Turkish Economic Review
econsciences.com

Volume 12 | December 2025 | Issue 4

Beyond benign neglect: An extreme bounds analysis of the relationship between monetary policy and financial stress indicators in South Africa

By Nomvula Z. NDLOVU †

Abstract. The 2008 global financial crisis fundamentally challenged the "benign neglect" orthodoxy, which posited that central banks should ignore asset price fluctuations unless they directly impact inflation outlooks. Since then, the debate has shifted toward "leaning against the wind," suggesting that monetary policy should proactively respond to financial misalignments. This paper investigates the empirical relationship between a broad set of financial stress indicator variables and the monetary policy interest rate in South Africa from January 2000 to December 2013. To address the lack of consensus on which financial variables are most relevant and to mitigate model uncertainty, the study employs Extreme Bounds Analysis (EBA) as proposed by Leamer (1985) and Sala-i-Martin (1997). This methodology assesses the robustness of 15 financial stress indicators across thousands of regression specifications, categorizing them into bond, equity, commodity, and exchange rate markets. The empirical results reveal that sovereign bond spreads, A-rated bond spreads, corporate bond spreads, stock market returns, credit extension growth, and property market returns are robustly associated with the South African repurchase rate. In contrast, variables such as oil market returns, the VIX S&P500, and sector-specific betas appear fragile and weakly linked to policy decisions. These findings suggest that the South African Reserve Bank implicitly accounts for specific financial imbalances in its policy deliberations. The study provides a necessary precondition for designing optimal monetary policy frameworks that integrate financial stability without compromising inflation targeting objectives.
Keywords. Monetary policy; Financial stress indicators; Extreme bounds analysis; South Africa; Asset price misalignment.
JEL. C52; E44; E52; E58; G12.

1. Introduction

The consensus view before the recent financial crisis was that monetary policy should focus on inflation and output stabilisation and ignore movements in asset prices. According to Issing (2011), the prevailing orthodoxy then was that central banks should take asset prices into account only if they might have an effect on the outlook for inflation. This view that is sometimes referred to as benign neglect became prominent among policy makers following the empirical support by Bernanke & Gertler (1999; 2001). Arguments advanced in support of this view are that asset price bubbles are difficult to detect and to measure in real time and that interest rates are too

† Department of Economics, University of KwaZulu-Natal, South Africa.
| | | CRediT (article last page)
Received 20 Nov. 2025; Received in revised from 10 Dec. 2025; Accepted 20 Dec. 2025.

https://doi.org/10.1590/xxx-2025-xxx

blunt an instrument to deal with asset price misalignments and could have unintended consequences on the economy in terms of lost output.

The recent financial crisis has demonstrated that asset prices play an important role in macroeconomic fluctuations and has challenged the pre-crisis consensus, strengthening the argument thatcentral banks should respond to developments in asset price misalignments. Empirical support in favour of this view also known as leaning against the wind is provided by Cecchetti et al. (2000; 2003), Borio & White (2004), Curdia & Woodford (2010; 2011) and Woodford (2012), among others. Despite the fact that the consensus view of benign neglect was a robust theory before the recent financial crisis, it has recently been called into question for not being optimal in all circumstances. This is because the recent financial crisis has shown that it is possible for financial imbalances to develop even in an environment of stable and low inflation as argues Borio & White (2004).

Recent empirical literature provides evidence that benign neglect may no longer be valid in models that consider frictions in financial intermediation. This literature builds on Edwards & Vegh (1997), Kiyotaki & Moore (1997), Bernanke & Gertler (1999; 2001), Bernanke et al. (1999) who build financial frictions into dynamic macroeconomic models. Recent advances in this literature include Taylor (2008), Gertler & Karadi (2009), Gertler & Kiyotaki (2011), Christiano et al. (2010), Curdia & Woodford (2010; 2011) and Woodford (2012). Alternative approachesinclude Cecchetti et al. (2000; 2003), Borio & Lowe (2004), Baxa et al. (2013), Gali (2013) and Gali & Gambetti (2013) who use monetary policy reactions function that are augmented with measures asset price misalignments such as credit and equity gaps. The use of financial stress indicators, which aggregate several asset price variables into a single measure that approximate financial misalignments, has also gained popularity and can be found in Illing & Liu (2006), Balakrishnan et al. (2009), Hakkio & Keeton (2009), Lo Duca & Peltonen (2011) and Borio (2012), among others.

Despite this burgeoning literature, a generally agreed framework for analysing the link between monetary policy and asset prices does not existas notes Borio (2011), Issing (2011), Caprio (2011) and Roger & Vclek (2012). Furthermore, there also exists no consensus on the variables to use in measuring financial stress as argues Kliesen et al. (2012). On the one hand, most of the literature on financial frictions concentrates more on linking individual variables such as house prices, stock market indexes and private sector credit extension to the macroeconomy. On the other hand, the literature that construct financial stress indicators do so based on aggregation of a wide range of variables subjectively chosen from bond and equity securities markets, commodity markets and foreign exchange markets.

The aggregation of these variables into a single measure of financial stress is also based on subjective weighting with methods that rely on internal correlations amongsuch variables such as principal components analysis and factor analysis. However, if these variables are to be monitored to possibly be targetedusing the monetary policy interest rate as the lean against the wind debate suggests and to form an important theme in monetary policy deliberations, it is important to understand their relationship with monetary policy interest rate. According to Gali & Gambetti (2013), understanding such a relationship is a necessary precondition to provide information on the design of monetary policy if it is to be used to target asset price misalignments.

This paper analyses the relationship between different financial stress indicator variables and monetary policy in South Africa since the advent of inflation targeting. Of particular interest is how robust these set of financial stress indicator variables are related to the monetary policy interest rate over the sample period. This is achieved using extreme bounds analysis methods proposed by Leamer (1985) and Sala-i-Martin (1997). These methods resample a large number of model specifications to determine the financial stress indicator variables that are robustly associated with the monetary policy interest rate across a large number of possible regression models.

Several studies have provided evidence of a robust relationship between the monetary policy interest rate and some individual financial variables in South Africa. These include Liu & Seeiso (2012) who find that small changes in monetary policy trigger stronger response in the real economy taking into account Basel II bank capital regulation and Kabundi & Ngwenya (2011) who find that financial variables react negatively to a contractionary monetary policy shock. Other contributions include Naraidoo & Raputsoane (2010), Kasai & Naraidoo (2012) as well as Naraidoo & Paya (2012) who find a statistically significant relationship between the policy interest rate and the composite index of financial conditions in South Africa.

The paper is organised as follows. Next the data description followed by methodology. This is followed by the discussion of theempirical results and the conclusion.

2. Data description

Monthly data spanning the period of January 2000 to December 2013 is used in estimation and is sourced from the South African Reserve Bank database. The repurchase rate, which is the nominal policy interest rate in South Africa measures monetary policy stance. The financial stress indicator variables comprise a set of 15 variables from the main segments of the South African financial market, including bond and equity securities markets as well as commodity market and the exchange rate market. These variables include the interbank spread, sovereign bond spread, A rated bond spread, corporate bond spread, stock market return, financial sector return, banking sector return, nominal effective exchange rate return, credit extension growth, property market return, commodity market return, oil market return, VIX S&P500, financial sector beta and banking sector beta.

The selection of these variables relied heavily on existing literature, their relevance and availability of data. Similar variables have been used in the literature to construct a composite financial stress index by Illing & Liu (2006), Balakrishnan et al. (2009), Cardarelli et al (2009), Hakkio & Keeton (2009), Lo Duca & Peltonen (2011), Borio (2012) and Cevik et al. (2012), while Kliesen et al. (2012) survey a wide variety of financial stress indicator variables that have been used in the literature to build different financial stress indexes. The descriptive statistics of all the financial distress indicator variables are presented in Table 1.

Interbank spread is the spread between the 3 month Johannesburg Interbank Agreed Rate (JIBAR) rates and the 3 month Treasury bill rate. Sovereign bond spread is the spread between the 3 month treasury bill rate and the 10 year government bond yield. A rated bond spread is the spread between the A rated Eskom bond and the 10 yeargovernment bond yield. Corporate bond spread is the spread between the FTSE/JSE All Bond yield and the 10 year treasury bill rate. Stock market return is the annualised change in the FTSE/JSE All Share stock market index. Financial sector return is the annualised change in the FTSE/JSE Financials stock market index. Banking sector return is the annualised change in the FTSE/JSE Banks stock market index.

Nominal eff. exchange rate return is the annualised change in nominal effective exchange rate. Credit extension growth is the annualised change in total private credit extension. Property market return is the annualised change in the average price of all houses compiled by the ABSA bank. Commodity market return is the annualised change the Economist's commodity price index. Oil market return is the annualised change in the Brent crude oil price. VIX S&P500 is the Chicago Board's implied volatility of the S&P 500 index. Financial and Banking sector betas are the capital asset pricing model betas computed over the one year rolling window of the annualised FTSE/JSE Financials and Banks stock market index returns, respectively.

Table 1. *Descriptive statistics*

	Mean	Std. Dev.	Skewness	Kurtosis	J-Bera	Probability
Repurchase rate	8.615	2.693	0.244	1.712	13.282	0.001
Interbank spread	0.380	0.334	1.198	3.790	44.577	0.000
Sovereign bond spread	-0.881	1.915	0.632	2.440	13.397	0.001
A rated bond spread	1.117	0.862	1.522	5.157	97.448	0.000
Corporate bond spread	1.027	0.824	-0.105	1.787	10.607	0.005
Stock market return	-16.129	20.007	0.575	3.441	10.607	0.005
Financial sector return	-11.350	20.448	0.222	2.444	3.543	0.170
Banking sector return	-13.831	20.606	-0.138	2.779	0.878	0.645
Nominal exch return	0.324	1.470	-0.493	2.781	7.150	0.028
Credit extension growth	0.807	0.588	0.282	2.053	8.506	0.014
Property market return	1.262	0.943	0.287	2.725	2.829	0.243
Comm market return	1.161	1.910	-0.049	2.482	1.941	0.379
Oil market return	2.277	3.493	0.743	5.021	44.072	0.000
VIX S&P500	21.377	8.441	1.577	6.544	157.597	0.000
Financial sector beta	0.794	0.535	0.307	2.970	2.641	0.267
Banking sector beta	0.436	0.549	-0.121	2.594	1.563	0.458

Notes: Own calculations with data from the South African Reserve Bank database

3. Empirical methodology

Extreme Bounds Analysis (EBA) methods proposed by Leamer (1985) and Sala-i-Martin (1997) are used to analyse the relationship between different financial stress indicator variables and monetary policy in South Africa. According to Hlavac (2014), extreme bounds analysis is a sensitivity test that assesses how robustly the explained variable of a regression model is related to a variety of possible explanatory variables. Extreme bounds analysis achieves this by resampling a large number of model specifications to determine the explanatory variables that are robustly associated with the dependent variable across a large number of possible regression models. Sala-i-Martin (1997), Levine & Renelt (1992) and Sturm & de Haan (2005) have used extreme bounds analysis to investigate the determinants of long term economic growth, while Reed (2009) and Cardak & Moosa (2006) have used extreme bounds analysis to investigate the determinants of regional growth rates and foreign direct investment, respectively.

The basic idea of extreme bounds analysis is to find out the explanatory variables from the set X that are robustly associated with the dependent variable Y. A large number of regression models each with Y as the dependent variable and a set of free explanatory variables F that are robustly related to the dependent variable regardless of model specification are estimated. In addition, each model includes a different subset of doubtful explanatory variables D such that $D \in X$. These variables may either measure similar concepts and may introduce multicollinearity in extreme bounds analysis. Furthermore, each model includes a different subset of focus explanatory variables V such that $V \in X$. These variablesmay be of particular interest to the analysis at hand.

Extreme bounds analysis involves estimating regression models of the following form to determine whether doubtful explanatory variables D and focus explanatory variables V that are a subset of explanatory variables X are robustly related with the dependent variable Y.

$$y_t = \alpha_{tj} + \gamma_j F_t + \beta_{tj} V_t + \delta_{tj} D_{tj} + \varepsilon_t \tag{1}$$

where j indexes the different regression models. F_t is a vector of free explanatory variables that will be included in every regression model. V_t is a vector of focus explanatory variables that are of particular interest to the analysis at hand and D_t is a vector of doubtful explanatory variables that include a set of variables that may measure similar concepts and those that may possibly be multicollineartaken from the set ofexplanatory variables X_t. α_t is the intercept, γ_j, β_{tj} and δ_{tj} are coefficients, while ε_t is the error term.

Leamer's (1985) extreme bounds analysis focuses on the upper and lower extreme bounds of regression coefficients. The criteria for robustness of explanatory variables in Leamer's (1985) extreme bounds analysis is demanding in that in order for a variable to be considered to be a robust explanatory variable, all its upper and lower bounds should have the same sign over all the estimated regression models. Alternatively, Sala-i-Martin's (1997) extreme bounds analysisconsiders the entire distribution of the regression coefficients of explanatory variables and not just their upper and lower extreme bounds by assigning some level of confidence to the robustness of each explanatory variable. It also presents two variants of extreme bounds analysis, a normal model where the estimated regression coefficients are assumed to follow a normal distribution across the estimated models and a generic model that does not assume any particular distribution of regression coefficients across different model specifications.

The advantages of extreme bounds analysis methods proposed by Leamer (1985) and Sala-i-Martin (1997) over existing alternatives are that they can estimate regression models of any size as well as alleviate multicollinearity and conceptual overlap of examined variables by allowing specification of different sets of mutually exclusive variables. A detailed discussion of these extreme bounds analysis methods can be found in Leamer (1985), Leamer & Leonard (1983) and Sala-i-Martin (1997).

4. Empirical results

Leamer's (1985) and Sala-i-Martin's (1997) extreme bounds analysis follow a two-step approach. The first step involves conducting naive extreme bounds analysis where the combinations of all the financial stress indicator variables are estimatedto determine the variables that are robustlyassociated with the monetary policy interest rate. According to Hlavac (2014), this type of extreme bounds analysis is naive in that it ignores the possibility of multicollinearity among explanatory variables or that some variables may measure similar concepts. However, conductingnaive extreme bounds analysis yields desirable insights that allow for a more sophisticated extreme bounds analysis. It indicates which explanatory variables are robustly associated with the dependent variableand can be treated as free explanatory variables, while the rest of the variables can be tread as either focus explanatory variables or doubtful explanatory variables in a more sophisticated extreme bounds analysis.

Although the results ofnaive extreme bounds analysis are not reported here on conciseness consideration, they show that interbank spread, sovereign bond spread, corporate bond spread, financial market return and property market return are robustly related to the policy interest rate, while the rest of the financial stress indicator variables are fragile and hence will be treated as focus explanatory variables in a more sophisticated extreme bounds analysis. The second step involves conductingthe sophisticated version of extreme bounds analysis. The results of naive extreme bounds analysis have shown that interbank spread, sovereign bond spread, corporate bond spread, financial market return and property market return are robustly related to the policy interest rate. Therefore, these variables are treated as free explanatory variables in sophisticated extreme bounds analysis. The rest of the financial stress indicator variables are fragile and are treated as focus explanatory variables in sophisticated extreme bounds analysis. Some financial market distress indicator variables measure similar concepts and may introduce multicollinearity in extreme bounds analysis estimation.

To prevent conceptual overlaps and to minimise the possibility of multicollinearity among the financial stress indicator variables, thegroup of financial stress indicator variables that measure either the bond and equity securities markets, commodity markets and the exchange rate market were estimated as mutually exclusivesuch that no more than two focus variables belonging to each of these groups were included in the same regression model, saving those that already make a set of free explanatory variables. The maximum acceptance variance inflation factor is set at 5 to minimise the possibility of multicollinearity among the financial stress indicator variables. The White (1980) heteroscedasticity consistent standard errors are used to allow the fitting of regression models that may contain heteroscedastic residuals. The McFadden (1974) likelihood ratio index weights are used to give more weight to regression models that provide a better fit to the data.

The results of Leamer's (1985) extreme bounds analysis are presented in Table 2, while the results of Sala-i-Martin's (1997) extreme bounds analysis are presented in table 3. For both extreme bounds analysis methods, all the1 660 possible combinations containing all the free explanatoryfinancial market distress indicator variables were estimated. However, fewer combinations of the focus explanatory variables are estimated to account for conceptual overlap and to minimise multicollinearity as discussed above. The first three columns of Leamer's (1985) and Sala-i-Martin's (1997) extreme bounds analysis in Tables 2 and 3 show the results of the weighted means of the coefficients, the associated standard errors and the percentage of regression coefficients that are both statistically significant for both the free and focus explanatory variables.

The results show that all coefficients of sovereign bond spread, A rated bond spread, corporate bond spread, stock market return, financial sector return, credit extension growth and property market return are statistically significant in all estimated regression models. About 99.0 percent of the coefficients of interbank spread are statistically significant in all estimated regression models. Between 88.5 and 84.5 percent of the coefficients of banking sector return, nominal effective exchange rate return and commodity market return are statistically significant. Less than 25 percent of the coefficients of oil market return, VIX S&P500, financial sector beta and banking sector betaare statistically significant in all estimated regression models. For the coefficients where 95.0 percent or above are statistically significant in all estimated regression models, the results show that a unit increase in the interbank spread, sovereign bond spread, financial sector return, credit extension growth and property market return is associated with about 2.2, 1.3, 0.04, 0.7 and 0.2 percentage increase in the policy interest rate, respectively. The results further show that a unit decrease in the A rated bond spread, corporate bond spread and stock market return is associated with about 0.8, 2.8, and 0.04 percentage increase in the policy interest rate, respectively.

The results of Leamer's (1985) extreme bounds analysis are reported in the last three columns of Table 2.Theyshow that sovereign bond spread, A rated bond spread, corporate bond spread, stock market return, financial sector return, credit extension growth and property market return are robustly associated with the policy interest rate, while the rest of the financial stress indicator variables are fragile or weakly associated with policy interest rate. It is important to notice that interbank spread is identified by Leamer's (1985) extreme bounds analysis as weakly associated with policy interest rate even though 99.0 percent of its coefficients are statistically significant in all estimated regression models. This is because its upper and lower extreme bounds have opposite signs. As discussed above, compared to Sala-i-Martin's (1997) extreme bounds analysis as will be seen below, Leamer's (1985) extreme bounds analysis is more demanding in thatit suggests relatively higher fragility of the estimated coefficients of financial stress indicator variables and henceidentifies it them as weakly associated withthe policy interest rate.

Table 2. *Leamer's extreme bounds analysis results*

	Coefficient	Std error	Significant	Lower EB	Upper EB	Rob/Frag
Intercept	9.928	0.409	100.000	7.265	13.170	robust
Interbank spread	2.155	0.465	98.976	-0.264	4.589	fragile
Sovereign bond spread	1.255	0.113	100.000	0.774	1.896	robust
A rated bond spread	-0.816	0.124	100.000	-1.405	-0.420	robust
Corporate bond spread	-2.824	0.250	100.000	-4.369	-1.841	robust
Stock market return	-0.044	0.006	100.000	0.007	0.146	robust
Financial sector return	0.041	0.008	100.000	-0.070	-0.025	robust
Banking sector return	-0.039	0.012	84.615	-0.112	0.015	fragile
Nominal exch return	0.200	0.056	88.453	-0.064	0.450	fragile
Credit extension growth	0.603	0.183	100.000	0.012	1.491	robust
Property market return	1.660	0.112	100.000	1.163	2.109	robust

Comm market return	0.151	0.047	84.527	-0.263	0.509	fragile
Oil market return	0.040	0.030	22.171	-0.096	0.146	fragile
VIX S&P500	0.011	0.016	0.000	-0.040	0.074	fragile
Financial sector beta	0.063	0.168	17.090	-1.483	1.143	fragile
Banking sector beta	0.008	0.160	4.619	-0.909	1.243	fragile

Notes: *Coefficient* and *Std error* are the weighted mean of size of regression beta coefficients and standard error estimates for variables across the estimated regression models, *Significant* is the percentage of regression coefficients that are both statistically significant and lower or greater than zero. *Lower EB* and *Upper EB* are the upper and the lower extreme bounds of regression coefficients estimates, classified as robust and fragile hence *Rob/Frag*.

The results of Sala-i-Martin's (1997) extreme bounds analysis are reported in last two columns of Table 3. Theresults from the generic model that makes no assumption about a particular distribution of the coefficients across the estimated regression models reported, while the results from the normal model are available on request. The results show that more than 95.0 percent of the coefficients of interbank spread, sovereign bond spread, A rated bond spread, corporate bond spread, stock market return, financial sector return, banking sector return, nominal effective exchange rate return, credit extension growth, property market return lie either above or below zero and hence these financial stress indicator variables are robustly associated with the policy interest rate. The results further show that less than 95.0 percent of the coefficients of commodity market return, oil market return, VIX S&P500, financial sector beta and banking sector beta lie either above or below zero and hence these financial stress indicator variables are weakly associated with the policy interest rate.

Table 3. *Sala-i-Martin's extreme bounds analysis results*

	Coefficient	Std error	Significant	Beta<=0	Beta>0
Intercept	9.928	0.409	100.000	0.000	100.000
Interbank spread	2.155	0.465	98.976	0.174	99.826
Sovereign bond spread	1.255	0.113	100.000	0.000	100.000
A rated bond spread	-0.816	0.124	100.000	100.000	0.000
Corporate bond spread	-2.824	0.250	100.000	100.000	0.000
Stock market return	-0.044	0.006	100.000	0.011	99.989
Financial sector return	0.041	0.008	100.000	100.000	0.000
Banking sector return	-0.039	0.012	84.615	96.556	3.444
Nominal exch return	0.200	0.056	88.453	0.686	99.314
Credit extension growth	0.603	0.183	100.000	0.119	99.881
Property market return	1.660	0.112	100.000	0.000	100.000
Comm market return	0.151	0.047	84.527	12.053	87.947
Oil market return	0.040	0.030	22.171	20.536	79.464
VIX S&P500	0.011	0.016	0.000	28.867	71.133
Financial sector beta	0.063	0.168	17.090	39.516	60.484
Banking sector beta	0.008	0.160	4.619	48.607	51.393

Notes: *Coefficient* and *Std error* are the weighted mean of size of regression beta coefficients and standard error estimates for variables across the estimated regression models, *Significant* is the percentage of regression coefficients that are both statistically significant and lower or greater than zero. *Beta<=0* and *Beta>0* are the cumulative distribution functions for the regression coefficients that are below or equal to zero and greater than zero, respectively, for the Generic model with no assumption about the distribution of beta coefficients across different models.

Figure 1 presents a set of histograms that summarise the estimation results of both Leamer's (1985) and Sala-i-Martin's (1997) extreme bounds analysis. The coefficients for each financial stress indicator variable from all the estimated regression models are represented by the grey bar charts. The blue line is a non-parametric kernel density approximation of the estimated regression coefficients, while green line is the normally distributed approximation of the regression coefficients for each financial stress indicator variable from all the estimated regression models. Visual inspection of the histograms confirms Leamer's (1985) and Sala-i-Martin's (1997) extreme bounds analysis estimation results. The histograms also suggest that the normally distributed approximation of the regression coefficients for the financial stress indicator variables do not provide a good fit to the data. This provides support for Sala-i-Martin's (1997) extreme bounds analysis results from the generic model that does not assume any particular distribution of regression coefficients across different specifications as being more appropriate.

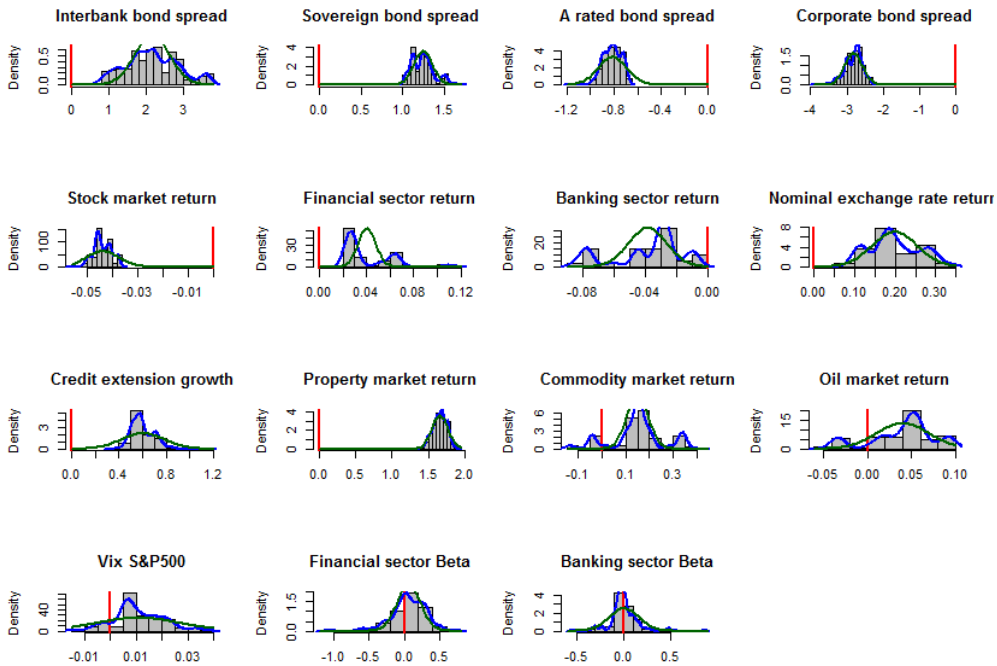

Figure 1. *Histograms of the variables across the estimated regression models*
Notes: The coefficients for each financial stress indicator are represented by the grey bar charts. The blue line is a non-parametric kernel density approximation of the estimated regression coefficients, while green line is the normally distributed approximation of the regression.

In general, the empirical results provide evidence that the set of financial stress indicator variables from the bond and equity securities markets as well as those from credit markets and property markets are robustly associated with the monetary policy interest rate, while the set of financial stress indicator variables from commodity markets and the exchange rate market are weakly associated with the monetary policy interest rate. As discussed above, Cecchetti et al. (2000; 2003), Borio & White (2004), Curdia & Woodford (2010; 2011) and Woodford (2012), among others, support the view that monetary policy should lean against the wind.

In the event that monetary policy could be conducted such that it leans against the wind, the financial stress indicator variables from the bond and equity securities markets as well as those from credit markets and property markets could be monitored and possibly targeted using the monetary policy interest rate. Therefore, these financial stress indicator variables could form an important theme in monetary policy deliberations by providing information on asset price misalignments and hence provide guidance on the possible monetary policy stance to the monetary authorities in South Africa.

5. Conclusion

This paper analysed the relationship between different financial stress indicator variables and monetary policyin South Africa since the advent of inflation targeting. Of particular interest was how robustly associated with the monetary policy interest rate these set of financial stress indicator variables are over the sample period. Extreme bounds analysis methods proposed by Leamer (1985) and Sala-i-Martin (1997) were used in the analysis. These methods resample a large number of model specifications to determine the financial stress indicator variables that are robustly associated with the monetary policy interest rate across a large number of possible regression models.

The empirical results show that the set of financial stress indicator variables from the bond and equity securities markets as well as those from credit markets and property markets are robustly associated with the monetary policy interest rate, while the set of financial stress indicator variables from commodity markets and the exchange rate market are weakly associated with the monetary policy interest rate. In particular, the results show that the set of financial stress indicator variables that include sovereign bond spread, A rated bond spread, corporate bond spread, stock market return, financial sector return, credit extension growth and property market return are robustly associated with the movement in the monetary policy interest rate in majority of the estimated regression models.

The results further show that the set of financial stress indicator variables that include commodity market return, oil market return, VIX S&P500, financial sector beta and banking sector beta are weakly associated with the movement in the monetary policy interest rate.In the event that monetary policy could be conducted such that it leans against the wind, the financial stress indicator variables from the bond and equity securities markets as well as those from credit markets and property markets could be monitored and possibly targeted using the monetary policy interest rate. Therefore, these financial stress indicator variables could form an important theme in monetary policy deliberations by providing information on asset price misalignments and hence provide guidance on the possible monetary policy stance to the monetary authorities in South Africa.

Future research could explore the possibility of nonlinearities in the relationship between these set of financial stress indicator variables and monetary policy interest rate in South Africa.

References

Balakrishnan, R., Danninger, S., Elekdag, S., & Tytell, I. (2009). *The transmission of financial stress from advanced to emerging economies* (IMF Working Paper No. 09/133). International Monetary Fund. https://doi.org/10.5089/9781451873801.001

Baxa, J., Horvath, R., & Vasicek, B. (2013). Time-varying monetary-policy rules and financial stress: Does financial instability matter for monetary policy? *Journal of Financial Stability, 9*(1), 117–138. https://doi.org/10.1016/j.jfs.2011.10.002

Bernanke, B. S., & Gertler, M. (1999). Monetary policy and asset price volatility. *Federal Reserve Bank of Kansas City Economic Review, 84*(4), 17–51. https://doi.org/10.3386/w7559

Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), *Handbook of macroeconomics* (Vol. 1, pp. 1341–1393). Elsevier. https://doi.org/10.1016/S1573-4412(99)30034-X

Bernanke, B. S., & Gertler, M. (2001). Should central banks respond to movements in asset prices? *American Economic Review, 91*(2), 253–257. https://doi.org/10.1257/aer.91.2.253

Borio, C. (2011). Rediscovering the macroeconomic roots of financial stability policy: Journey, challenges, and a way forward. *Annual Review of Financial Economics, 3*(1), 87–117. https://doi.org/10.1146/annurev-financial-102710-144819

Borio, C. (2012). *The financial cycle and macroeconomics: What have we learnt?* (BIS Working Paper No. 395). Bank for International Settlements. https://www.bis.org/publ/work395.pdf

Borio, C., & Lowe, P. (2004). *Securing sustainable price stability: Should credit come back from the wilderness?* (BIS Working Paper No. 157). Bank for International Settlements. https://www.bis.org/publ/work157.pdf

Borio, C., & White, W. R. (2004). *Whither monetary and financial stability? The implications of evolving policy regimes* (BIS Working Paper No. 147). Bank for International Settlements. https://www.bis.org/publ/work147.pdf

Caprio, G. (2011). *Macro-financial linkages: A syllabus* (IMF Working Paper No. 11/07). International Monetary Fund. https://doi.org/10.5089/9781455211869.001

Cardak, B. A., & Moosa, I. A. (2006). The determinants of foreign direct investment: An extreme bounds analysis. *Journal of Multinational Financial Management, 16*(2), 199–211. https://doi.org/10.1016/j.mulfin.2005.07.002

Cardarelli, R., Elekdag, S., & Lall, S. (2011). Financial stress and economic contractions. *Journal of Financial Stability, 7*(2), 78–97. https://doi.org/10.1016/j.jfs.2010.01.005

Cecchetti, S. G., Genberg, H., Lipsky, J., & Wadhwani, S. (2000). *Asset prices and monetary policy* (Geneva Reports on the World Economy 2). International Center for Monetary and Banking Studies.

Cecchetti, S. G., Genberg, H., & Wadhwani, S. (2003). Asset prices in a flexible inflation targeting framework. In W. C. Hunter, G. G. Kaufman, & M. Pomerleano (Eds.), *Asset price bubbles: The implications for monetary, regulatory, and international policies* (pp. 427–444). MIT Press.

Cevik, E. I., Dibooglu, S., & Kutan, A. M. (2013). Measuring financial stress in transition economies. *Journal of Financial Stability, 9*(4), 597–611. https://doi.org/10.1016/j.jfs.2012.10.001

Christiano, L., Ilut, C., Motto, R., & Rostagno, M. (2010). *Monetary policy and stock market booms* (NBER Working Paper No. 16402). National Bureau of Economic Research. https://doi.org/10.3386/w16402

Curdia, V., & Woodford, M. (2010). Credit spreads and monetary policy. *Journal of Money, Credit and Banking, 42*(s1), 3–35. https://doi.org/10.1111/j.1538-4616.2010.00328.x

Curdia, V., & Woodford, M. (2011). The central bank balance sheet as an instrument of monetary policy. *Journal of Monetary Economics, 58*(1), 54–79. https://doi.org/10.1016/j.jmoneco.2010.09.011

Edwards, S., & Vegh, C. A. (1997). *Banks and macroeconomic disturbances under predetermined exchange rates* (NBER Working Paper No. 5977). National Bureau of Economic Research. https://doi.org/10.3386/w5977

Gali, J. (2013). *Monetary policy and rational asset price bubbles* (NBER Working Paper No. 18806). National Bureau of Economic Research. https://doi.org/10.3386/w18806

Gali, J., & Gambetti, L. (2013). *The effects of monetary policy on stock market bubbles: Some evidence* (Barcelona GSE Working Paper No. 724). Barcelona Graduate School of Economics. https://doi.org/10.1257/mac.20130091

Gertler, M., & Karadi, P. (2011). A model of unconventional monetary policy. *Journal of Monetary Economics, 58*(1), 17–34. https://doi.org/10.1016/j.jmoneco.2010.10.004

Gertler, M., & Kiyotaki, N. (2010). Financial intermediation and credit policy in business cycle analysis. In B. M. Friedman & M. Woodford (Eds.), *Handbook of monetary economics* (Vol. 3, pp. 601–650). Elsevier. https://doi.org/10.1016/B978-0-444-53238-1.00011-9

Hakkio, C. S., & Keeton, W. R. (2009). Financial stress: What is it, neow can it be measured, and why does it matter? *Federal Reserve Bank of Kansas City Economic Review, 94*(2), 5–50.

Hlavac, M. (2014). *ExtremeBounds: Extreme bounds analysis in R* (R package version 0.1.2). The R Project for Statistical Computing. https://CRAN.R-project.org/package=ExtremeBounds

Illing, M., & Liu, Y. (2006). Measuring financial stress in a developed country: An application to Canada. *Journal of Financial Stability, 2*(3), 243–265. https://doi.org/10.1016/j.jfs.2006.06.002

Issing, O. (2011). *Lessons for monetary policy: What should the consensus be?* (IMFS Working Paper Series No. 44). Institute for Monetary and Financial Stability. https://www.imfs-frankfurt.de/fileadmin/user_upload/IMFS_WP_44.pdf

Kabundi, A., & Ngwenya, N. (2011). Assessing monetary policy in South Africa in a data-rich environment. *South African Journal of Economics, 79*(1), 91–107. https://doi.org/10.1111/j.1813-6982.2011.01265.x

Kasai, N., & Naraidoo, R. (2012). Financial assets, linear and nonlinear policy rules: An in-sample assessment of the reaction function of the South African Reserve Bank. *Journal of Economic Studies, 39*(2), 161–177. https://doi.org/10.1108/01443581211222644

Kiyotaki, N., & Moore, J. (1997). Credit cycles. *Journal of Political Economy, 105*(2), 211–248. https://doi.org/10.1086/262072

Kliesen, K. L., Owyang, M. T., & Vermann, E. K. (2012). Disentangling diverse measures: A survey of financial stress indexes. *Federal Reserve Bank of St. Louis Review, 94*(5), 369–398. https://doi.org/10.20955/r.94.369-97

Leamer, E. E. (1985). Sensitivity analysis would help. *American Economic Review, 75*(3), 308–313. [suspicious link removed]

Leamer, E. E., & Leonard, H. (1983). Reporting the fragility of regression estimates. *The Review of Economics and Statistics, 65*(2), 306–317. https://doi.org/10.2307/1924497

Levine, R., & Renelt, D. (1992). A sensitivity analysis of cross-country growth regressions. *American Economic Review, 82*(4), 942–963. [suspicious link removed]

Liu, G., & Seeiso, N. (2012). Business cycle and bank capital regulation: Basel II procyclicality. *Economic Modelling, 29*(3), 848–857. https://doi.org/10.1016/j.econmod.2011.10.015

Lo Duca, M., & Peltonen, T. A. (2011). *Macro-financial vulnerabilities and future financial stress: Assessing systemic risks and predicting systemic events* (ECB Working Paper No. 1311). European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1311.pdf

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in econometrics* (pp. 105–142). Academic Press.

Naraidoo, R., & Paya, I. (2012). Forecasting monetary policy rules in South Africa. *International Journal of Forecasting, 28*(2), 446–455. https://doi.org/10.1016/j.ijforecast.2011.04.006

Naraidoo, R., & Raputsoane, L. (2010). Zone-targeting monetary policy preferences and financial market conditions: A flexible non-linear policy reaction function of the SARB monetary policy. *South African Journal of Economics, 78*(4), 400–417. https://doi.org/10.1111/j.1813-6982.2010.01256.x

Reed, W. R. (2009). The determinants of U.S. state economic growth: A less extreme bounds analysis. *Economic Inquiry, 47*(4), 685–700. https://doi.org/10.1111/j.1465-7295.2008.00127.x

Roger, S., & Vlcek, J. (2012). *Macrofinancial modeling at central banks: Recent developments and future directions* (IMF Working Paper No. 12/21). International Monetary Fund. https://doi.org/10.5089/9781463931118.001

Sala-i-Martin, X. X. (1997). I just ran two million regressions. *American Economic Review, 87*(2), 178–183. [suspicious link removed]

Sturm, J. E., & de Haan, J. (2005). Determinants of long-term growth: New results applying robust estimation and extreme bounds analysis. *Empirical Economics, 30*(3), 597–617. https://doi.org/10.1007/s00181-005-0252-x

Taylor, J. B. (2008). *The financial crisis and the policy responses: An empirical analysis of what went wrong* (NBER Working Paper No. 14631). National Bureau of Economic Research. https://doi.org/10.3386/w14631

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica, 48*(4), 817–838. https://doi.org/10.2307/1912934

Woodford, M. (2012). *Inflation targeting and financial stability* (NBER Working Paper No. 17967). National Bureau of Economic Research. https://doi.org/10.3386/w17967

Author(s) Statements:
Acknowledgements: Not applicable.
Author contributions: The contribution of the authors is equal.
Funding: No funding was received for this study.
Availability of data and materials: Not applicable.
Ethics Declarations:
Ethics approval and consent to participate: Not applicable.
Consent for publication: Not applicable.
Consent to participate: Not applicable.
Competing interests: The authors declare that they have no competing interests.
Informed consent: Not applicable.
Consent for publication: All authors agreed with the content and gave explicit consent to submit the manuscript to *Turkish Economic Review.*
Data Availability Statement: Not applicable.

CRediT Author(s) Statements:

Contribution	NZ Ndlovu			
Conceptualization	X			
Methodology	X			
Software	X			
Validation	X			
Formal analysis	X			
Investigation	X			
Resources	X			
Data curation	X			
Writing –original draft	X			
Writing –review & editing	X			
Visualization	X			
Supervision	X			
Project administration	X			
Funding acquisition	X			

SCAN ME