A total return index for South Africa

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ABSTRACT
In this paper I developed a broad methodology whereby the total return on national asset portfolios can be calculated, with South Africa as a first example. As an end result I present a suite of indices that tracks the total return, yield and volatility of the South African household asset portfolio. In this methodology I identified the five most important asset classes in the household portfolio, namely bonds, shares, cash, commodities and property. The next step was to estimate five total return indices (TRIs), one for each asset class. To do this I listed all the traded securities I could find in each class which had a daily TRI going back 13 years, and derived TRIs where none was available. I used principle component analysis to combine these individual TRIs into a mixed blend, one for each asset class. These five asset-class TRIs were then blended again, this time according to their respective weights in the household asset portfolio. The result was a TRI that tracks the value of a basket of assets, representative of South African households' asset holdings.

By taking the growth rate of this TRI, I obtained a financial conditions index (FCI), which tracked, in advance, a very similar path than annual economic growth and can thus be used to improve mechanical GDP forecasts. A volatility index was also derived from the TRI; it highlights periods of shocks in the financial system such as the international financial crisis and quantitative easing (QE). From all these, I were able to conclude that property is one of the safer, yet higher yield investments, in the household asset portfolio. I also found that South Africa is very open and vulnerable to international financial conditions. They tend to have a real impact on domestic economic growth.

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1. Introduction

The gradual integration of the world financial system enabled investors, large and small, to choose from an ever growing number of foreign assets in which to invest. The challenge to evaluate and compare different investments has expanded beyond the local bourse. As a result, investors, fund managers, and even policy makers are confronted with a larger amount of data to analyse, in order to make sense of the financial situation. This analysis, which can be complex and sophisticated at times, are gradually becoming even more so. As such, there might be a need to develop financial indicators that are able to accurately summarise a large set of data. The main purpose of such a summarised-indicator would thus be to simplify the task of the investor or analyst.

In practice, one of the tools used by investors to compare different investment assets is the total return index (TRI). In general, a TRI can be used to measure the returns an investor would have received on his investment (Nyberg & Vaihekoski, 2010). More specifically, they indicate the actual value of an investment portfolio over time, assuming that all dividends and interest are reinvested in the portfolio. However, TRIs are published for individual companies, as well as combined sectors on stock exchanges. They have not, as far as I could determine, been developed for countries. This presented an opportunity to develop a methodology whereby national TRIs can be derived. Such TRIs can then serve as tools to accurately summarise financial and investment data on a national basis. This will save the international investor and analyst the time and effort to filter through large sets of sub-national data. They would be able to directly compare countries in terms of investment return.

In this endeavour I managed to develop a TRI for South Africa. It gives an indication of the performance, over time, of a representative portfolio invested in the country. Not only this, I found the TRI and its derivatives could be used for other macro-economic purposes too, besides portfolio comparison. Firstly, the TRI presents an index whereby the savings component of the national household portfolio can be isolated. Secondly, the first derivate (annual growth rate) of the TRI can also be used as a financial conditions index (FCI), which may add value in macro-economic modelling and forecasting. Thirdly, a national volatility index can be derived, useful for investment frontier analysis.

The rest of this paper is organized as follows. Section 2 explains how Total Return Indices (TRIs) are calculated, and how they can be used. Section 3 describes the methodology I used to develop the TRI for South Africa, while section 4 presents the empirical results. In sections 5 and 6 the derived indices are discussed, followed by the conclusion in section 7.

2. Background on TRIs

The name “total return index” refers to an index which tracks the total return of an asset, whether it be shares, bonds or bank deposits. TRI’s track the value of a portfolio of investment assets with the principle assumption that all returns (dividends or interest) are reinvested in the portfolio (Investopedia, 2015).

Price indices, on the other hand, focus only the price per unit of the capital in a portfolio. Price indices can be used to track price levels of goods, services and assets, among others. The All Share Index (ALSI) on the Johannesburg Stock Exchange (JSE) is a prime example of a price index: it reflects only the average price level of shares over time. In contrast, TRIs are applicable to assets only, and it captures both the asset price and yield. The companies listed on the JSE pay dividends, and if those dividends are reinvested to buy more of the same shares, then the portfolio will grow by the dividends and the price. A TRI can therefore be calculated for the ALSI.

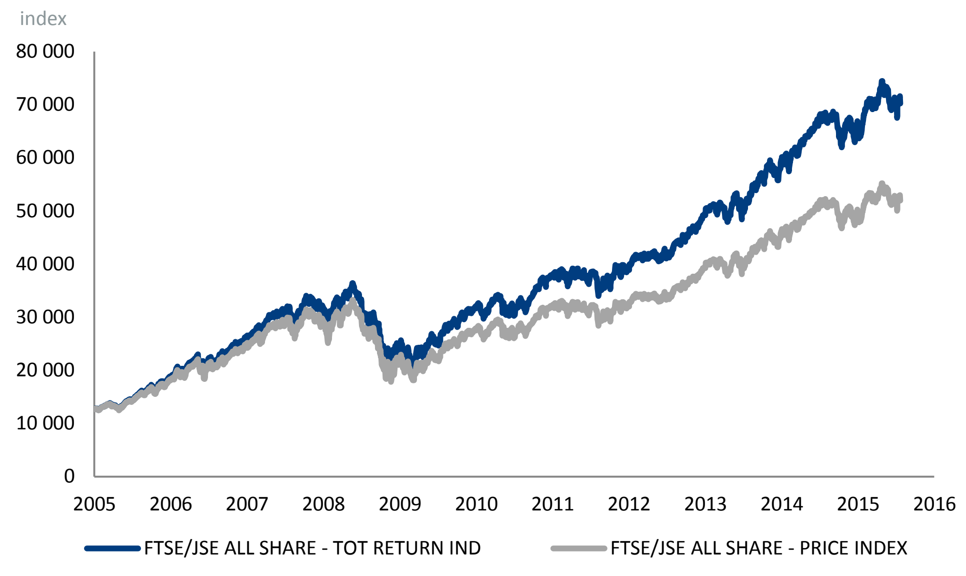

Figure 1: The JSE all share: price index vs. TRI
Source: Thomson Reuters

Figure 1 above compares the actual ALSI with its TRI counterpart. If they started at the same base of 3 January 2005, then by June 2015 the TRI turned out around 70 000 points, whereas the ALSI was around 52 000 points. The earning and reinvestment of dividends contributed another 35% to the ALSI's total return in 10 years' time.

2.1 Why a TRI for South Africa?

A major use for TRIs is to make a fair comparison between the performances of different asset portfolios over time. For example, R1 million invested in platinum in January 2005 would be worth R2.34 million in June 2015. Over the same period, R1 million invested in a large house would be worth R4.92 million (rental income reinvested), which is clearly superior to the investment in platinum. The same applies to countries. South Africa competes with other emerging markets to attract foreign investments. These investors are looking for a good return on their investment, given a specific level of risk. A TRI for South Africa can serve as an indication of the return that a diversified portfolio in the domestic economy could yield.

3. Index methodology

The first step in the process to develop a TRI for South Africa is to identify a list of criteria with which to comply. The list will then help to steer the data selection and calculation methods. In this instance, I listed the following points of compliance:

1. The index should represent the return of an average investment in South Africa.
    a. The basket of assets should be dynamic, adjust over time.
    b. The assets in the basket should be tradable (an investor should be able to set up an actual portfolio which is a mirror image of the index).
2. The index should be of a high frequency (daily if possible).
3. The index should have a fairly long history (5 years or more) to evaluate its performance.
4. The index should be real-time and free from data revisions.
5. The index should not exhibit induced structural breaks.

The second step is to identify an appropriate portfolio of assets (weights and financial indicators) that comply with the rules above, to base the index on. The third step is the calculation of the index, were the different indicators are combined into a single index. This is followed by an evaluation process whereby the index and its derivatives are measured according to different criteria.

3.1 Broad overview

To better understand the methodology I developed to estimate a TRI for South Africa, I will start off with a simplified overview. Firstly, the broad method ended up as a two-stage process. In stage one I developed five different TRIs for the five main asset classes. In stage two I combined these five sub-TRIs into the main TRI for South Africa. As an added use of the TRI, a financial conditions index and volatility index could also be derived. The flow diagram below explains the broad methodology in graphical format, with stage one depicted in green and stage two in red. Firstly, sub-TRIs are calculated for each asset class, using the individual TRIs of each individual asset. The sub-TRIs are then combined into a single TRI for South Africa. Taking the annual yield on the TRI results in an FCI and the standard deviation of the differenced TRI results in a volatility index (VI).

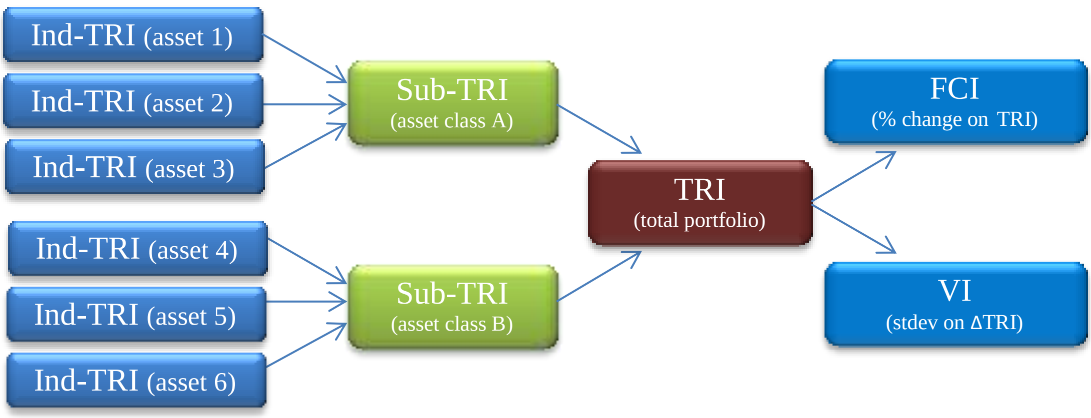

Figure 2: Simplified flow-diagram of the methodology

3.2 Data selection: a portfolio to represent South Africa

Investors aim to maximise their profits, and this incentive determines the way they set up their asset portfolios. There are many theories in place, most of them emphasising diversification, or spreading the risk (Callan Associates Inc, 2012). However, one purpose of the intended TRI is to enable comparison between countries. Thus I needed to choose a portfolio selection strategy that could be standardised between countries while also be representative of those countries.

Consequently, I based the TRI-portfolio on the composition of South Africa's household balance sheet, published annually by the South African Reserve Bank (SARB) since 2012. The household balance sheet indicates how much of five main asset classes households own. There is a slight change in the composition each year, indicating that the portfolio's weights will have to be adjusted periodically. From this data, presented in Figure 3 below, it is clear that households tend to keep most of their assets at pension funds & long-term insurers. This allocation is followed by residential buildings (houses) and then other financial assets such as shares and unit trusts. They also keep a small part of their wealth in the form of non-financial assets such as gold, jewellery, cars, furniture etc.

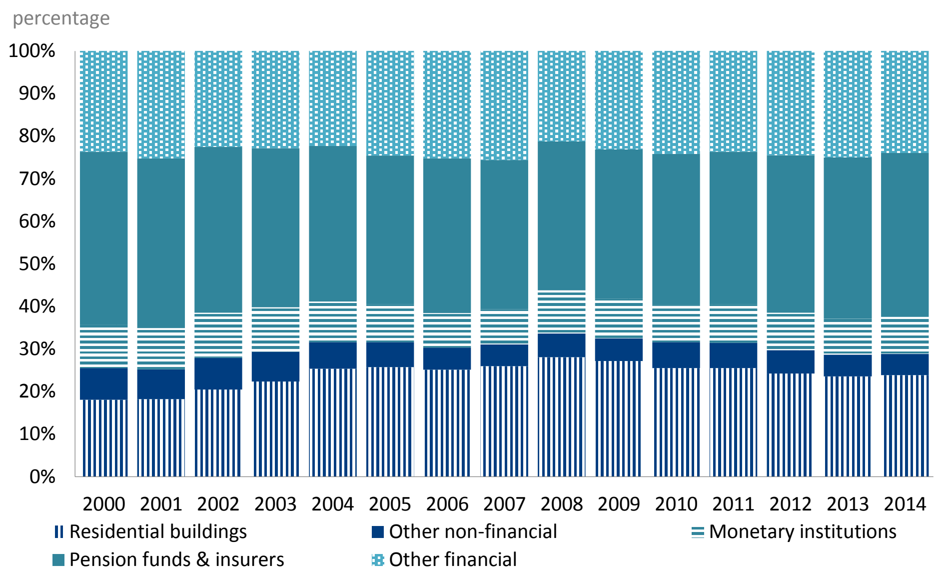

Figure 3: SA household balance sheet
Source: SARB

The main five asset classes

To build a portfolio of tradable assets, the main five asset classes in the household balance sheet need to have their own TRIs to track their performance over time. This is directly possible for the first three, but pension funds & long term insurers and other financial assets (partly unit trusts) need to be broken down into their sub-components. These pension funds, insurers and unit trusts are themselves major investors in the financial markets and their balance sheets are also published by the SARB. Interestingly, they keep more than half their portfolio invested in shares. Table 5 in the appendix presents the items in the household balance sheet, along with their respective asset groups for which a price history is available. I used the next coded abbreviations for the five asset classes:

1. PROP – residential property;
2. CMD - commodities;
3. JSE – shares;
4. INT – cash, deposits and other interest bearing securities;
5. BOND – bonds.

Note that non-financial assets (Figure 3), such as cars, furniture, precious metals and jewellery are mostly not traded on the financial markets. However, commodity prices might be a rough proxy for the price level of this asset class, especially for gold, jewellery and assets that contain lots of metal such as cars. To sub-divide non-financial assets into its sub-components will not be worth the effort, since the SARB do not publish it openly. Also, it should not make any significant difference to the overall TRI since non-financial assets constitute a very small portion of the total (5%) portfolio. Therefore, in the lack of any better options, this rough approximation will be allowed.

Commodity prices will also be used as a proxy for the "other assets" in which pension funds & long-term insurers invest. The reason is that derivatives such as forwards and options for commodities are not listed anywhere in the portfolio. South Africa do have an active market in the trade of commodity derivatives such as maize, gold, crude oil, diesel etc. (JSE, 2014).

Please note that although households own foreign assets too, it will not be entered into this portfolio as a separate item or asset class. After all, the main purpose of the portfolio is to track conditions in the South African financial markets. However, many of the large companies listed in the JSE are dual-listed in London or New York, and many other South

African companies have significant operations in foreign countries. Therefore, the selected portfolio will still be indirectly exposed to international financial conditions.

Further to this, the commodity prices in our portfolio will be expressed in rand terms (local currency; ZAR). Fluctuations in the rand would thus enter the portfolio through two channels: share prices (on account of duel listings) and commodity prices.

3.3 Calculation method

By this point it becomes clear that the estimation of the national TRI will be a two-stage process. Stage one is the estimation of the TRIs of each asset class, followed by the estimation of the main TRI from them. For this reason there is two distinct methods of deriving weights in the portfolio:

1. Accounting method: five weights, one for each main asset class to calculate the main TRI.
2. Statistical method: various weights for various assets to calculate the asset-class TRIs.

Keeping dynamic: new weights every year

To keep the index and its underlying portfolio dynamic and synchronised with reality, the weights for both the individual assets as well as the asset classes are adjusted every year. The weights of the individual assets are based on daily market data. Thus, it is possible to calculate new weighs for a calendar year once the previous one is totally completed on 31 December. This enables us to roll over from the old to the new weights at the very beginning of the new calendar year. The weights of the five asset classes are also rolled over in the same manner, but at the beginning of every April (not January as in the case of the individual assets). The SARB publishes the household balance sheet only once a year in March, therefore the new data for the main five weights will only be available for use from April.

Avoiding induced shocks: the rollover procedure

An important property of our intended index is that it should not exhibit methodologically induced structural breaks. Still, in some years there are noticeable shifts in the portfolio of households, such as in 2008 (see Figure 3 above). These shifts carry the risk of causing structural breaks in any TRI that base their portfolio weighting on them. To soften such structural breaks and yield a more gradual adjustment in the portfolio, I based the five main weights on a three-year moving average of the household balance sheet. Similarly, I based the weights of the individual assets on a five-year moving average of the daily return indices.

However, data is only available for all the individual assets from 2002. As a result, the weights of 2007 was the first to have five years of historical data available. However, in order to extend the index history back by two years, I allowed the weights of 2005 and 2006 based on three and four years of historical data respectively.

Also, to smooth the impact of switching from the old weights to the new weights every year (for both the individual assets and the asset classes), I used a rollover procedure. Similar rollover methods are used by commodity funds such as those of Standard Bank (Standard Bank, 2011). These procedures also allow index-funds to readjust their portfolios gradually over a period of time, instead of instantaneous and all in one day. The rollover procedure is accomplished as follows:

1. On the first trading day of the new year, we use only 10% of the new weights and 90% of the old weights.
2. On the next day we use 20% of the new weights, and 80% of the old weights.
3. This process continues, until the 9th trading day where we use 90% of the new weights and only 10% of the old weights.
4. On the 10th trading day we use only the new weights.

Table 1: Rollover procedure

Trading day	Old weights	New weights
0	100%	0%
1	90%	10%
2	80%	20%
3	70%	30%
4	60%	40%
5	50%	50%
6	40%	60%
7	30%	70%
8	20%	80%
9	10%	90%
10	0%	100%

Asset class weights (by accounting method)

The final weights for each of the five asset classes are summarised in Table 2 below. They are based on a three-year moving average of the household portfolio, as published in the national accounts by the SARB (see Figure 3 above and Table 5 in the appendix).

Table 2: Final weights for the asset classes in the TRI portfolio

	BOND	JSE	CMD	INT	PROP	TOTAL
2003	0.11	0.39	0.12	0.18	0.21	**1.00**
2004	0.11	0.37	0.11	0.18	0.22	**1.00**
2005	0.11	0.36	0.11	0.18	0.24	**1.00**
2006	0.10	0.37	0.10	0.18	0.26	**1.00**
2007	0.09	0.38	0.09	0.17	0.26	**1.00**
2008	0.09	0.39	0.08	0.17	0.27	**1.00**
2009	0.09	0.36	0.08	0.19	0.27	**1.00**
2010	0.09	0.34	0.08	0.20	0.28	**1.00**
2011	0.10	0.34	0.09	0.20	0.28	**1.00**
2012	0.10	0.35	0.09	0.19	0.27	**1.00**
2013	0.10	0.36	0.09	0.19	0.26	**1.00**
2014	0.11	0.37	0.09	0.18	0.25	**1.00**
2015	0.11	0.38	0.09	0.17	0.24	**1.00**

Source: BER

Now that the weights for each asset class have been determined, the next step is to derive weights for the individual assets inside each asset class.

Individual asset weights (by principle component (PC) analysis)

A number of price and return indices are available for each asset class. For example, I found at least nine different commodities relevant to South Africa that has a daily price history dating back from April 2002. The question is now to weight them in such a way that the combined index captures as much variance in the asset class as possible. One method to obtain such a weighted average is to use the factor loadings of the first principle component (PC). The literature indicates that PC-analysis is perhaps one of the favourite methods to determine such weights, especially in the case of financial conditions indices (FCIs) (Gumata, Klein, & Ndou, 2012). PC-analysis is just one of various statistical methods in the field of factors models.

The factor model aims to extract from a table of variables, X_t, a similar sized table of variables, F_t, which captures the variation of the original set. The columns of F_t are called common factors, and the mean of each column is 0. Each column of F_t is a weighted average of the columns of the original table X_t. The weights can be written in a smaller table of their own, called the coefficient matrix β. We can write the mathematical formula as follows:

$$X_t - \mu = \beta F_t - U_t$$

where μ is a vector (column) of the means of the variables in X_t, and U_t is a matrix (table) of residuals (error values). One method to derive the coefficient matrix β is through PC-analysis. In this case the eigen vectors of the covariance matrix would form the columns of β. In PC-analysis, the first column of F_t captures most of the variance. In the special case where all the variables in X_t are normalised, their coefficient weights in β is the same as their correlations with F_t.

To calculate the first PC of each asset class respectively, I collected a set of daily historical price data of assets that constitute each asset class (listed in Table 3). I rebased the data and applied PC-analysis on a rolling window of five years to estimate weights of the individual assets, within each of the five asset classes respectively. These weights were recalculated every year, in order to keep the TRI dynamic, as described in the sub-section above. The Eviews code I developed for this task is presented in the appendix.

Note that in some years the resultant weights given by PC-analysis were negative for some input assets. That would imply a short position, which presents a challenge in the case of most assets, and goes against the intention of the household asset portfolio. Therefore, all negative weights were readjusted to zero in the calculation of the five asset-class TRIs.

Table 3 below presents all the individual TRIs used to compose the main TRI, grouped according to their respective asset classes. In the case of bonds and cash deposits, both interest bearing securities, the uniformity of the weights is striking. The reason for this uniformity is the close correlation between the TRIs within each asset class. When the correlations are so high, the different TRIs are very similar and should therefore carry similar weights. It also implies that fewer TRIs are actually needed within these asset classes. I have already reduced them considerably.

Table 3: The TRIs that constitute each asset class, and their respective weights

Nr	Datastream code	Data series	2013	2014	2015
Bonds					
BOND1	SAFRA13	South African All 1-3 Years - Tot Return Ind	0.166	0.166	0.166
BOND2	SAFRA37	South African All 3-7 Years - Tot Return Ind	0.167	0.167	0.167
BOND3	SAFRA7T	South African All 7-12 Years - Tot Return Ind	0.167	0.167	0.167
BOND4	SAFRA12	South African All 12+ Years - Tot Return Ind	0.166	0.166	0.166
BOND5	SAFRGOV	South African Govt. (Govi) - Tot Return Ind	0.167	0.167	0.167
BOND6	SAFROTH	South African Other (Othi) - Tot Return Ind	0.167	0.167	0.167
Shares					
JSE1	JSEI3C3	Ftse/Jse Chemicals - Tot Return Ind	0.118	0.117	0.119

JSE2	JSEI1BM	Ftse/Jse Basic Materials - Tot Return Ind	0.050	0.058	0.041
JSE3	JSEI1ID	Ftse/Jse Industrials - Tot Return Ind	0.120	0.118	0.120
JSE4	JSEI1CG	Ftse/Jse Consumer Gds - Tot Return Ind	0.120	0.118	0.121
JSE5	JSEI1H1	Ftse/Jse Health Care - Tot Return Ind	0.117	0.118	0.120
JSE6	JSEI1CS	Ftse/Jse Consumer Svs - Tot Return Ind	0.120	0.118	0.120
JSE7	JSEI1T1	Ftse/Jse Telecom - Tot Return Ind	0.113	0.116	0.120
JSE8	JSEI1FN	Ftse/Jse Financials - Tot Return Ind	0.121	0.118	0.120
JSE9	JSEI1G1	Ftse/Jse Technology - Tot Return Ind	0.121	0.118	0.119
Commodities					
CMD1	SAYCS01	Safex-Yellow Maize Continuous Ltdt - Sett. Price	0.130	0.116	0.113
CMD2	SACCS01	Safex-Wheat Continuous Ltdt - Sett. Price	0.128	0.115	0.121
CMD3	SAUCS00	Safex-Sunflower Seed Continuous - Sett. Price	0.133	0.115	0.099
CMD4	OILBRNP	Crude Oil-Brent Dated Fob U$/Bbl	0.140	0.123	0.126
CMD5	GOLDBLN	Gold Bullion Lbm U$/Troy Ounce	0.082	0.123	0.124
CMD6	PLATFRE	London Platinum Free Market $/Troy Oz	0.105	0.113	0.117
CMD7	DIAHGVS	Diamonds-0.5 Carat G Vs2 U$/Carat	0.093	0.109	0.113
CMD8	HWWICS$	Coal 2 Sa Steam Coal Avg Fob Rich.Bay	0.100	0.102	0.090
CMD9	STSIOMP	Steel Composite Price Index - Price Index	0.090	0.084	0.098
Cash and loans					
INT1	SAJIB1M	South African Jibar 1 Month - Middle Rate	0.250	0.250	0.250
INT2	SAJIB3M	South African Jibar 3 Month - Middle Rate	0.250	0.250	0.250
INT3	SAJIB6M	South African Jibar 6 Month - Middle Rate	0.250	0.250	0.250
INT4	SAJIB1Y	South African Jibar 1 Year - Middle Rate	0.250	0.250	0.250
Property					
PROP1		Middle Class Propes: Large - Index (2000=100)	0.255	0.253	0.252
PROP2		Middle Class Propes: Medium - Index (2000=100)	0.255	0.253	0.252
PROP3		Middle Class Propes: Small - Index (2000=100)	0.239	0.242	0.246
PROP4		Fnb Prope Price Index (Hpi) (Index: Jan 2001=100)	0.251	0.252	0.251

Source: DataStream, BER calculations

4. Empirical results

4.1 The TRIs

Figure 4 below depicts the TRIs that I calculated for the five asset classes in the main portfolio, together with the composite TRI (SATRI). They all start on 3 January 2005 at a level of 1, which can be seen as investing R1 or R1 million on that day. By June 2015 the total return on shares reached a level of 6.13. This jump implies that the initial investment of R1 million in shares would have grown to R6.13 million (including dividends reinvested) in slightly more than ten years. An investment of R1 million in bonds would have grown to R2.15 million. The combined TRI for the portfolio of South African households (SATRI) have reached a value of 4.29 by June 2015. This level is more-or-less in the middle of the performance spectrum of the five asset classes.

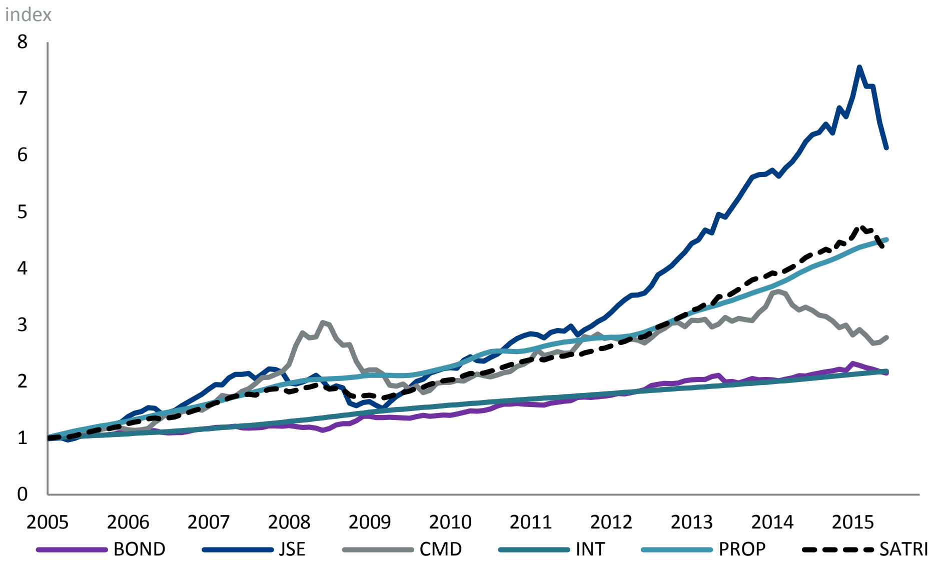

Figure 4: Sub-TRIs for each of the five asset classes
Source: BER

Shares (JSE)

Shares constitute by far the largest portion of the household asset portfolio. Therefore, shares would influence the SATRI more than any other asset class (see Table 2). Individual TRIs are published by FTSE for shares traded on the JSE, their sub-sectors and main sectors. I selected nine main sectors[1] which were available on DataStream. They are listed in Table 3 above along with their respective abbreviations (JSE1 to JSE9).

In the case of shares, the inter-correlation among the nine individual TRIs was not as high as for some of the other asset classes. The inter-correlation also changed significantly from year to year, resulting in changing factor loadings from the first principle component –and thus changing weights for the combined shares-TRI. In Figure 5 below it is clear the major shift in weights started to happen in 2011. For example, the weight of basic materials (JSE2) diminished from 11% in 2010 to only 4% in 2015. This readjusted shares portfolio performed slightly better than the equally weighted portfolio would have (see Figure 16 in the appendix).

[1] The Oil and Gas index made irregular structural breaks, were rebased by FTSE and unsuitable for use in the TRI. Refer to this note by FTSE:
http://www.ftse.com/products/index-notices/home/getnotice/?id=1358478
I therefore replaced it by the Chemicals index.

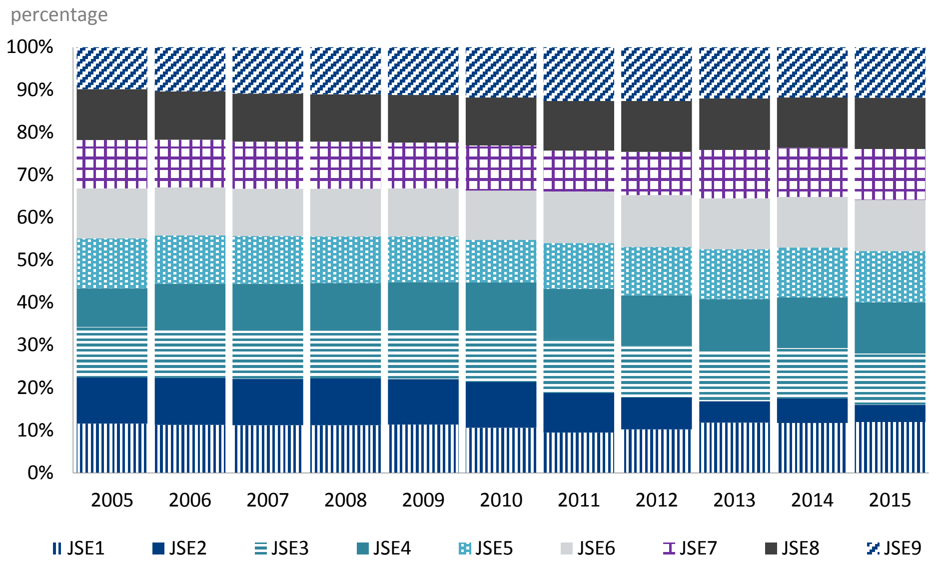

Figure 5: Weights of each sector in the shares-TRI
Source: BER

Commodities (CMD)

Commodities have price indices, but since they do not pay dividends or yield an income, their TRIs will be the same as their price indices. Nine commodities were selected for the basket based on their relevance to South Africa as well as the availability of a daily price index from 2002. The list is presented in Table 3 above.

The inclusion of crude oil needs special clarification. Though crude oil is not produced domestically, it was also included since South Africa still consumes great quantities of it. Energy companies keep huge reserves of liquid fuels and South Africans can invest in crude oil futures on the JSE. The price of crude oil is also one of the most important gauges of international commodity prices.

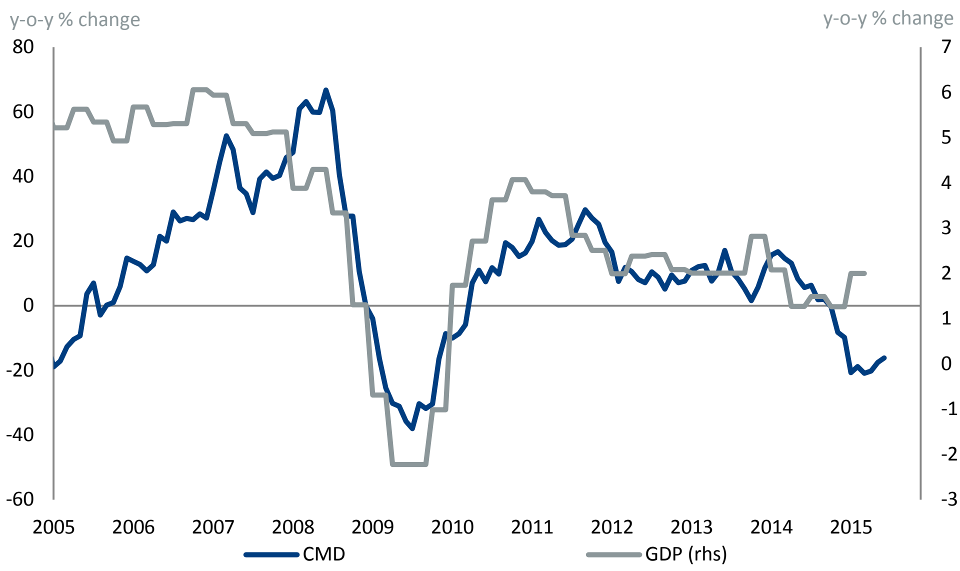

Figure 6: Commodity total return rate vs. GDP growth rate
Source: SARB & BER

Figure 6 above compares South Africa's GDP growth with the commodity total return rate. From this figure it seems that since 2008 South Africa's annual economic growth rate became significantly interlinked with the price of commodities for a period of time. Commodity prices peaked in February 2014, but decline significantly since then. Looking forward, the price of commodities is unlikely to pick up on account of China's growth slowdown; consequently, growth in South Africa might also remain subdued.

Commodity prices are also interlinked with domestic consumer prices, leading inflation by roughly 6-12 months (see Figure 15 in the appendix). The gradual decline in commodity prices since the beginning of 2014 partly explains why inflation moved below 6% later that year.

Residential property (PROP)

In the case of residential property, monthly house price indices (HPIs) are published by Absa and FNB with a lag of one month. However, a TRI for houses is not readily available for South Africa, thus I had to derive my own. To do this, I first had to calculate a total rate of return index which combines price growth and rental income. The monthly rental yield index was derived in the following general formula:

$$monthly\ rental\ yield = \frac{monthly\ rental\ income}{house\ price}$$

Or more specifically:

$$rental\ yield_t = \frac{C_1 * RPI_t}{C_2 * HPI_t} \text{ where}$$

RPI refers to the consumer price sub-index for housing rentals[2], as published by Statistics South Africa (StatsSA) with a lag of two months;

HPI refers to the house price index for middle class houses published by Absa;

C_1 *and* C_2 refers to constants (and can reduce to a single constant *C*), and *t* to the month.

I then calibrated *C* such that the annual rental yield for 2014 would be 8% (rental income less maintenance, insurance, property tax and income tax)[3]. Next I added the rental yield to the price growth rate to obtain total return rates for each of the HPIs respectively.

$$total\ yield_t = rental\ yield_t + price\ growth_t$$

(Note that when growth rates are added, the logarithmic approach should be used for further calculations.) Finally, I derived four daily TRIs for property by applying the total yield rate above to indices with a base of 1 on 3 January 2005 (see appendix for the formula). By using the factor loading of the first principle component as weights, a combined TRI was calculated for residential property.

[2] Before 2008 StatsSA did not publish a CPI for housing rentals. As a proxy before 2008 I used the CPI for Household operation: Other household services.

[3] Derived from a quick scan of properties in the market during 2014 in terms of selling prices and rentals asked (considering similar properties in similar neighbourhoods).

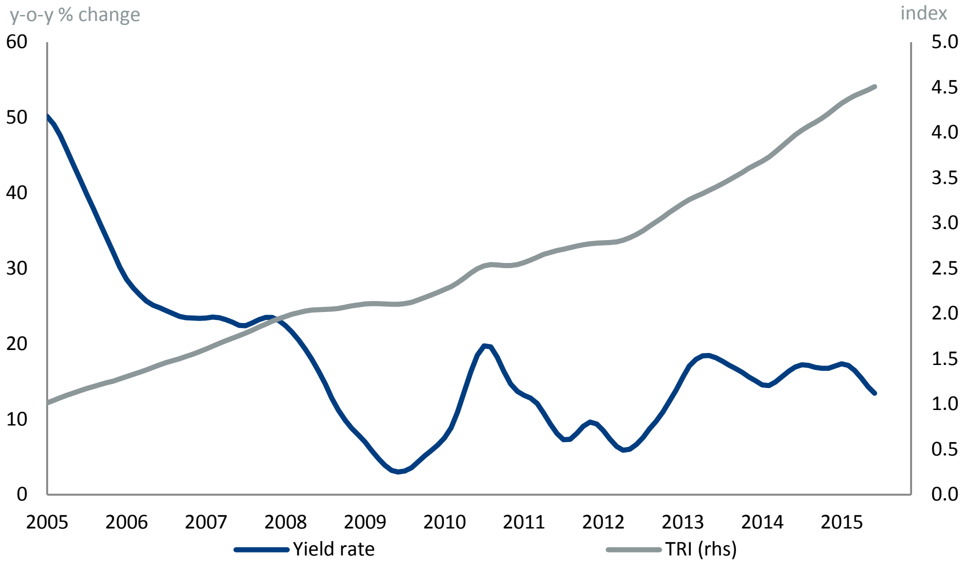

Figure 7: Total return rate and TRI for houses
Source: BER

The yield rate on houses has been abnormally high at the beginning of 2005, as seen in Figure 7 above. House prices grew significantly during the asset bubble that preceded the financial crises in 2008. This bubble originated in the US where low interest rates drove yield-seeking investors to lend money to sub-prime borrowers –fuelling the market price of houses. When the bubble bust, share prices fell sharply in the wake of the global financial crises that followed. However, South African house prices never declined to the same extent as shares or houses in the US.

We can deduct form the housing-TRI that a household who bought a house for R1 million in January 2005, will now (June 2015) have an asset worth R 4.51 million. That is if they reinvested the owner's rent equivalent also in housing.

Cash and deposits (INT)

In 2014 households owned 17% of their portfolio in the form of cash (or money), which were invested in deposits at banks, the money market or loans to borrowers. They earned an interest on these, which depends on the period of investment. To track the interest rate over different maturities, I calculated a combined TRI on the Jibar interest rates for one month up to one year (see Table 3). Initially, other interest rates were also included in the basket, such as the prime rate, but due to the nearly exact correlation among them all, I dropped some.

Individual TRIs are not readily available from any source, only the actual interest rates. I had to derive individual TRIs, assuming a level of 1 on 3 January 2005 as the base day, then calculating the growth in the index should all interest earned be reinvested. For more detail on the formula I used to derive the TRIs, see the appendix.

Among the five asset classes, cash turned out to be the least volatile (see the smooth yield rate in Figure 8 below). However, lower volatility (or risk) comes at a price –a lower total return. R1 million invested in the money market on 3 January 2005 will have grown to R2.19 million by June 2015. This return is on the lower side among the five asset classes (see Figure 4).

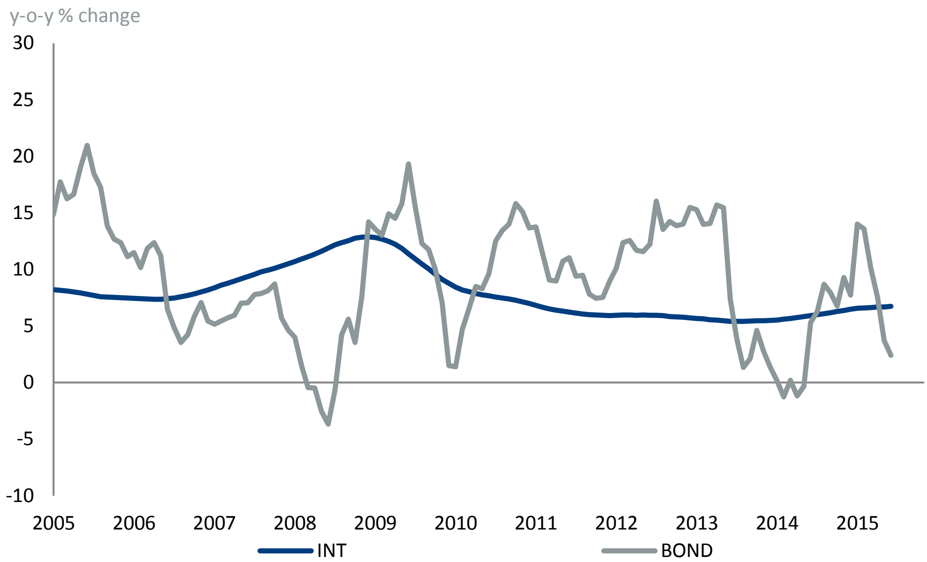

Figure 8: Total return rates on cash vs. bonds
Source: BER calculations

Bonds (BOND)

Bonds, also an interest bearing security such as money market deposits, exhibit much more volatility in its yield rates. The reason for this fluctuation is the fixed coupon rates and maturity dates, which are then discounted to net present value and traded relative to new issued bonds. As a result, the net present value of existing bonds can trade at large premiums or discounts, depending on differences in the coupon interest rate with newly issued bonds. Consequently, the yield rates on bonds fluctuated much more compared to money market yield rates (see Figure 8 above). However, despite this volatility, the return on bonds is not higher compared to money market deposits. R1 million invested in bonds in January 2005 was worth R2.15 million in June 2015.

To derive a single TRI for the bond market, I calculated a weighted index based on the individual TRIs of six different bonds. Similar to money market interest rates, I selected bonds of different maturities, from 1 year to more than 12 years. Government as well as private bonds were included in the basket. In the case of bonds, individual TRIs were readily available from the Bond Exchange division of the JSE. It is published daily on Thomson Reuters' DataStream. The bonds included in the basket are listed in Table 3.

4.2 The South Africa Total Return Index (SATRI)

Now that I have estimated a TRI for each of the five asset classes, I can combine them into one TRI for South Africa. I do this using the weights as determined by the household balance sheet, and according to the moving averages and rollover periods described above. The final result is presented below in Figure 9. One major advantage of the SATRI is its direct and practical interpretation.

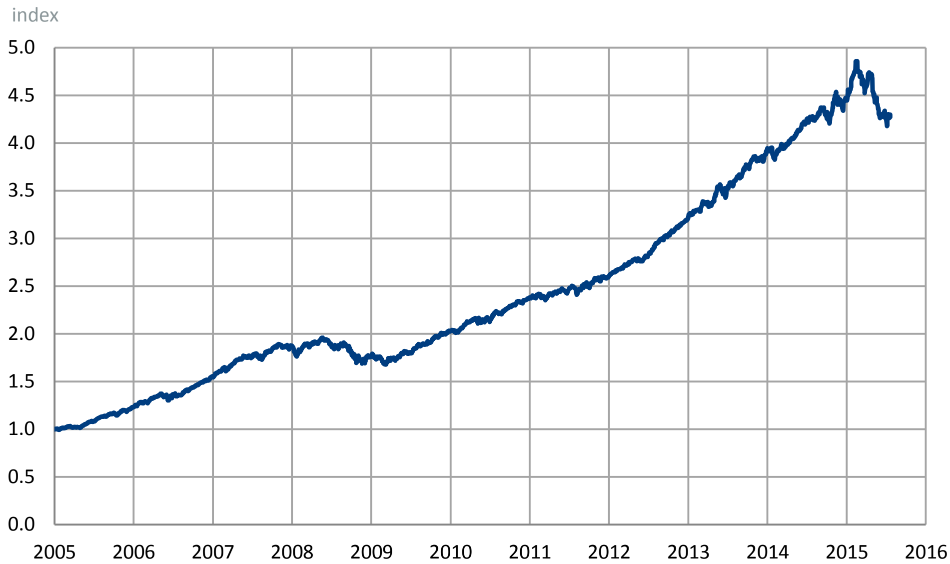

Figure 9: The SATRI
Source: BER

The SATRI indicates that each R1 of the average South African asset portfolio at the beginning of 2005, nearly doubled in value in just 3½ years. Then the global financial crisis in 2008 caused a decline of around 25c, which was recouped 18 months later. From there on the portfolio's value took four years to double again (2010-2014). Much of this growth coincided with the asset purchase programme of the US Federal Reserve (Fed), otherwise known as quantitative easing (QE). This growth streak run out of steam by the end of 2014, when the

Fed finally winded down its QE-programme. A similar programme, announced by the European Central Bank (ECB) in January 2015, initially caused some optimism in financial markets. However, the high hopes were short lived; the index peaked on 20 February 2015 at a level of 4.86. Since then the index receded somewhat on account of lower commodity prices, troubles with Greece, a crash in Chinese stock prices and expectations of an interest rate hike by the Fed.

4.3 Scenario analysis: the household asset portfolio

We can now use the SATRI to calculate what the household asset portfolio could have been, if households did not withdraw from it[4]. This is done by taking a specific base year, and then inflate the portfolio by the SATRI. For example, at the very beginning of 2005 the portfolio was worth R2.7 trillion, while the SATRI stood on 1.00 at the same time. By the first day of 2015 the SATRI reached a value of 4.46, indicating an expansion of 347%. If the asset portfolio increased to the same extent, it would have been worth R14.4 trillion. In reality, the SARB reported it to be only R9.9 trillion, thus households lost R4.5 trillion in potential wealth duo to withdrawals. Figure 10 below present the year-by-year value of the actual portfolio, compared to its potential, and the yearly withdrawals.

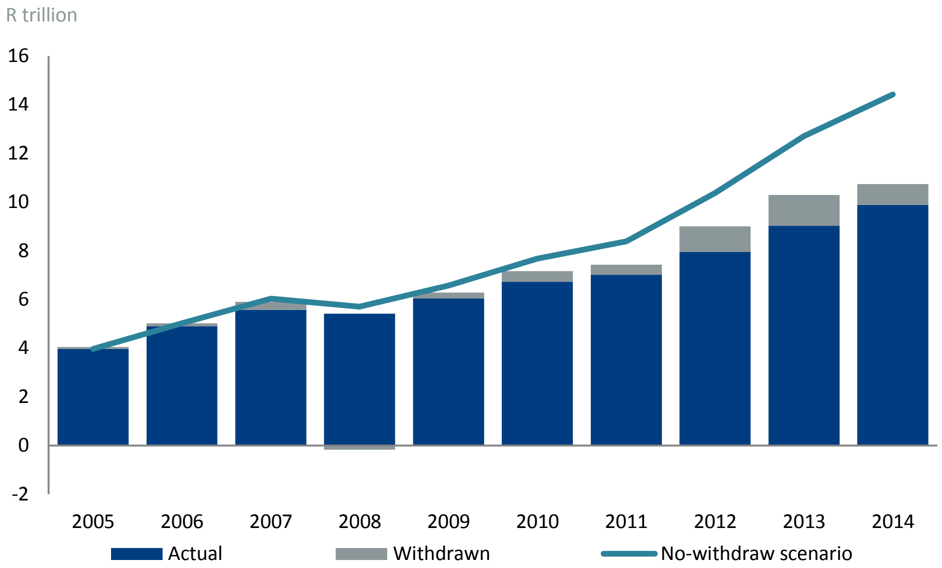

Figure 10: Portfolio size: actual compared to potential
Source: BER

[4] But still changed the composition each year to match the dynamic weighting.

Note that in 2009, in the midst of the global financial crisis, households actually contributed to their portfolios. They might have done this in a spree of bargain hunting as assets were priced relatively lower in 2009. In all the other years they withdrew some of the dividends and interest that their investments yielded. We can deduct from Figure 10 above that South African households mostly use their investment income to save, and rarely their labour income.

5. From a TRI to an FCI

Naturally, investors and analysts will not only be interested in the actual level of the SATRI, but also in its rate of change (growth rate). When I plotted the SATRI growth rate over some existing financial conditions indices (FCIs) for South Africa, the similarity was striking. Therefore I investigated if the SATRI growth rate would comply to the general definition of FCIs. The literature defines an FCI very broadly, and there is no consistent methodology to construct them (Gumata et al (2012), Hatzius et al (2010), Thomson et al (2013)). However, three properties in them are universal:

1. They are a blended mix of different indicators;
2. These indicators are strictly from the financial sector.
3. The final index is in first difference (growth rate) format.

Considering the year-on-year percentage change in the SATRI, it complies in full to these three conditions. Firstly, the indicators on which the SATRI is based are all assets traded in the financial sector, whether houses, shares, bonds, cash or commodities. Secondly, their return indices are all blended into one, namely the SATRI. Thirdly, the SATRI growth rate is in first difference format, thus qualifying it as a suitable FCI.

Because the SATRI is constituted on daily data, I calculate its rate of change on a 260-day difference. Figure 11 below depicts this financial conditions index for South Africa, which I dubbed the SAFCI, along with annual GDP growth. The link with the real economy is clearly visible up to 2012, with the SAFCI leading economic growth by three to six months. The impact of the global financial crisis (2008 - 2010) is also visible in both, but the impact of the Fed’s asset purchases (QE3) only visible on the SAFCI.

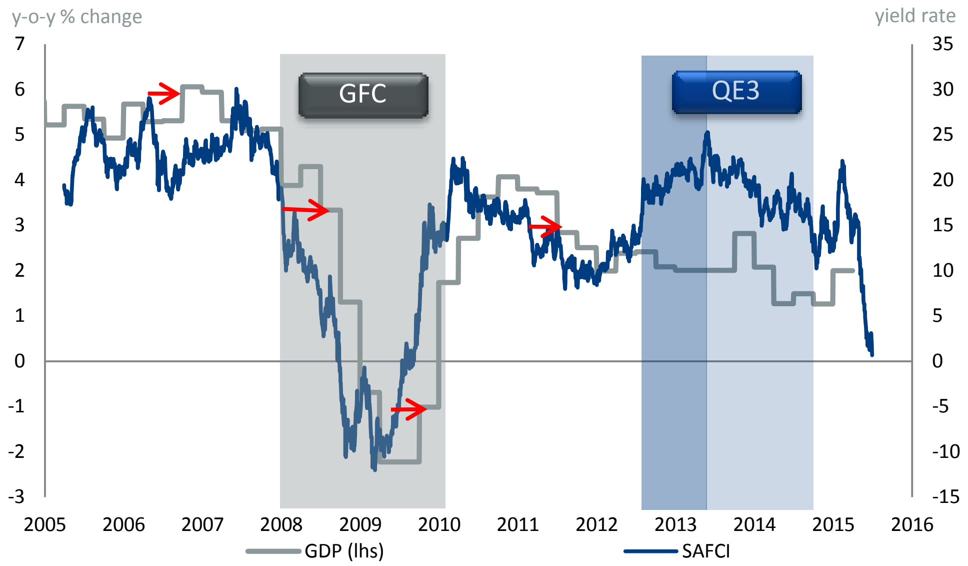

Figure 11: FCI for South Africa vs. GDP growth
Source: BER

The Fed's third wave of asset purchases, which commenced in September 2012, inflated international asset prices above normal levels. The SAFCI adhered to the same market distortions and jumped sharply. In May 2013 the Fed announced that it would start to taper these purchases again, and the SAFCI receded quickly from another recent spike. By October 2014, when the QE3 programme finally winded down, the SAFCI fell sharply. After that it recovered following the QE announcement of the European Central Bank (ECB) in January 2015. However, this improvement did not last long as the SAFCI plummeted severely on the back of a Chinese slowdown and market collapse. By June 2015 the SAFCI was close to the 0-level, last reach during the global financial crisis.

Note should also be taken that the SAFCI is very similar the SARB equivalent-FCI (see Figure 17 in the appendix). They have an 87% correlation with each other.

5.1 Explaining the real economy

One of the main purposes that analysts have for FCI's is to use them as a gauge for the real economy (Hatzuis, Hooper, Mishkin, Schoenholtz, & Watson, 2010). Figure 11 above compares the SAFCI with annual GDP growth. Between 2005 and 2012 the correlation was very good, with the SAFCI leading GDP growth by three to six months. However, since September 2012 there was a disconnection, which coincided with the third wave of asset purchases (QE3) by the Fed. During, and slightly after this period, a gap between the FCI and

GDP is clearly visible in Figure 11; in econometric terms: a structural break. An XY-plot is a practical tool to present the relationship between the FCI and GDP.

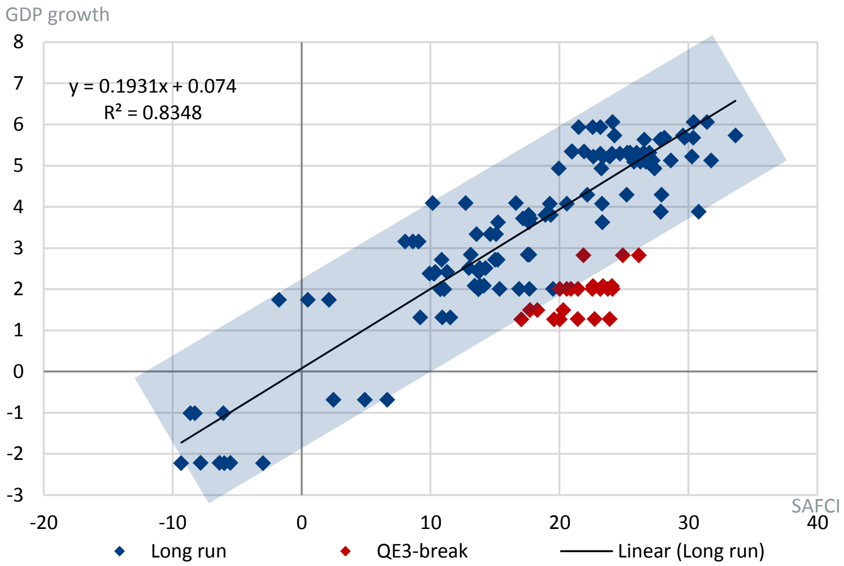

Figure 12: XY-plot of the SAFCI vs. 6-month lagged GDP growth
Source: BER

The slope of the fitted trend-line above indicates that for every 10 percentage points (% pts) that total annual financial returns (price and yields) decline in South Africa, annual economic growth will lose 1.9% pts of its potential six months later.

By the second quarter of 2015 the SAFCI fell to an average of 9.1%, from 18.8% in the first quarter. In the long run such a fall would imply a loss of 1.8% pts in the GDP growth rate two quarters later. This yield rate in the SAFCI should relate to an economic growth interval between -0.25% and 3.75% in the fourth quarter of 2015 (June lagged by six months is December). Given the structural break, it is more likely the GDP growth will be on the lower end of the probability interval.

5.2 Forecast performance

In order to measure the value added by an FCI to a GDP growth forecast, I will compare the accuracy of such a forecast with a naïve forecast (Van der Wath, 2013). In the naïve forecast, real-time GDP growth is regressed on itself, in this case, nine months in the past (AR9)[5]. One

[5] GDP is published with a lag of three months. The FCI leads GDP growth by 6 months, therefore the naïve forecast will be based on GDP growth of 9 months previously.

method to determine forecast accuracy is to estimate the RMSE (root of the mean squared error) of a forecast (Krainz, 2011). The RMSE measures the average size of the error in a forecast, and therefore a smaller RMSE is preferred. I calculated the naïve forecast from March 2009 to March 2015. In a control regression equation, I included the FCI lagged by 6 months (FCI(-6)) as an external variable. Then I calculated the RMSE of both forecasts in order to determine if there was any improvement in the accuracy.

As additional comparison, I also estimated a third equation based on only the FCI, and a fourth on only the growth in the shares-TRI, as exogenous variables. **Importantly**: all four these forecast series were compiled from rolling regressions, such that real time forecast series could be compiled for comparison. Finally I also calculated the RMSE of the BER's quarterly macro-economic forecast for two quarters ahead. The results are presented in the table below:

Table 4: RMSEs of the different 6-month-ahead forecasts

Forecast	6 months
From	Mar-09
AR(9)	3.13
FCI(-6) AR(9)	1.80
FCI(-6)	1.57
JSE(-6)	1.97
BER(2)	1.07

Source: BER

The RMSE of the naïve forecast (AR9) was 3.13, but when the FCI lagged by 6 months was included, the RMSE dropped to 1.80. The inclusion of the FCI thus improved the forecast accuracy of the naïve forecast significantly. Interestingly, when the real-time-GDP lag of 9 months were excluded, leaving only FCI(-6) as external variable, the RMSE declined even more (to 1.57). The RMSE of the BER-forecast was the smallest among the models, indicating it was more accurate than the others.

No conclusion can be made on the ability to forecast turning points in the business cycle, since the window of evaluation is too short.

6. A volatility index for South Africa

6.1 Background on volatility

Volatility is a measure of the variation in the price of any financial instrument over time, and is used to quantify the risk associated with that instrument. Two main types exist, namely historical and implied volatility (Brenner & Galai, 1989). Historical volatility is based on a historical price time series of an asset, and implied volatility on the option prices of an asset (traded derivative with a future expectation). In statistical terms, volatility is defined as the standard deviation of the logarithmic returns of a time series and represented by the symbol σ. It is calculated for a specific time period, for example a 22 or 65 day horizon (Kotze, 2005).

A high volatility is indicative of large swings in the value of an asset, and is associated with greater forecast difficulty –thus more risk. Lower volatility is indicative of price stability and better forecasts of future changes –thus smaller risk. An advantage of high volatility is that it presents more opportunity for speculation (to buy low and sell high), but at the penalty of more uncertainty. Normally, riskier assets would carry higher rates of return in order to compensate the investor for carrying that risk. Alternatively, safer assets carry lower rates of return to penalise the investor for being risk averse. This ratio explains why investment yield rates are lower in the advanced economies compared to emerging economies.

The best known volatility index in the financial markets is probably the Chicago Board Options Exchange Market Volatility Index, or better known as the CBOE-VIX. The VIX is an implied volatility measure and is calculated as a weighted blend of a range of options on the S&P500 index (CBOE, 2003).

6.2 Calculating volatility on the SATRI

As mentioned above, volatility can be calculated for different periods of time, say monthly, quarterly or annually. This variety of periods leads to the question of which frequency would be the most suitable to derive a single volatility index from the SATRI. I decided to test and compare six different horizons, from weekly to annually, calculating a moving standard deviation based on 5, 10, 22, 65, 130 and 260 days respectively. At the end I settled on a simple average of all six horizons[6]. In effect, this methodology resulted in a volatility index

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[6] I tested a weighted average with the rolling weights being the factor loadings of the first principle component, but the result was not significantly different from the simple average.

which is horizon-free. Interestingly enough, I applied this methodology to the S&P500, and obtained a volatility index (S&P500-vol) which has a 95% correlation to the VIX. See Figure 18 in the appendix for a graphical comparison. Figure 13 below compares the final volatility index (which I dubbed the SAVI) derived from the SATRI with the S&P500-vol.

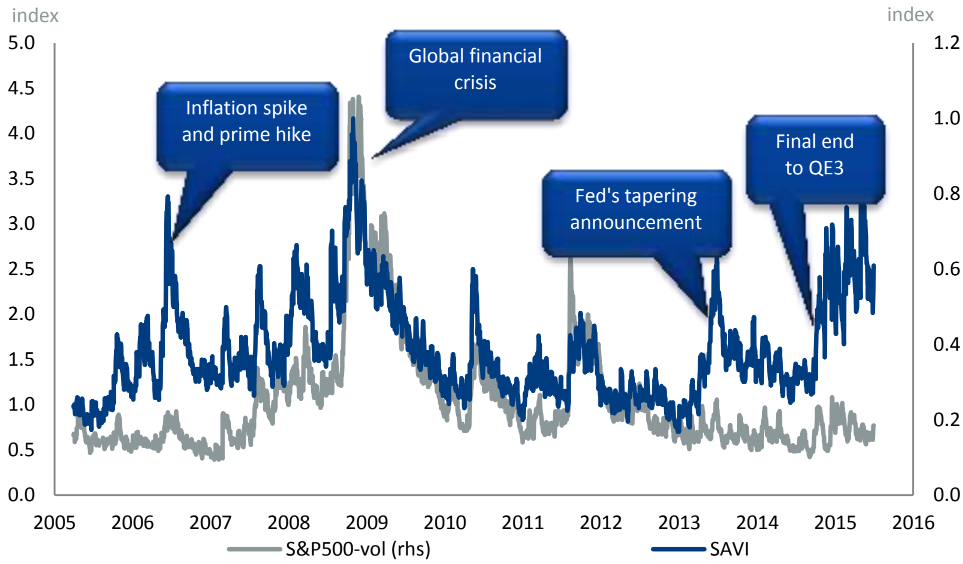

Figure 13: SA-volatility index vs. S&P500-volatility[7]
Source: BER

Interestingly, but as expected, the SAVI (portfolio of assets) is significantly less volatile compared to the S&P500 (shares only). Still, the co-movement between them is striking; the largest impact on South African financial conditions was definitely the global financial crises in 2008. The second largest was in May and June of 2006, when the inflation rate nearly doubled within three months, and the prime rate was hiked for the first time in 45 months. The IMF reported a synchronized tightening in monetary policy around the world at that stage, due to inflationary pressures (IMF, 2006). A recent major shock was in May 2013, when the Fed made the famous tapering announcement, followed by the actual end of QE3 in October 2014. Since then volatility has escalated significantly into 2015, reaching levels last seen in the global financial crisis.

[7] Note that these two indices actually run on the same scale, but the SAVI is much lower than the S&P500-vol, and therefore presented on its own scale for comparative purposes.

6.3 The efficient frontier in investment

One method used by investment analysts is an XY-ploy of the return versus the risk. Ideally, the preferred investment would yield a higher return given a specific level of risk. We can plot a theoretical line, called the efficient frontier, which represents the best return attainable for each level of risk (Callan Associates Inc, 2012). This efficient frontier is upward sloping, since safer investments demand lower returns and riskier investments higher returns. Thus, for any level of risk, the ideal would be to attain a yield rate close to the efficient frontier. Yields above the efficient frontier are abnormal. To assess the five different asset classes in the typical household portfolio, I present such a plot in Figure 14 below.

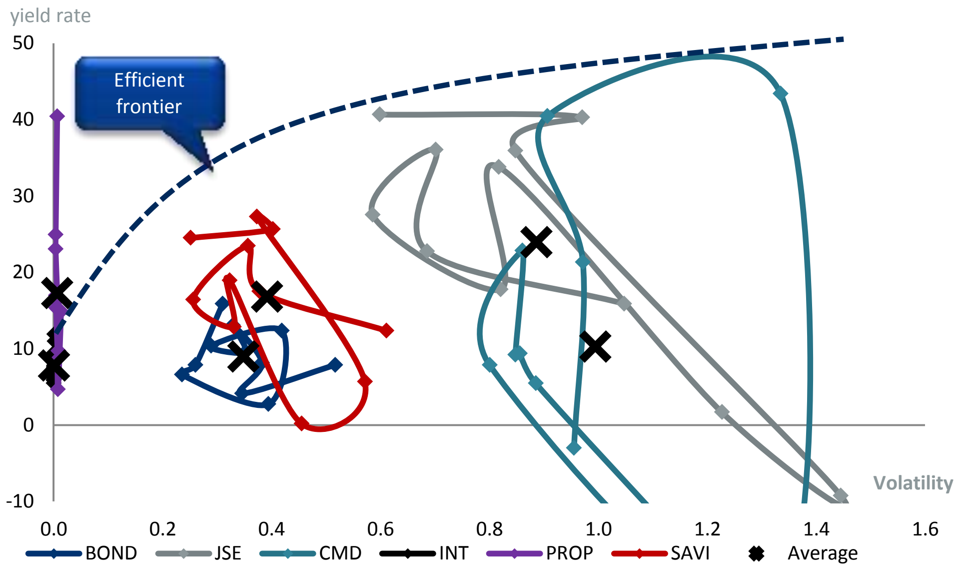

Figure 14: The investment frontier (XY-plot of yield rate vs. daily volatility)
Source: BER data from 2005 to 2015

On average, cash deposits (INT) and property (PROP) are the least risky among the five asset classes, and commodities (CMD) this most risky. Simultaneously, cash deposits also have the lowest yield rate. Shares and commodities were the only investments that had negative returns during the global financial crisis. It is also clear that commodities (CMD) are a sub-optimal investment; its return is too low given the level of risk associated with it. This outcome is not surprising since commodities have no dividend or interest return, only price growth. In contrast to commodities, residential property (PROP) turns out to have a low risk given its higher yield rates.

Another point to take notice of is the negative relation between yield and risk for shares and commodities over time. In other words, they tend to be volatile when their yields are low; quite the opposite of the ideal investment. In contrast, residential property behaves much more according to theory. As its yield declined over time, so did its volatility. Over the last decade it turned out that property had a lower risk but higher yield than the other asset classes, placing it above the efficient frontier on average.

The plot for the combined portfolio of the five asset classes (SAVI) is also presented in Figure 14. The portfolio has a yield which is fair given its volatility, though its huge exposure to shares nearly resulted in some losses during the international financial crisis.

7. Conclusion

I developed a suite of financial indices, each with a very practical use. The SATRI, which is the base index, tracks to the total return of the portfolio of assets belonging to South African households. It has a base of 1 on 3 January 2005, and grew to a value of 4.26 by June 2015. It can be used by investors to gauge the performance of the portfolio of assets which is typical to South Africa. The index is updated daily, and therefore also useful as a real time indicator.

Secondly, the SAFCI, which is the year-on-year percentage change in the SATRI, falls in the same broad class of financial conditions indicators. It correlates highly with annual growth in the real economy, leading it by three to six months. It can be used by analysts to assist in the forecasting of economic growth. The SAFCI is highly influenced by international financial events and policies –an indication of the openness of the South African economy.

Thirdly, the SAVI, which is the standard deviation of daily changes in the SATRI, tracks volatility in the domestic financial market. It highlights the magnitude of domestic shocks and their linkages to international shocks. The volatility indices of the five assets classes in the portfolio also indicate that property and cash deposits are a better assets compared to commodities and bonds.

Finally, I will now be able to update this suite of indices on a regular basis (even daily) in order to inform the consumers of economic and financial data to make better policy, business and investment decisions.

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9. Appendix

This addendum provides additional tables, graphs and explanations to supplement the main text.

Table 5: Household balance sheet divided into asset classes

Household balance sheet (2014)	R billion	Asset class
Residential buildings	2 355	property
Other non-financial assets	491	commodities
Assets with monetary institutions	859	cash
Interest in pension funds and long-term insurers	3 805	a., b. and c.
Other financial assets	2 370	shares & unit trusts (d.)
TOTAL	**9 879**	
a. Official pension and provident funds	***1 693***	
Cash and deposits	*48*	cash
Fixed-interest securities: Government	*351*	bonds
Fixed-interest securities: Local governments	*2*	bonds
Fixed-interest securities: Public enterprises	*152*	bonds
Fixed-interest securities: Other	*85*	bonds
Ordinary shares	*921*	shares
Other assets	*133*	commodities
b. Private self-administered pension and provident funds	***908***	
Coin, banknotes and deposits	*59*	cash
Fixed-interest securities: Government	*163*	bonds
Fixed-interest securities: Local governments	*5*	bonds
Fixed-interest securities: Public enterprises	*16*	bonds
Fixed-interest securities: Other	*120*	bonds
Ordinary shares	*508*	shares
Loans: Mortgage	*0*	loans
Loans: To public sector	*0*	loans
Loans: Other	*2*	loans
Fixed property	*14*	property
Other assets	*21*	commodities
c. Long-term insurers	***2 371***	
Coin, banknotes and deposits	*182*	cash
Fixed-INTerest securities: Government	*198*	bonds
Fixed-INTerest securities: Local governments	*5*	bonds
Fixed-INTerest securities: Public enterprises	*29*	bonds
Fixed-INTerest securities: Other	*147*	bonds
Ordinary shares	*1 247*	shares
Loans: Mortgage	*1*	loans
Loans: Against policies	*2*	loans
Loans: To public sector	*3*	loans
Loans: Other	*173*	loans
Fixed property	*58*	houses
Other assets	*326*	commodities
d. Unit trusts	***1 652***	
Public-sector securities	*206*	bonds
Stocks, debentures and preference shares	*65*	shares
Ordinary shares	*947*	shares
Cash and deposits	*435*	cash

Source: SARB Quarterly Bulletin, March 2014

9.1 Deriving a TRI from a growth rate series

First, we are working with daily data, and there is normally 260 trading days in a calendar year (public holidays are included), and 260/12 trading days in a month. Secondly, bank deposit interest is compounded monthly, but the TRI is calculated daily. To avoid any compound differences building up over time, I will use the logarithmic formula for growth, where the daily growth rate are:

$$growth_t = 100 * (\ln(level_t) - \ln(level_{t-1})) \qquad \ldots(1)$$

But for money market deposits, the daily interest rate in the market is quoted in annual terms. Thus, to convert it to daily terms:

$$growth_t = growth_{y_t}/260 \qquad \ldots(2)$$

Where *t* refers to the day and *y* indicates annual rate. To derive the formula for the TRI, we need to substitute equation (2) into equation (1) and make $level_t$ the subject of the equation.

$$\therefore \ln(level_t) - \ln(level_{t-1}) = \frac{growth_{y_t}/260}{100}$$

$$\therefore \ln(level_t) = \frac{growth_{y_t}}{100 * 260} + \ln(level_{t-1})$$

$$\therefore level_t = e^{\left(\frac{growth_{y_t}}{100*260} + \ln(level_{t-1})\right)}$$

9.2 Some additional figures

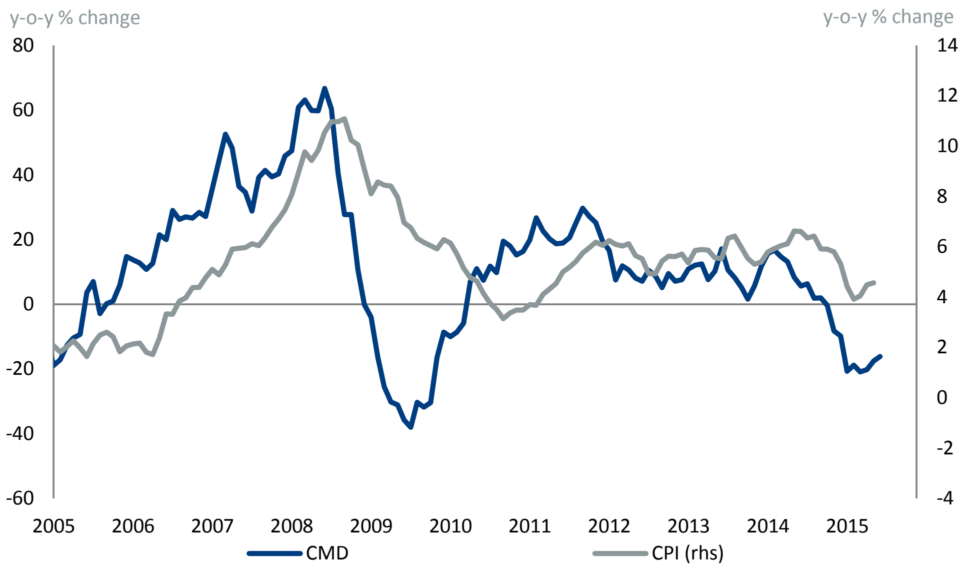

Figure 15: Commodity yield rate vs. inflation rate
Source: StatsSA & BER

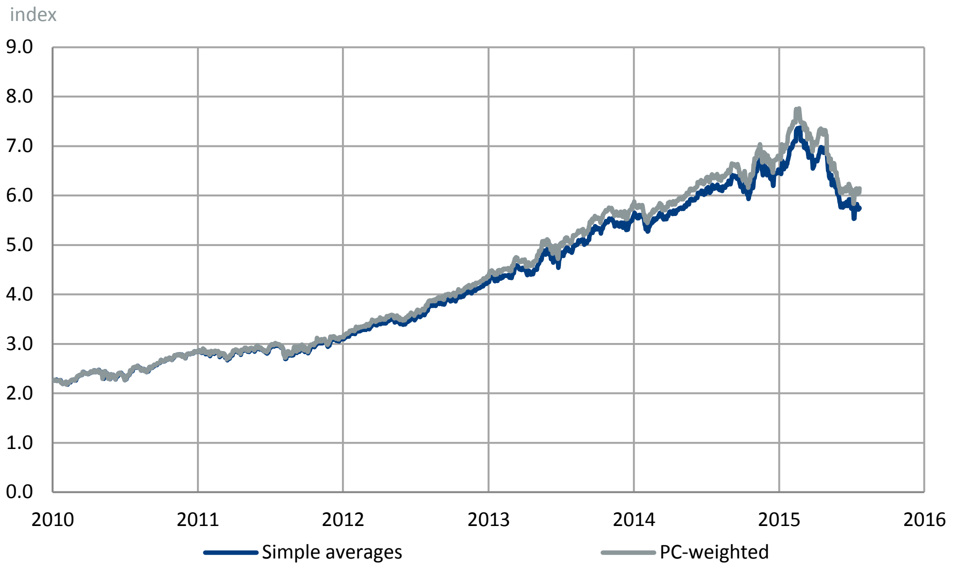

Figure 16: Shares-TRIs: the PC-weighted vs. the simple average
Source: BER

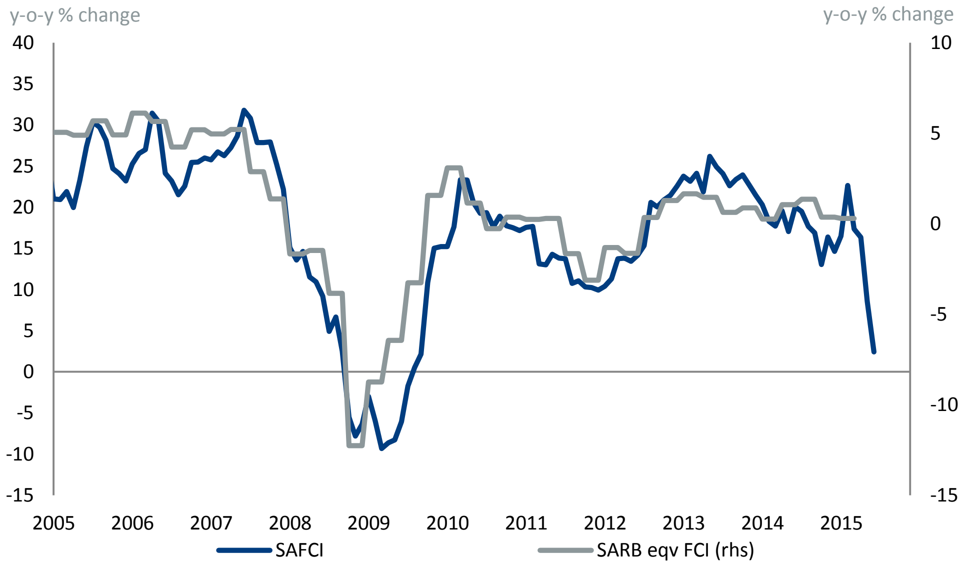

Figure 17: Comparison between the SAFCI and SARB-FCI
Source: BER

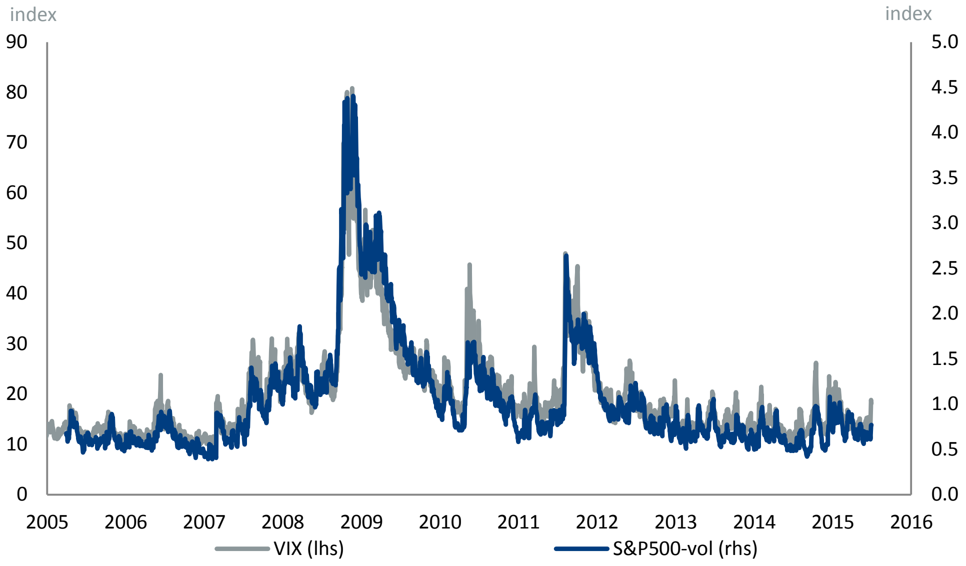

Figure 18: VIX vs. weighted average volatility on S&P500
Source: Thomson Reuters & BER

9.3 Eviews code to calculate rolling principle components

```
smpl @all
!end=12
matrix(6,1) mg_bond
matrix(9,1) mg_cmd
matrix(4,1) mg_int
matrix(9,1) mg_jse
matrix(4,1) mg_prop
matrix(1,!end+2) all

For %group g_bond g_jse g_cmd g_int  g_prop
        For !obs =  0 to !end
        smpl if @year>=2003+!obs-5 and @year<2003+!obs
        {%group}.pcomp(eigvec=m_!obs) i_{%group}
        vector v_!obs = @columnextract(m_!obs,1)
        matrix m{%group} = @hcat(m{%group}, v_!obs)
        next
        matrix all=@vcat(all,m{%group})
next

matrix weight=@transpose(all)
```

9.4 Eviews code to calculate real-time forecasts

```
        For !obs =  0 to 81

        smpl 2003m7+!obs 2003m7+!obs+59
        equation eq_gdp_ar.ls rt_gdp rt_gdp(-9) c
        equation eq_gdp_ar_fci.ls rt_gdp fci(-6) rt_gdp(-9) c
        equation eq_gdp_fci.ls rt_gdp fci(-6) c
        equation eq_gdp_jse.ls rt_gdp jse(-6) c

        smpl 2003m07+!obs+68 2003m07+!obs+68
        eq_gdp_ar.fit gdp_ar_f
        eq_gdp_ar_fci.fit gdp_ar_fci_f
        eq_gdp_fci.fit gdp_fci_f
        eq_gdp_jse.fit gdp_jse_f

        series rt_gdp_ar_f=gdp_ar_f
        series rt_gdp_ar_fci_f=gdp_ar_fci_f
        series rt_gdp_fci_f=gdp_fci_f
        series rt_gdp_jse_f=gdp_jse_f
next
smpl @all
```