t+1}$ , is the return on the net foreign asset position during the respective quarter. The subsequent capital accumulation identity proposed by Gourinchas and Rey (2007a) is,

$$NA_{t+1} = R_{t+1}(NA_t + NX_t) \quad . \quad (8.1)$$

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<sup>10</sup>The change in timing is handled similarly to figure 7.1, where the opening balance of period  $t + 1$  is equal to the closing balance of period  $t$ .

The identity is assumed to hold in the long run, however, short run deviations could theoretically occur due to unilateral transfers, capital account transactions and changes in net errors and omissions. The respective return on assets and liabilities is simply the ratio of adjacent periods given by  $R_{t+1}^a \equiv A_{t+1}/A_t$  and  $R_{t+1}^l \equiv L_{t+1}/L_t$ . In the presence of possible deviations from the capital accumulation identity, as well as the substantial measurement error associated with external positions, the net return is approximated by a weighted sum in each period of each return,

$$R_{t+1} = \gamma^a (R_{t+1}^a - 1) - \gamma^l (R_{t+1}^l - 1) + 1 \quad , \quad (8.2)$$

where weights  $\gamma^a$  and  $\gamma^l$  are constant and proportional to each external position.

### 8.1.2 Defining cyclical external imbalances

Two cases of equation (8.1) are considered in terms of the respective normalised variables. The first specification corresponds to a short run stochastic economy, whereas the second relates to a long run steady state economy, which approximates a balanced growth path.

The capital accumulation identity corresponding to the stochastic variables that define the nature of the economy are derived after dividing equation (8.1) by net household wealth,  $W_t$ , and substituting in the definitions of  $NA_t$  and  $NX_t$ , such that,

$$\hat{A}_{t+1} - \hat{L}_{t+1} = \frac{R_{t+1}}{\Gamma_{t+1}} (\hat{A}_t - \hat{L}_t + \hat{X}_t - \hat{M}_t) \quad .$$

where  $\Gamma_{t+1} = W_{t+1}/W_t$  is the growth in net household wealth during period  $t+1$ . Similarly, the long run case is defined in terms of the trend of each variable normalised by the long run trend in net household wealth,  $\bar{Z}_t$ ,

$$\bar{A}_{t+1} - \bar{L}_{t+1} = \frac{\bar{R}_{t+1}}{\bar{\Gamma}_{t+1}} (\bar{A}_t - \bar{L}_t + \bar{X}_t - \bar{M}_t) \quad .$$

Here  $\bar{\Gamma}_{t+1}$  corresponds to the long run growth in wealth, whereas  $\bar{R}_{t+1}$  corresponds to the trend component of the net return on the external portfolio during period  $t+1$ .

In what follows, we define  $\epsilon_t^z \equiv \ln(\hat{Z}_t/\bar{Z}_t)$ ,  $\epsilon_t^{\Delta w} \equiv \ln(\hat{\Gamma}_t/\bar{\Gamma}_t)$  and  $\hat{r}_t \equiv \ln(R_t/\bar{R}_t)$ , as the deviations from the respective trends. It is assumed that each of these variables is stationary and small, such that  $|\epsilon_t^z| \ll 1$ ,  $|\epsilon_t^{\Delta w}| \ll 1$  and  $|\hat{r}_t| \ll 1$ . This allows us to decompose the log of each variable into a sum of trend and stochastic components, such that  $\ln\hat{Z}_t = \ln\bar{Z}_t + \epsilon_t^z$  in each period  $t$ .

The cyclical net assets and cyclical net exports are defined as the weighted combinations of the stationary components of assets and liabilities, as well as the exports and imports, respectively:

$$na_t \equiv \mu_t^a \epsilon_t^a - \mu_t^l \epsilon_t^l \quad (8.3)$$

$$nx_t \equiv \mu_t^x \epsilon_t^x - \mu_t^m \epsilon_t^m \quad (8.4)$$

with weights given by,

$$\mu_t^a = \frac{\bar{A}_t}{\bar{A}_t - \bar{L}_t} \quad \mu_t^l = \mu_t^a - 1 \quad (8.5)$$

$$\mu_t^x = \frac{\bar{X}_t}{\bar{X}_t - \bar{M}_t} \quad \mu_t^m = \mu_t^x - 1 \quad . \quad (8.6)$$

Over the long run, each variable is assumed to follow a shared trend,  $\mu_t$ , such that  $\bar{Z}_t = \bar{Z}\mu_t$ , where  $\bar{Z}$  is each variables' individual scaling factor. In other words, the trends of normalised assets, liabilities, exports and imports are common up to a constant multiple. Subsequently, the trend terms,  $\mu_t$ , in the numerator and denominator cancel eachother out, thus purging the dynamics from each coefficient. Consequently, all weights are time invariant and the index subscript is dropped.<sup>11</sup> Theoretically this condition may be used to describe the case where all variables are driven by the same international trends in the internationalisation of capital markets and globalisation, which is also clear in the context of each pair.<sup>12</sup>

The aforementioned weights may then be used to determine coefficients  $\gamma^a$  and  $\gamma^l$ , which are used to calculate the net return defined in equation (8.2). The weight of the return on liabilities,  $\gamma^l$ , is normalised to unity, whereas the return on assets coefficient is chosen to be the ratio of the asset weight to the liability weight, such that  $\gamma^a = \mu^a/\mu^l$ . Therefore, the net return reflects the magnitude of each portfolio return during the sample, as well as each period return on assets and liabilities.

Therefore, the change in cyclical net exports,  $\Delta nx_{t+1}$ , cyclical external imbalances,  $nxa_t$ , and return during the current period,  $r_t$ , are given by,

$$\Delta nx_{t+1} = |\mu^x| \Delta \epsilon_{t+1}^x - |\mu^m| \Delta \epsilon_{t+1}^m - \epsilon_{t+1}^{\Delta w} \quad (8.7)$$

$$nxa_t = |\mu^a| \epsilon_t^a - |\mu^l| \epsilon_t^l + |\mu^x| \epsilon_t^x - |\mu^m| \epsilon_t^m \quad (8.8)$$

$$r_{t+1} = \frac{|\mu^a|}{\mu^a} \hat{r}_{t+1} \quad . \quad (8.9)$$

Equation (8.7) corresponds to a trend stationary version of the net exports definition stated in equation (8.4), where  $\Delta nx_t$  increases in exports and decreases in imports. The third term is an adjustment for the change in wealth between periods, which is included through the normalisation to net household wealth.

Equation (8.8) is an approximation of (8.1.2) about it's trend, given by (8.1.2). The cyclical external imbalances are increasing in external assets and exports, and decreasing in external liabilities and imports. As this variable includes information relating to the external position, it is a more extensive measure of external sustainability than an equivalent measure of the current account about a long run trend (Gourinchas and Rey, 2007a).

Finally, the sign of the stationary net return is corrected, such that returns rise with an increase in external assets and decreases with an increase in external liabilities.

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<sup>11</sup>This condition would also be satisfied if the pairs of assets and liabilities, as well as exports and imports, share their own respective trends.

<sup>12</sup>In this instance, it would be peculiar if the forces driving the increasing external asset stock did not affect the external liability stock.

## 8.2 Stochastic Volatility

To explicitly model the properties of the respective variables, we incorporate a stochastic volatility specification in the vector autoregressive model, which allows for a non-constant variance covariance matrix,  $\Sigma_t$ . The purpose of this is to account for the domestic agents' incentive to hold foreign assets to derive diversification benefits that may give rise to superior risk-adjusted returns.

The univariate geometric random walk stochastic volatility model includes a stochastic innovation to the conditional variance of the error term, given by  $\sigma_t^2$ .<sup>13</sup> The resulting model is written in terms of the observed error process,  $u_t$ , the conditional variance and a standard normal innovation,  $e_t$ ,

$$u_t = \sigma_t e_t \quad (8.10)$$

$$\log \sigma_t = \log \sigma_{t-1} + \eta_t \quad (8.11)$$

where,

$$e_t \sim N(0, 1) \quad (8.12)$$

$$\eta_t \sim N(0, W) \quad (8.13)$$

This characterisation of the error term allows for clusters in the volatility, which has been empirically observed in financial returns (Campbell, 1987; Glosten et al., 1993). However, this improved specification of shock dynamics is obtained at a cost, as for each error term the model includes two innovations and the estimation of an unobserved process. This is handled with the aid of a quasi-likelihood estimation procedure that utilises Markov Chain Monte Carlo sampling methods (Jacquier et al., 2002; Kim et al., 1998; Melino and Turnbull, 1990).

## 8.3 Vector autoregressive framework

A vector autoregression, hereinafter referred to as VAR, is used to analyse the intertemporal relations between the net return on external positions, the change in net exports and the cyclical external imbalances as initially proposed in the seminal framework of Sims (1980). This framework is extended to model the non-constant variance covariance matrix using the methods that are proposed in Del Negro and Primiceri (2015); Primiceri (2005). As the estimates of an unobserved process are required in the evaluation of the likelihood function, we make use of a Bayesian approach that treats all of the parameters as random variables. In this section, the general specification of the model is presented before we address issues relating to Bayesian estimation and stochastic volatility.

The dependent vector of interest is given by  $\mathbf{y}_t = [r_t, \Delta n x_t, n x a_t]'$ , the same ordering as Gourinchas and Rey (2007a). The structural form of the model may then be stated as,

$$A\mathbf{y}_t = B_1\mathbf{y}_{t-1} + \dots + B_p\mathbf{y}_{t-p} + \mathbf{u}_t \quad (8.14)$$

where  $\mathbf{u}_t \sim N(0, \Sigma\Sigma')$  (Nakajima et al., 2011). When abstracting from stochastic volatility, the covariance matrix of the error term,  $\Sigma$ , is assumed to be a diagonal matrix given by,

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<sup>13</sup>Note that the coefficient of  $\sigma_t^2$  is unitary. Therefore, the log evolution of volatility follows a random walk process.

$$\Sigma = \begin{bmatrix} \sigma_{1,1} & 0 & \dots & 0 & 0 \\ 0 & \sigma_{2,2} & 0 & \dots & 0 \\ \vdots & & \ddots & & \vdots \\ & & & & 0 \\ 0 & 0 & \dots & 0 & \sigma_{nn} \end{bmatrix} .$$

It is worth noting that each shock is drawn from a standard normal distribution and is multiplied by an additional diagonal matrix of fixed standard deviations.

The constraint matrix,  $A$ , is given by a lower Cholesky decomposition,

$$A = \begin{bmatrix} a_{1,1} & 0 & \dots & 0 \\ a_{2,1} & a_{2,2} & 0 & \dots & \vdots \\ \vdots & & \ddots & & \\ & & & & 0 \\ a_{n,1} & a_{n,2} & \dots & a_{n,n-1} & a_{n,n} \end{bmatrix} .$$

Pre-multiplying each side by  $A^{-1}$  results in an expression for  $\mathbf{y}_t$ ,

$$\mathbf{y}_t = \tilde{B}_1 \mathbf{y}_{t-1} + \dots + \tilde{B}_p \mathbf{y}_{t-p} + A^{-1} \Sigma \boldsymbol{\varepsilon}_t , \quad (8.15)$$

where  $\tilde{B}_j = A^{-1} B_j$  for  $j \in 1, \dots, p$  and  $\boldsymbol{\varepsilon}_t \sim (0, 1)$ . The above equation may be reduced to a first order companion form with appropriately stacked coefficient and regressor matrices, given by  $X_t$  and  $\beta$ , respectively. The stacked regressor matrix could then be defined as,

$$X_t' = I_n \otimes [1, y_{t-1}', \dots, y_{t-k}'] , \quad (8.16)$$

where  $\otimes$  denotes the Kronecker product. This allows us to arrive at the corresponding first order companion form,

$$\mathbf{y}_t = X_t \beta + A^{-1} \Sigma \boldsymbol{\varepsilon}_t . \quad (8.17)$$

Apart from attributing each shock to an initial source, this decomposition also facilitates realistic assumptions on the interactions between the three variables and each shock. Firstly, the net return is not contemporaneously affected by the change in net exports or the cyclical external imbalances. Furthermore, the change in net exports is not contemporaneously affected by the cyclical external imbalances. This is natural, as one could not expect an improvement in the trade balance to significantly affect global and domestic asset prices in order for returns to increase substantially. Furthermore, the trade balance typically responds to changes in the exchange rate with a substantial delay and so this channel also should not be large. The current cyclical external imbalances should also not alter the cyclical return on the net foreign asset portfolio (in a way that is similar to how returns affect the cyclical net imbalances).

### 8.3.1 Bayesian structural VAR with stochastic volatility

The previous theoretic specification in equations (8.14) and (8.17) are adjusted so that the variance covariance matrix,  $\Sigma$ , is also allowed to vary with time. The regressors,  $\mathbf{y}_t$ , and error term,  $\boldsymbol{\varepsilon}_t$ , are unchanged. Therefore, equation (8.14) is rewritten with the additional time subscripts,

$$A \mathbf{y}_t = B_1 \mathbf{y}_{t-1} + \dots + B_p \mathbf{y}_{t-p} + \mathbf{u}_t \quad (8.18)$$

The first order companion form, as in equation (8.17), is similarly created, where  $\beta$  also includes a time subscript as both of  $B_j$  and  $A_j$  for  $j = 1, \dots, p$  are time variant (Primiceri, 2005),

$$\mathbf{y}_t = X_t \beta_t + A_t^{-1} \Sigma_t \varepsilon_t \quad . \quad (8.19)$$

Each coefficient matrix,  $\beta_{i,t}$  and the constraint matrix  $A_t$ , evolve according to element-wise random walk processes, whereas each element of the variance covariance matrix,  $\log \Sigma_t$ , evolves according to a geometric random walk process (Nakajima et al., 2011; Primiceri, 2005). For ease of specification, the  $\beta_t$ ,  $A_t$  and  $\Sigma_t$  are reformulated as stacked vectors. The constraint matrix, excluding the unitary diagonal elements, is given by  $\hat{A}_t = (a_{2,1,t}, a_{3,1,t}, \dots, a_{n,n-2,t}, a_{n,n-1,t})'$ . Similarly, the diagonal matrix  $\Sigma_t$  is restated as the vector  $\hat{\Sigma}_t = (\sigma_{1,1,t}, \sigma_{2,2,t}, \dots, \sigma_{n,n,t})'$ . The coefficient matrix  $\beta_t$  is also reformulated into a vector  $\hat{\beta}_t$ , the structure of which depends on the amount of lags used, denoted by  $p$ . These processes are discussed individually and are given by,

$$\hat{\beta}_t = \hat{\beta}_{t-1} + \nu_t \quad (8.20)$$

$$\hat{A}_t = \hat{A}_{t-1} + \zeta_t \quad (8.21)$$

$$\log \hat{\Sigma}_t = \log \hat{\Sigma}_{t-1} + \eta_t \quad (8.22)$$

The choice of a random walk process leads to a lower parametrisation of the model as opposed to using stationary processes, such as an autoregressive process (Nakajima et al., 2011). For example, each element in a given lag coefficient matrix only requires the variance of the error to be estimated. By stacking each vector of innovations, the overall distribution of disturbances is given by equation (8.23). The diagonal structure reduces further the parametrisation of the model and the innovation specific variance covariance matrices,  $V_B$ ,  $V_A$  and  $V_\sigma$ , are assumed to be positive definite.

$$\mathbb{V} \begin{pmatrix} \varepsilon_t \\ \nu_t \\ \zeta_t \\ \eta_t \end{pmatrix} \sim N \left( 0, \begin{pmatrix} I_n & 0 & 0 & 0 \\ 0 & V_B & 0 & 0 \\ 0 & 0 & V_A & 0 \\ 0 & 0 & 0 & V_\sigma \end{pmatrix} \right) \quad (8.23)$$

Each element of  $\hat{\beta}_t$  follows a random walk process, often set with a lower variance prior than those associated with  $\hat{\Sigma}_t$  or  $A_t$  (Nakajima et al., 2011). As measuring the drift of coefficients over time is not objective of this paper, we set  $\nu_t = 0$ .

As previously stated, each element of the variance covariance matrix,  $\Sigma_t$ , follows a geometric random walk. This process ensures positive standard deviations and allows for typical clustering of volatilities seen in the univariate case. As this matrix is diagonal, each volatility evolves separately and is unobserved (Primiceri, 2005).

The lower structure of the  $A_t$  matrix makes use of a recursive identification scheme for the system of equations (Nakajima et al., 2011). Additionally, it models the interactions between innovations and the associated volatilities of each variable. As it is non-constant, this structure allows for the relations between each innovation to influence the volatility over time (Primiceri, 2005).

The estimation process makes use of a Gibbs sampling Markov Chain Monte

Carlo algorithm that proceeds according to the following steps (Nakajima et al., 2011; Primiceri, 2005). First, parameters are initialised according to OLS estimates from a sub-sample. Second, the conditional posterior distribution of  $\hat{\beta}$  given  $A$ ,  $\hat{\Sigma}$ ,  $V_B$  and  $\mathbf{y}_t$  is sampled. Third, the conditional posterior distribution of  $V_B$  given  $\hat{\beta}$  is sampled. Fourth, the same procedure for  $A$  is performed. Fifth, the conditional posterior of  $V_A$  is sampled given  $A$ . Sixth, The previous two steps are repeated for  $\hat{\Sigma}$  and its covariance matrix  $V_\sigma$ . Once this is complete, the algorithm returns to step two (Nakajima et al., 2011). To ensure that we make draws from the correct posteriors of model parameters, we make use of the updated algorithm outlined in Del Negro and Primiceri (2015).

### 8.3.2 Prior distributions

As a Bayesian estimation methodology is used, prior distributions of each parameter are required for each coefficient and each element in the variance covariance matrix. The prior assumptions are the same as those in Primiceri (2005). The prior estimates for each parameter, variance and covariance are created from an OLS specification of the corresponding structural model with constant coefficients that relate to a subsample of 40 observations. Each element in the  $\beta$  matrix is assumed to be normal with a mean from the OLS estimation and variance of four times the OLS variance (Primiceri, 2005). The same specification is used for the  $A$ . The log stochastic volatility is assumed to be distributed normally with the mean of each constant variance in the OLS estimation. This is comparable to the univariate stochastic volatility model that is outlined in section 8.2. The prior specification of the variance matrices for the remaining processes are assumed to be independent inverse-Wishart distributions (Primiceri, 2005).

## 8.4 Impulse response analysis

Each variable is modelled as a stationary variable. In particular, the returns,  $r_t$ , correspond to the observed returns,  $R_t$ . The cyclical change in net exports,  $\Delta nx_t$ , is a stationary equivalent of the level first difference of the net exports,  $\Delta NX_t$ . Following Gourinchas and Rey (2007a), log-linearisation of equation (8.1) about its trend results in,

$$nxa_{t+1} \approx \frac{1}{\rho} nxa_t + r_{t+1} + \Delta nx_t \quad (8.24)$$

where  $\rho$  is a constant discount rate. This equation suggests that the following period cyclical external imbalances, which correspond to the right hand side, are proportional to the stationary returns and the cyclical change in net exports. The level of the net foreign asset position could then be increased by a corresponding increase in the returns or a positive change in net exports. This intertemporal relationship is the focus of the impulse response analysis.

## 9 Empirical results

The reporting on the results is broken down into two subsections. The first of these considers the estimation for the model that includes  $R_t$ ,  $\Delta nx_t$  and  $nxa_t$ , after which the three variable VAR model is estimated.

## 9.1 Estimation of cyclical net external imbalances

As previously noted each variable is normalised with respect to household wealth, such that  $\hat{Z}_t = Z_t/W_t$  for each  $Z \in \{A, L, X, M\}$ . To ensure that these variables are stationary, unit root tests are performed as per Dickey and Fuller (1979, 1981). The unit root null hypothesis is not rejected at the 5% level for the normalised assets and liabilities series. However, this statistic is rejected at the 5% level for exports and imports after we include trend and constant terms, which implies that it could be difference stationary. In addition, a test on the first difference of assets and liabilities result in each null being rejected. This would suggest that all series would appear to incorporate a stochastic or deterministic trend. Subsequently, each return for gross assets and liabilities are created as previously described and are found to be stationary.

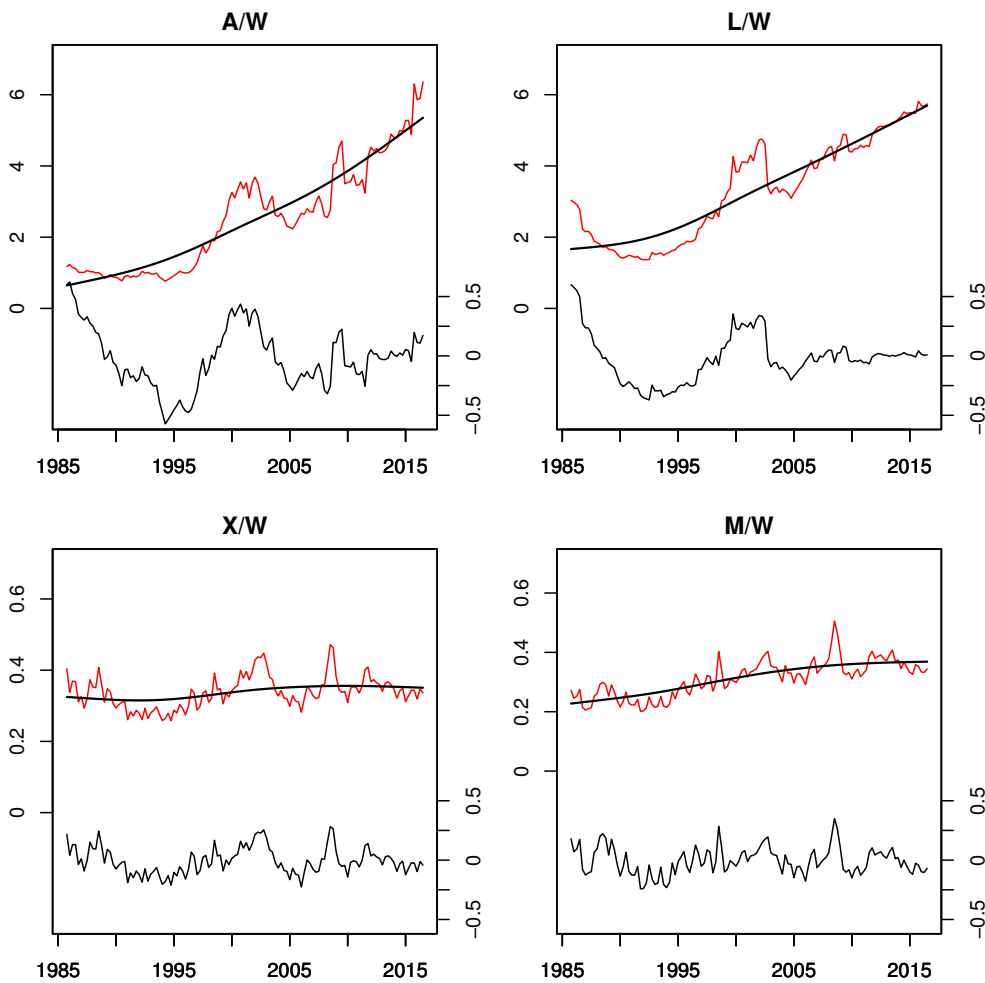


Figure 9.1: Trend decomposition of  $\hat{A}_t$ ,  $\hat{L}_t$ ,  $\hat{X}_t$ ,  $\hat{M}_t$ . The actual and trend variables are plotted in red and black on the left axis. The stationary component below corresponds to the right axis.

A natural way to identify the long run stochastic trend in economic variables is to use a Hodrick and Prescott (1980, 1997) filter. In this case each stochastic trend is extracted with the aid of the filter and the  $\epsilon_t^z$  terms are subsequently created according to the previous definitions. The actual, stationary and trend components are plotted in figure 9.1 for assets, liabilities, exports and imports.

Figure 9.1 illustrates a strong upward trend in the normalised assets and liabilities series for the duration of the sample. Additionally, imports and exports relative to wealth have increased moderately. This is most pronounced between 1995 and 2005, following the full liberalisation of the external accounts and the abolition of the dual exchange rate mechanism. The  $\epsilon_t^z$  terms deviate from their trends during the beginning period for each variable and are relatively large. Dickey and Fuller (1979, 1981) unit root tests reject the null of a unit root in each case.

This procedure is also used to create  $r_t$  and  $\epsilon_t^{\Delta w}$ , even though each vari-

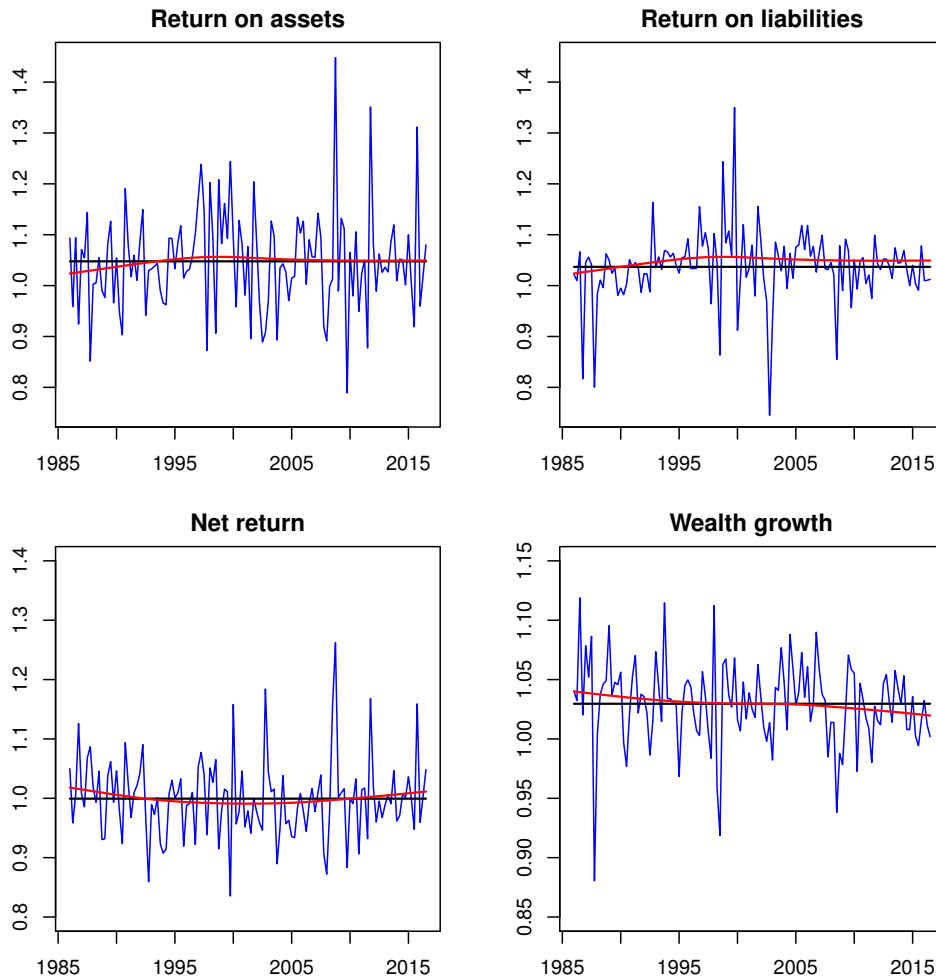


Figure 9.2: Return on assets and liabilities, net return and wealth growth. The actual series, sample mean and trend is plotted in blue, black and red respectively.

able's components are stationary.<sup>14</sup> A similar breakdown to that which has been presented before is plotted in figure 9.2 for each return and includes the change in net household wealth. This is discussed following the creation of weights  $\gamma^a$  and  $\gamma^l$ .

It is important to note that a non-standard smoothing value has been used. In order to include as much information as possible in the cyclical component, whilst ensuring that the  $\epsilon_t^z$  terms are stationary, the parameter value used is  $\lambda \approx 133108$ , which corresponds to the removal of cycles with a periodicity of longer than 30 years. This value is consistent with the one that is used in Gourinchas and Rey (2007a) and also partially alleviates the end point problem associated with the Hodrick and Prescott (1980, 1997) filter.<sup>15</sup>

### 9.1.1 Cointegration and the shared trend

As two variables are integrated of order one and two are trend stationary, a cointegration relationship could possibly exist. Such a relationship would imply that all variables are affected by similar trends in international integration or that two sets share similar trends. The latter case could exist from the pairs of assets and liabilities, while exports and imports could also share a common deterministic trend. However, it would be peculiar to think that the rapid expansion in financial integration would affect assets more than liabilities. A similar motivation could be made for exports and imports.

After performing an Engle and Granger (1987) procedure, we note that the results suggests that assets and liabilities are cointegrated at the 10% level. However, the Johansen (1988) maximum eigenvalue and trace statistics suggest that there is no cointegrating vector when incorporating all four variables in a single regression. This result is corroborated by the results of an autoregressive distributed lag model that is subjected to the bounds test, proposed by Pesaran et al. (2001), which also suggests there is no long run relationship.

These results could be caused by three main factors. Firstly, the sample includes two distinct data generating processes due to the capital controls that were only fully relaxed 10 years into the sample. An alternative hypothesis is that the sample does not extend back far enough to capture the preceding decades of relative autarky, where international trade and investment positions were near zero, and so it is truncated to a point where trends could seem linear. Secondly, the measurement issues outlined previously could result in each variable sharing a common trend in reality but the inaccuracy in measurement masks this. Thirdly, it could be the case that international trade and external positions have differing trends or are driven by different forces, such as the previously mentioned risk sharing motives that only apply to one case. However, if each pair can be reduced to stationary random variables, the resulting sum of the two random variables would also be stationary. All of these factors could

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<sup>14</sup>This should have a minimal effect in practice, as the mean should dominate the extracted trend. This is evident in figure 9.1.

<sup>15</sup>To further address the end point problem five observations have been removed from each side of the final three variables.

affect the existence of, or ability to establish, a cointegration relation.<sup>16</sup>

In conclusion, we assume that the pairs of assets and liabilities and exports and imports share common trends. Therefore, the respective trends in the numerators and denominators of equations (8.5) and (8.6) cancel each other out and the weights  $\mu_t^z$  are constant. For example, if  $\bar{A}_t = \bar{A}\mu_t$  and  $\bar{L}_t = \bar{L}\mu_t$  then,

$$\mu_t^a = \frac{\bar{A}\mu_t}{\bar{A}\mu_t - \bar{L}\mu_t} = \frac{\bar{A}}{\bar{A} - \bar{L}} = \mu^a \quad .$$

In order to avoid estimating the cointegration relation explicitly, given the previous failures to do so, sample averages of each variable are used such that  $\bar{Z} = \mathbb{E}[Z]$  for each of the four variables. Subsequently, the weights for the net return variable, given by  $\gamma^a$  and  $\gamma^l$ , are created.

### 9.1.2 Variable creation

Cyclical external imbalances and the change in net exports are estimated according to equations (8.7), (8.8) and (8.2). The resulting expressions for the change in net exports, net external imbalances and net return on the external positions are given by,

$$\Delta nx_{t+1} = \Delta \epsilon_{t+1}^x - 0.92 \Delta \epsilon_{t+1}^m - \epsilon_{t+1}^{\Delta w} \quad (9.1)$$

$$nxa_t = 0.25 \epsilon_t^a - 0.32 \epsilon_t^l + \epsilon_t^x - 0.92 \epsilon_t^m \quad (9.2)$$

$$R = 0.76 (R_t^a - 1) - (R_t^l - 1) + 1 \quad . \quad (9.3)$$

The return on assets, return on liabilities, net return and growth in wealth is illustrated in figure 9.2. It is immediately clear that the return on assets is the most volatile with 4 large spikes of over 25% since 2005. The return on liabilities exhibited the largest volatility between 1997 and 2005. The net return is far less volatile than each individual return, which is partly due to the relatively more volatile return on assets, being weighted downward by 0.76, but also due to the balancing nature of returns in response to exchange rate fluctuations. Therefore, many returns on assets and liabilities, that are possibly due to exchange rate dynamics, offset each other. The volatility in national wealth growth is the lowest, where most points are contained within 12% of the mean.

The mean quarterly return on assets is approximately 4.8%, whereas the mean return on external liabilities is approximately 3.7%. Given that the weights on external asset and liability returns are 0.76 and 1 respectively, the mean net return is negligibly different from zero. The mean of the growth in wealth is approximately 3%. In each case, the trend in each return hardly differs from the sample mean and is approximately within 3% of the respective means. Given the non-standard smoothing parameter value, the positive returns on assets weight and zero mean of the net return series,  $R_t$ ; the detrended series,  $\hat{r}_t$ , hardly differs from the net return series.

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<sup>16</sup>All pairwise cointegration relations are also considered with the use of Engle and Granger (1987) tests. Relationships exist for exports and liabilities, exports and assets, imports and assets and imports and liabilities that are significant at the 5% level. Relationships for assets and liabilities and exports and imports at the 10% significance level.

These results suggest that, unlike the case of the US, South Africa does not experience an ‘exorbitant privilege’, as they do not systematically experience a positive net return on the net foreign asset portfolio (Gourinchas and Rey, 2007b, 2014). This is also understandable given the compositional similarities of external portfolios that were noted in section 5.

Figure 9.3 illustrates the final estimation sample of each of the three main variables. It is clear that the detrended returns and cyclical changes in net exports exhibit fairly low persistence when compared to the cyclical external imbalances.

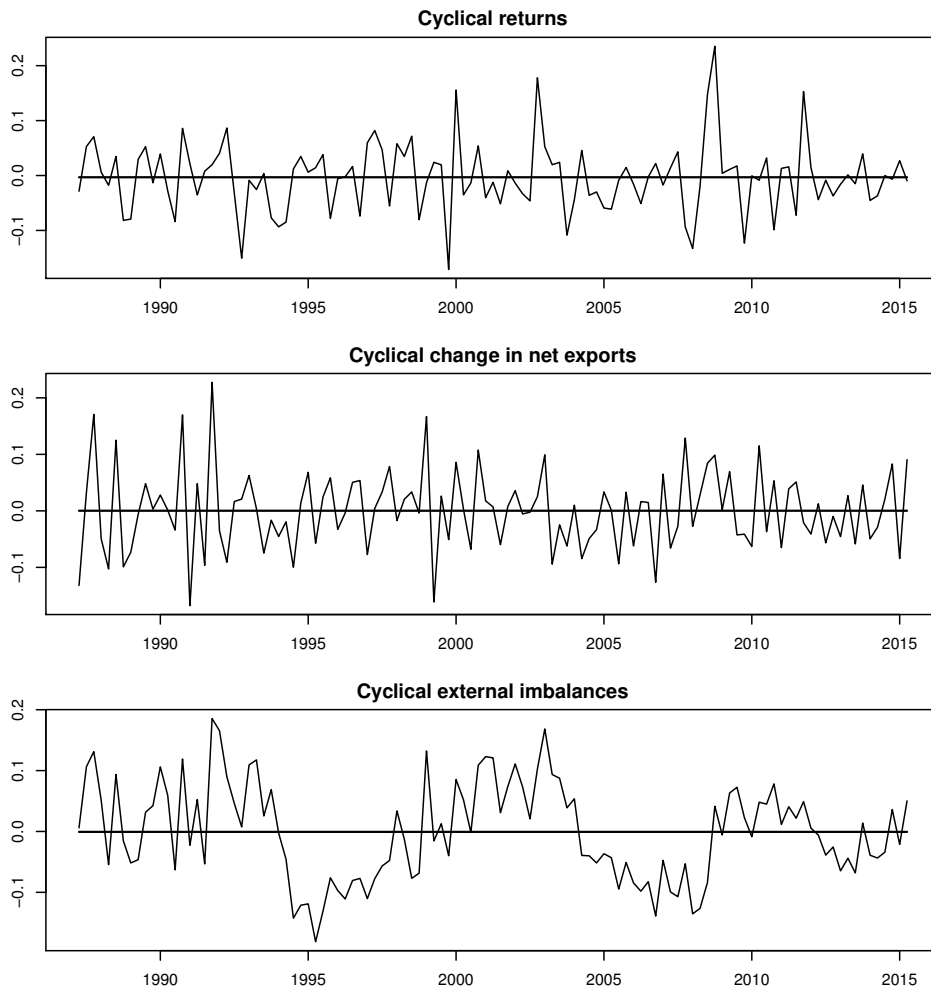


Figure 9.3: Final cyclical variables for model

## 9.2 Model estimation

In this section, the estimation process and results of the Bayesian VAR with stochastic volatility are included. Lag selection is determined according to the Schwarz (1978) Bayesian information criterion in a traditional reduced form VAR with constant coefficients. Although this model has differing likelihood functions, as well as differing parametrisation to the subsequent model, this statistic

is adequate for the intended purpose. Furthermore, there are few better *a priori* model selection methods pertaining to this model class. As a result, a single lag is selected.

The Markov Chain Monte Carlo makes use of 5000 draws to initialise the sampler after the OLS estimates are obtained on the first 40 observations, for the prior distributions. Thereafter, 100 000 draws are used to sample each parameter distribution.

The posterior distributions for the intercept, which have a zero median for all variables, coefficient matrix and residual variance covariance matrix are illustrated in figures B.1, B.2 and B.3 respectively.<sup>17</sup> In each case, the median is given by the vertical line. The variation in the coefficient matrix is neutralised by pooling the sequences over every time period. Therefore, the median value is the median value across all time periods. This is extended to the entirety of each distribution. As the coefficient parameters are bounded by relatively tight prior distributions (Primiceri, 2005), this should result in a good approximation of each term across the full sample.

### 9.2.1 Impulse responses

The fundamental objective of this paper is to quantify the intertemporal effect of innovations in net returns on the external imbalances. To achieve this objective we generate impulse response functions, where the sources for the innovations are the shocks to net returns,  $r_t$ , and the change in net exports,  $\Delta nx_t$ , and the response is in each case from the cyclical external imbalances,  $nxa_t$ . In each pane of figure 9.4 the median response is plotted in black and the 10<sup>th</sup> and 90<sup>th</sup> percentile responses are plotted in red. These impulse responses are generated for a lower Cholesky decomposition of the error variance covariance matrix using all simulated draws. The impulse responses are taken at the final time step for simplicity, using estimates of each parameter from the associated period. It is important to note that these results are robust to changes in the time period across the sample, as there is negligible variation in the initial magnitude of the shock, the subsequent dynamics and the overall significance of responses from differing time periods.

These results suggest that a positive innovation in the net return has a significant and positive effect on cyclical external imbalances. This increase decays smoothly and is no longer significant after approximately one year. This can be related to the underlying process as a once off positive deviation of the return on the net external portfolio results in an improvement in the external imbalances that lasts for approximately a year, after which the external balances return to the related trend. When relating these effects to their level equivalents, these results suggest that a positive innovation in the returns from its trend increases the net foreign asset position for approximately a year before returning to the trend.

The effect of a positive one unit innovation in the change in the net exports also increases the cyclical net export. However, the trajectory does not decay

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<sup>17</sup>The distributions have been plotted with non-parametric kernel density estimation techniques using a Gaussian kernel, the Silverman (1986) plug-in bandwidth and the full Markov Chain Monte Carlo sequence.

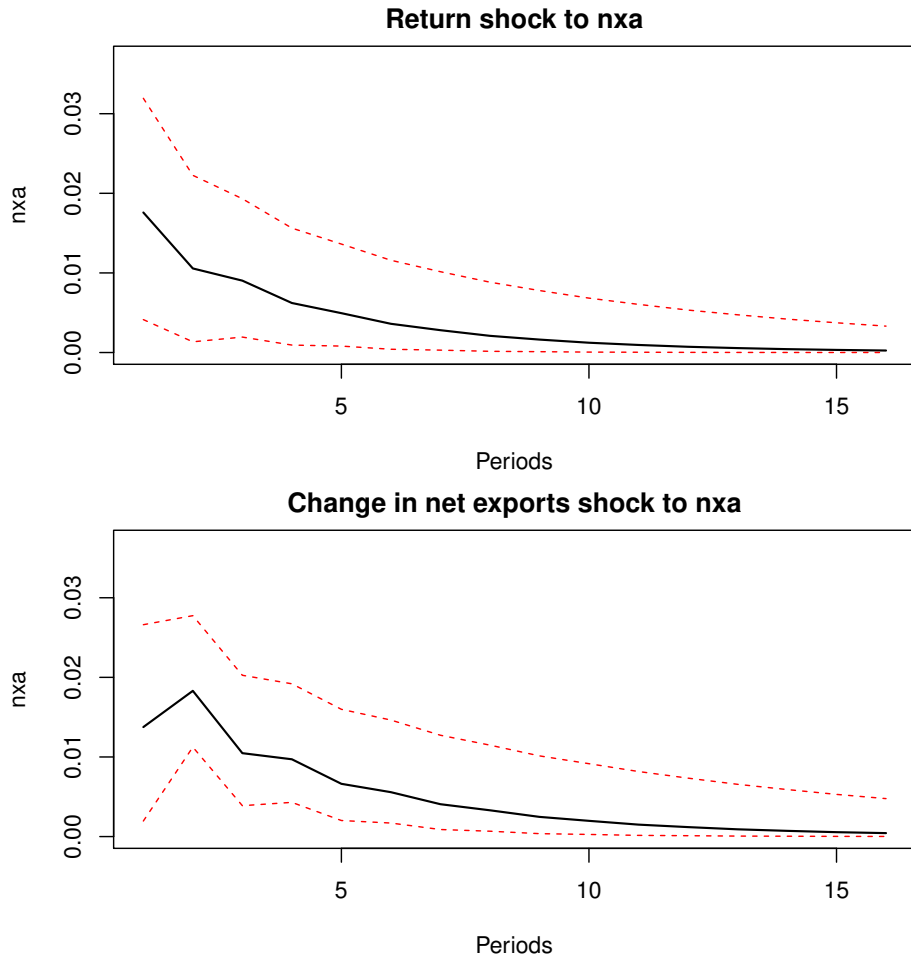


Figure 9.4: Impulse response functions

smoothly, as the second quarter effect is larger than the first, before it subsequently tapers off with higher persistence than the previous case. As a result, the effect is significant for approximately two years. Similarly, as the once off deviation from the trend in net exports leads to an improvement in the net foreign asset position that persists for approximately two years, before returning to its trend value.

Therefore, a positive one unit innovation in the net return and the change in the trade balance results in a similar improvement in the external imbalances. However, the latter effect is more persistent and is significant for approximately another year. It is worth noting that the duration of significance of each shock is linked to the persistence of the cyclical net exports series. For example, an innovation in the external imbalances would take longer to normalise.

### 9.2.2 The effect of stochastic volatility

Figure B.4 illustrates the evolution of the stochastic volatility,  $\Sigma_t$ , over the out of sample period. It is clear that each term exhibits low variability over time, in

terms of the median as well as 10<sup>th</sup> and 90<sup>th</sup> percentiles. This is reiterated by the median of each diagonal posterior distribution of each diagonal element being approximately the square of each standard deviation across all time periods. This suggests that a VAR model that makes use of fixed variances may have similar performance.

## 10 Conclusion

In this paper, we investigate the South African international investment position and consider how the valuation channel could affect the external imbalance. We show that in the case of South Africa investors have a relatively symmetric position across investment types. This is in contrast to the case of most developing and emerging market economies, where foreign assets are predominantly low risk and foreign liabilities are largely direct investments. We also note that future growth in foreign assets could occur from further integration of BRICS countries or through the rapid expansion into the rest of Africa.

The results of the model suggest that positive valuation effects are found to be present in the external adjustment of the South African economy, where a positive innovation has a significant, positive effect on the net position over the course of the following year. Furthermore, it is characterised by a similar initial magnitude as that of a positive improvement in the trade balance.

To derive this result we needed to estimate the quarterly international investment position. When performing this exercise, we note that the annual estimates were subject to significant revisions and the quarterly estimate required a number of assumptions. Although the quality of the data that we have used in this analysis may be called into question, we believe that a reasonable attempt has been made to derive accurate estimates for the respective variables that have been used in the analysis. It should also be noted that while the South African Reserve Bank has started to collect quarterly measures for the investment position, these may also be subject to some of the concerns that relate to the annual estimates.

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## A South African Reserve Bank data and query codes

Class	Code	Start date (frequency)
<b>Foreign assets of South Africa</b>		
<b>Total direct investment</b>	5600J	1956 (Annual)
<b>Total portfolio investment</b>	5614J	1956 (Annual)
Public corporations		
Equity and investment fund shares	5606J	1956 (Annual)
Debt instruments	5607J	1956 (Annual)
Banking sector		
Equity and investment fund shares	5609J	1956 (Annual)
Debt instruments	5610J	1956 (Annual)
Private non-banking sector		
Equity and investment fund shares	5612J	1956 (Annual)
Debt instruments	5613J	1956 (Annual)
<b>Total financial derivatives</b>	5535J	1956 (Annual)
<b>Total other investment</b>	5635J	1956 (Annual)
<b>Total reserve assets</b>	5539J	1956 (Annual)
<b>Total foreign assets</b>	5636J	1956 (Annual)
<b>Foreign liabilities of South Africa</b>		
<b>Total direct investment</b>	5550J	1956 (Annual)
<b>Total portfolio investment</b>	5564J	1956 (Annual)
General government		
Debt instruments	5554J	1956 (Annual)
Public corporations		
Equity and investment fund shares	5556J	1956 (Annual)
Debt instruments	5557J	1956 (Annual)
Banking sector		
Equity and investment fund shares	5559J	1956 (Annual)
Debt instruments	5560J	1956 (Annual)
Private non-banking sector		
Equity and investment fund shares	5562J	1956 (Annual)
Debt instruments	5563J	1956 (Annual)
<b>Total financial derivatives</b>	5485J	1956 (Annual)
<b>Total other investment</b>	5583J	1956 (Annual)
<b>Total foreign liabilities</b>	5584J	1956 (Annual)

Table 2: South African Reserve Bank (2016) query codes of International Investment Position data.

<b>Variable</b>	<b>Code</b>	<b>Start date (frequency)</b>
<b>Current account</b>		
<b>Balance on current account</b>	5007K	1960 (Quarterly)
Exports of goods and services	6013K	1960 (Quarterly)
Imports of goods and services	6014K	1960 (Quarterly)
<b>Financial account</b>		
Net direct investment	5683K	1985 (Quarterly)
Net incurrence of liabilities	5640K	1985 (Quarterly)
Net acquisition of assets	5656K	1985 (Quarterly)
Net portfolio investment	5684K	1985 (Quarterly)
Net incurrence of liabilities	5644K	1985 (Quarterly)
- Equity and investment fund shares	5756K	1985 (Quarterly)
- Debt securities	5757K	1985 (Quarterly)
Net acquisition of assets	5660K	1985 (Quarterly)
- Equity and investment fund shares	5758K	1985 (Quarterly)
- Debt securities	5759K	1985 (Quarterly)
Net financial derivatives	5760K	1985 (Quarterly)
Net incurrence of liabilities	5672K	1985 (Quarterly)
Net acquisition of assets	5677K	1985 (Quarterly)
Net other investment	5685K	1985 (Quarterly)
Net incurrence of liabilities	5650K	1985 (Quarterly)
Net acquisition of assets	5666K	1985 (Quarterly)
Reserve assets	5679K	1985 (Quarterly)
<b>Household balance sheet</b>		
Net wealth	6931J	1975 (Annual)
Ratio net wealth to disposable income	6288L	1975 (Quarterly)
Disposable income of households	6246L	1960 (Quarterly)
<b>Other</b>		
Real effective exchange rate	5392M	1970 (Monthly)
Real gross domestic product	6006C	1960 (Quarterly)
Nominal gross domestic product	6006K	1960 (Quarterly)

Table 3: South African Reserve Bank (2016) query codes of balance of payments, household balance sheet and other data.

## B Supplementary estimation results

### B.1 Posterior distribution estimates

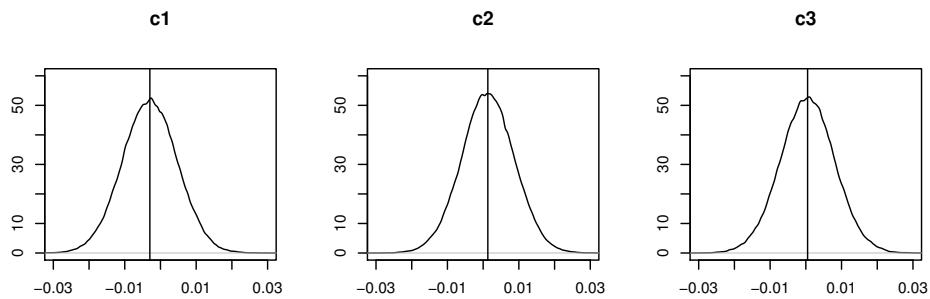


Figure B.1: Posterior distributions of the intercept vector,  $\mathbf{c}$ .

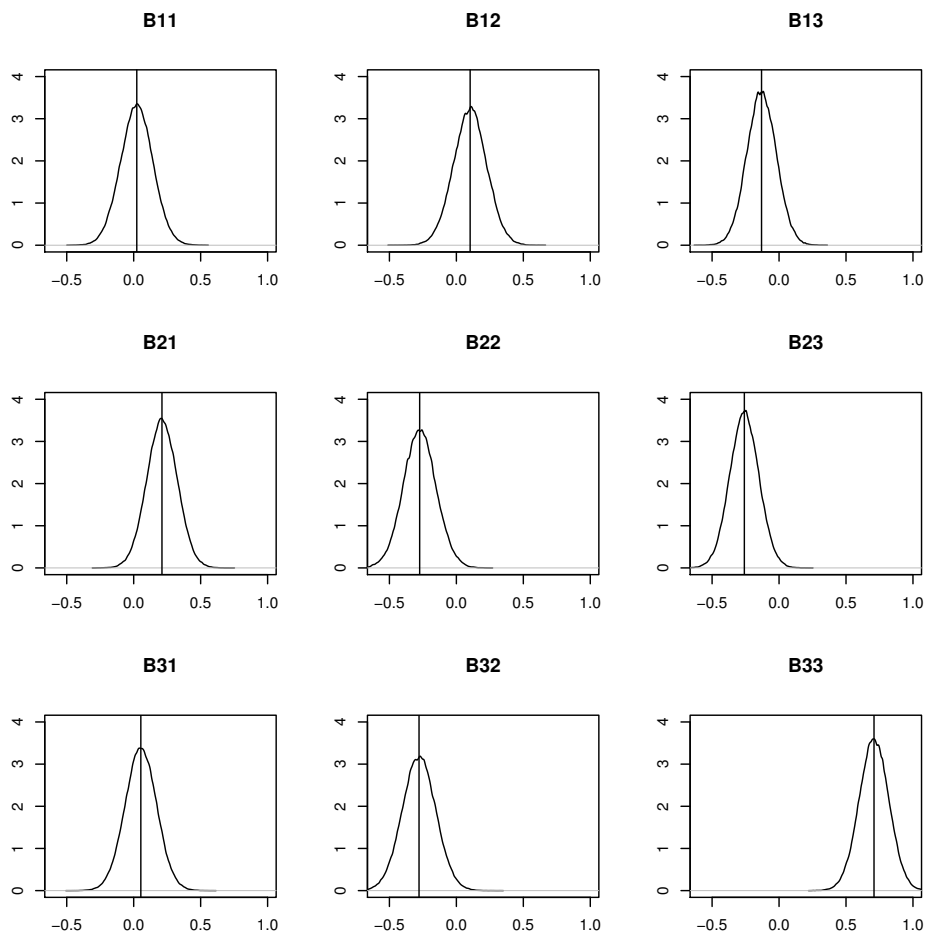


Figure B.2: Posterior distributions of the coefficient matrix,  $B_1$ .

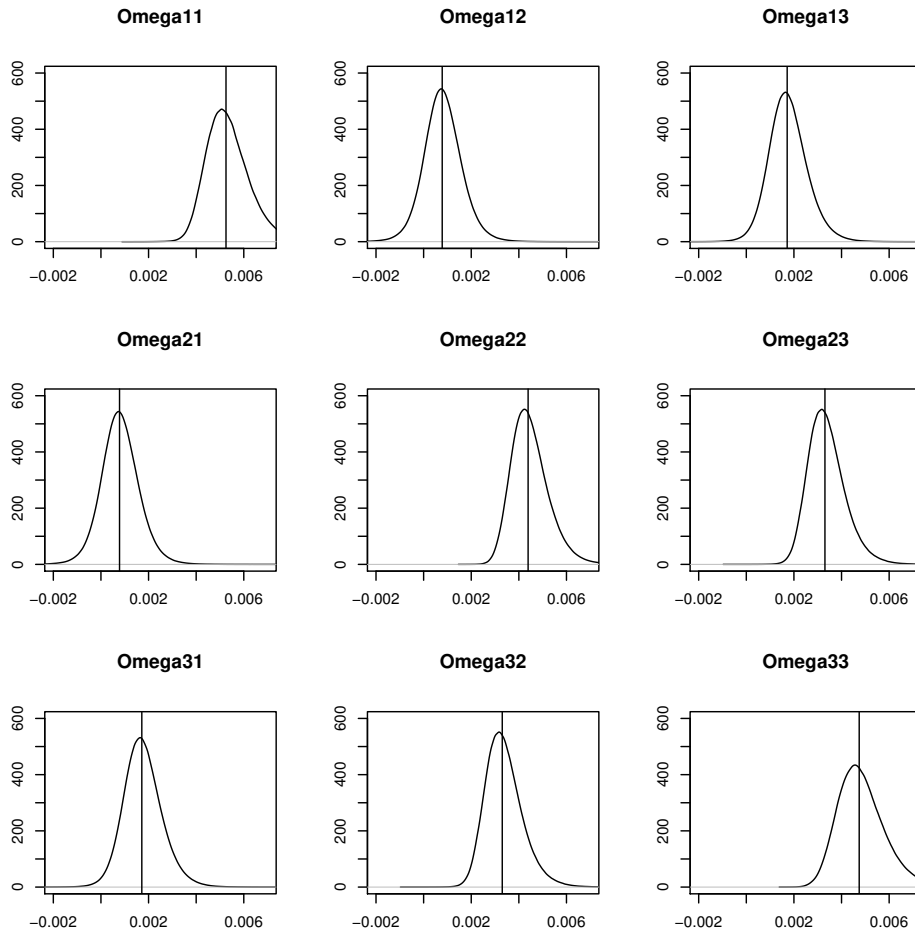


Figure B.3: Posterior distributions of the variance covariance matrix, where  $\Omega_t = \mathbb{V}(A_t^{-1}\Sigma_t\varepsilon_t)$ . Draws from all periods are pooled to calculate the unconditional distribution,  $\Omega$ .

## B.2 Evolution of volatility

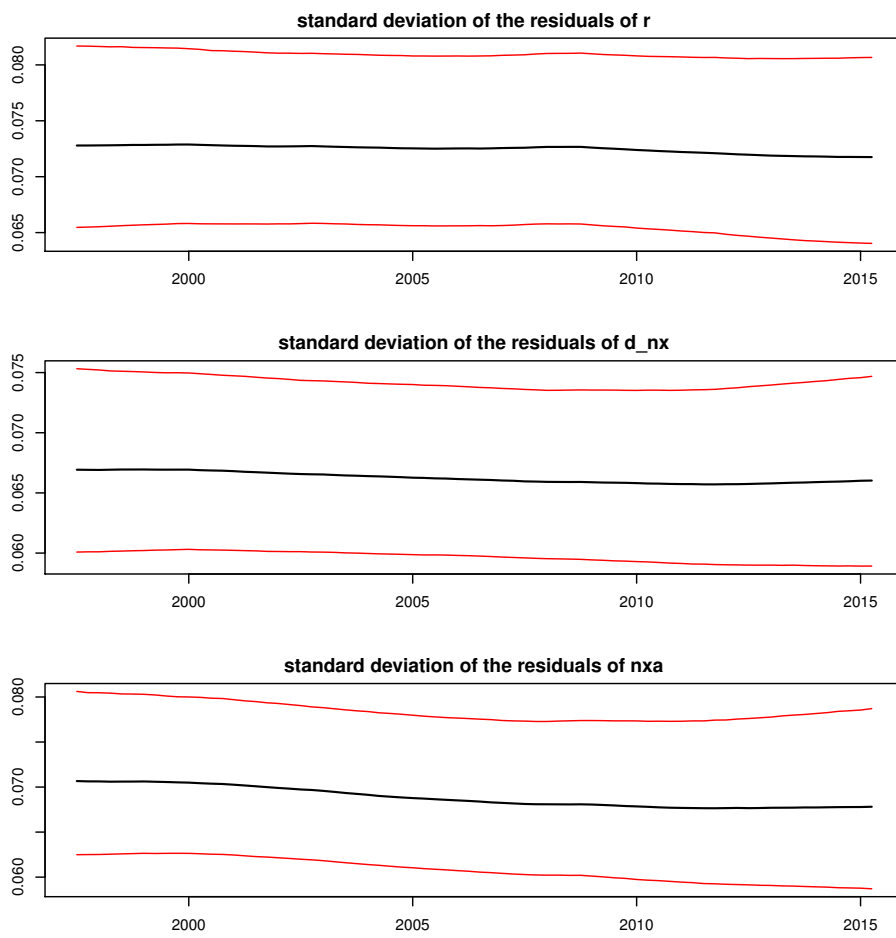


Figure B.4: Standard deviation of residuals,  $\sigma_{11,t}$ ,  $\sigma_{22,t}$  and  $\sigma_{33,t}$ , from the volatility matrix,  $\Sigma_t$ .