Master of Management in Finance and Investments

Research Report – 2022

The behaviour of the risk premium of South African Government Bonds during crisis periods.

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Abstract

Bond markets are fundamental to the functioning of financial markets, and investors view government-issued bonds as a safe investment due to their liquid nature and the safety the backing of the sovereign provides. The yield on a government bond represents its risk as much as it represents the return, and the excess return reflects a risk premium that the bond carries. The willingness to hold one government's sovereign bond over the other despite the yield difference is called a convenience yield. This study looks at quantifying the difference in the convenience yield of South African government bonds (SAGBs) and the bonds of other similarly rated emerging market economies by measuring the gap between the South African rand (ZAR) yield (implied by entering into foreign exchange swaps) paid by foreign governments and the nominal ZAR yield on South African government bonds. This difference or wedge is termed the SAGB yield premium or a convenience yield, which we argue is synonymous with "SAGB risk premium", and the study focuses on its evolution or behaviour during crisis periods.

This research is essential in highlighting the behaviour of the SAGB risk premium over time compared to the premium of other major emerging market economies, and therefore provides a practical picture in terms of where South Africa's bond market stands relative to other major emerging markets. Furthermore, the study will afford policy makers and risk managers with an opportunity to view how the cost of borrowing for government as measured by the yield of SAGBs behaves leading up to the crisis, thus providing an opportunity for better preparation leading up to future crisis periods. The study finds that the SAGB premium for 10-year bonds oscillated around zero in the June 2010 to July 2011 period, increased by approximately 200 basis points in the August 2011 to July 2012 period, and reverted to oscillate around zero for a great deal of the sample period until the Covid-19 pandemic. At the height of the Covid-19 pandemic, the SAGB premium increased to approximately 180 basis points for 10-year bonds and reverted to zero post the crisis as economies opened up. That is, the difference in the convenience yield of SAGBs and the bonds of other major emerging market economies increases in times of crisis, reflecting that in times of crisis investors are willing to forego a higher yield offered by bonds issues by other emerging market governments and hold SAGB.

Keywords: Risk premium, South African Government Bonds (SAGBs), Yield

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Declaration

I hereby declare that this research report is my own original work and has not been submitted to any institution for assessment before. It is submitted to partially fulfil the requirements for the Master of Management degree in Finance and Investments offered by the Wits Business School. I further declare that I have obtained the necessary consent to undertake this research.

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Chapter 1: Introduction

1.1 Introduction

Bond markets are fundamental to the functioning of financial markets, being a cornerstone that offers a safe haven for investors' money. Although often deemed to be less exciting than stocks, bonds are less volatile and provide more consistent returns when held to maturity. Governments across different economies use bonds to raise long-term funding, and these are viewed by investors as being free from credit risk due to being backed by the sovereign (International Monetary Fund, 2001). As defined by Jarrow (1998), the return on a bond is measured by its yield, which is a function of the price and interest payment. The returns across different maturities are represented by a yield curve, whose shape communicates risk sentiment. There are three main shapes that a yield curve can take on: a normal shape (i.e., an upward-sloping yield curve, where the yields of longer-dated bonds are higher than those of the shorter-dated bonds), an inverted shape (i.e. a downward-sloping yield curve, where the shorter-maturity bonds have yields higher than the yields of the longer-dated bonds), and a humped shape (i.e., a flat yield curve, where the shorter-dated yields are very close to the longer-dated yields). A normal yield curve communicates a period of economic expansion, an inverted yield curve points to an economic recession, and a flat-shaped curve predicts an economic transition (Benzoni et al., 2018).

Risk or financial risk is the chance that a financial investment's actual gains will deviate from an expected outcome or return (Investopedia, 2020). The capital asset pricing model (CAPM), specified as:

$$R_i = R_f + \beta_i \left(R_m - R_f\right),$$

where:

R_i = the expected return on the investment,

R_i = the risk-free rate,

β_i = the beta of the investment[1],

[1] The beta of an investment is representative of an asset's systematic risk (Adrian et al, 2009)

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R_m = the expected return of the market portfolio,

postulates the positive correlation between risk and return (Adrian et al, 2009). As such, the yield (and thus interest rate) of a bond represents its risk as much as it represents the return on the asset. In the case where the excess return $(R_m - R_f)$ is positive, an asset is said to possess a positive market risk premium (compensation over and above the risk-free rate).

The South African Government Bond (SAGB) yield curve has undergone a dramatic transformation since its inception (South African National Treasury, 2009). The shape of the yield curve has gone from being inverted to taking on a "normal" shape with long-end rates trading higher than those in the short-end, and this upward sloping nature is mainly attributed to the existence of term premia (Soobyah & Steenkamp, 2020). That is, the South African government bond yield curve has transitioned from signalling an economy in recession to an expanding economy, and long-term yields are now higher than short-term yields due to future risks being accounted for. Apart from this change in the slope of the curve, yield levels have also fallen by a sizable amount over the years, indicating that it has become considerably cheaper for government to borrow or raise funding through issuing bonds or long-term debt compared to 1994 when the Debt Board (previously Bond Exchange of South Africa (BESA)) was first formed. The average yield on five- to ten-year local currency government bonds declined from as high as 18% in the 1990s, to as low as 6% in 2013. Furthermore, the South African bond market has moved from being an unstructured market dominated by government bonds to one that is more structured, deep, and liquid relative to other emerging markets. Recently however, the shape of the SAGB yield curve has attracted some attention. This as term spreads (i.e., difference between interest rates on short- and long-dated government securities) have widened substantially, owing to idiosyncratic issues (Loewald & Cassim, 2017). According to Bloomberg data, the yield spread between the 2-year and 10-year SAGBs peaked above 600 basis points during the early part of 2019.

Owing to the higher yields on longer-dated bonds, which are seen as a risk premium (the compensation for the higher risk, over and above the risk-free rate), the SAGBs have become increasingly attractive to investors, with market participants becoming increasingly interested in having exposure to South African government bonds as they offer high returns. This said however, South Africa does not present the highest yields amongst similarly rated emerging markets, yet investors are willing to forego the higher yields and hold SA bonds over other

emerging market bonds (Debeila, 2017). This is termed a bond convenience yield. Evidence from Valchev (2020) shows that convenience yields drive excess currency returns, and thus here the convenience yield conversely represents a risk premium[2]. In this paper we quantify this convenience yield (and thus risk premium) differential between the FX swap market implied South African Rand (ZAR) yield paid by foreign governments and the yield of SAGBs by taking the difference between the implied South African Rand yield paid by foreign governments and South Africa. Henceforth, this differential is called the SAGB risk premium.

A positive premium implies that the South African government is paying less to borrow in real terms compared to other emerging markets, and this measure shows the superiority of the South African sovereign as a debt issuer compared to other emerging markets.

We measure the SAGB premium against government issued bonds in Brazil, Russia, India, and China. This specific sample is chosen as the included countries are all regarded as the five major emerging economies (BRICS[3]).

In this study we find that the SAGB premium for 10-year government bonds oscillated around zero in the June 2010 to July 2011 period, increased by approximately 200 basis points in the August 2011 to July 2012 period, and reverted to oscillate around zero for a great deal of the sample period until the Covid-19 pandemic. At the height of the Covid-19 pandemic, the SAGB premium increased to approximately 180 basis points for 10-year bonds and reverted to zero post the crisis as economies opened up. That is, based on the 10-year government issued bonds for each respective country, the South African sovereign paid similar in real terms to borrow compared to the comparable emerging markets for the period spanning June 2010 to July 2011, before South Africa started paying approximately 200 basis points less than other emerging market sovereigns during the August 2011 – July 2012 period. From August 2012 until the Covid-19 period, all countries in the sample paid the same until just before the Covid-19 crisis, which then saw South Africa once again being charged less in real terms for issuing debt compared to other economies in the sample. From this, it is seen that in times of crisis, the

[2] By the capital asset pricing model.

[3] BRICS is the group composed of the five major emerging countries - Brazil, Russia, India, China and South Africa -, which together represent about 42% of the population, 23% of GDP, 30% of the territory and 18% of the global trade (http://brics2019.itamaraty.gov.br/en/about-brics/what-is-brics, last accessed January 2022).

South African government pays less for issuing debt compared to the sampled foreign governments.

Similar to Du et al. (2018) and Valchev (2020) we argue for the potential drivers of the convenience yield differential by decomposing the SAGB risk premium into three parts:

i. the differential between the sovereign credit risk of the respective foreign country and that of South Africa;
ii. the mispricing observed in the swap market, which are inferred from the deviations from covered interest rate parity (CIP) for interbank funding instruments (Du et al., 2018); and
iii. a residual term, which is mainly made up of a loosely used liquidity term.

In essence, the cost of debt which was issued by emerging market economies which are integrated financially should not differ particularly from the cost experienced by developed market economies when they issue debt that is non-investment grade (González-Rozada & Yeyati, 2008). Both prices are meant to reflect the level of risk contained in the government-issued debt and a risk premium[4] (the cost of risk) which, in turn, reflects the risk appetite of international investors (González-Rozada & Yeyati, 2008). Csonto & Ivaschenko (2013) examine the relationship between the idiosyncratic and global factors as well as emerging market debt spreads from three different perspectives and conclude that while both the idiosyncratic factors and developments globally are important determinants of spreads in the long-run, global factors are most important in the short-run.

In contrast, further research has shown that African countries face a lot of sovereign risks, and in turn their assets attract a high sovereign risk premium. That is, borrowing costs are substantially higher for developing and emerging economies, as they need to compensate investors a lot more for the risks that are embedded in their assets. The risks are brought about by various factors, and the key drivers of the risk premia is of significance. In addition to other literature, Mpapalika & Malikane (2019) find that GDP growth, public debt/GDP, the rate of

[4] As defined by Bankrate, the risk premium is the rate of return on an investment over and above the risk-free or guaranteed rate of return.

inflation, the foreign exchange reserve of a country, commodity prices and market sentiment are highly significant when the risk premium of African sovereigns in determined.

Apart from studies similar to the aforementioned literature in investigating the drivers of risk premia, extensive research has been done by the likes of Fedderke, 2021 and He et al., 2021 on the behaviour of the respective risk premium in US Treasuries. Furthermore, studies have been conducted by authors such as Du et al., 2018 on the risk premium embedded in equities of both developed and emerging markets. There is however insufficient investigation on how the risk premium of SAGBs has evolved over time, and especially how it behaves during crisis periods.

Previous studies of this research topic have been explored mainly by Du et al. (2018), and thus this research paper is the main point of reference. Du et al. (2018) provide the study from a US Treasury against G10 countries' perspective, while here we look at the case of South Africa vis-à-vis Brazil, Russia, India, and China to allow policy makers to understand how South Africa's government bonds have evolved in comparison to the other four major emerging markets.

In this context, the rest of this document is organized as follows: chapter two is a literature review that highlights the main points of reference and pre-existing literature that may be linked to the topic of study. The research approach and methodology are laid out in chapter 3 – a section which also explains the relationships between variables. Chapter 4 contains the main results obtained from implementing the research methodology, and in this same chapter I proceed to interpret and analyse the results. Chapter 5 subsequently concludes.

1.2 Problem statement

Financial market fundamentals break when a crisis strikes, leaving policymakers and market participants in huge disbelief. Like other crisis periods, the COVID-19 pandemic sent international financial markets into a tailspin and rendered economies helpless, and research by the Institute of International Finance (2021) shows that some pockets of the global landscape are still languishing in the aftermath more than a year later.

By way of sampling data from Bloomberg, in the wake of the Covid-19 induced (economic and financial markets crisis) panic, liquidity conditions in South African financial markets (more specifically, the SAGB space) got stunted. The South African government bond market saw a significant widening of spreads oscillating between larger than before ranges – on

average, there was an increase of 6% in bid-offer spreads in the March 2020 peak. The increased participation of non-residents in domestic sovereign debt markets is believed to have significant effects on the recipient economies (Broner et al., 2021), and the bond maturing in the year 2036 (i.e., R209 bond) was amongst those mostly sold off by non-residents at the height of the Covid-19 pandemic (JSE, 2020), indicating the loss of appetite for risk or appetite for holding longer-term South African bonds by investors.

Additionally, the SA government bond market exhibited a gapping tendency, where a gapping market is defined as one that experiences areas of discontinuity in security prices. That is, there is a significant difference in where the price of an asset closed the previous day and where it opens (De Wet & Botha, 2019). On both an intraday and interday basis, the largest price gaps were observed at the height of the unprecedented crisis. This wild roller-coaster ride is reflective of the great uncertainty and attenuated liquidity in the market at the time, where even the smallest volume traded caused a large movement in price (South African Reserve Bank, 2021).

In response, the South African Reserve Bank (SARB) deployed various intervention measures such as capital relief on restructured loans that were in good standing before the COVID-19 crisis, a lower liquidity coverage ratio (LCR) and reduced capital requirements (South African Reserve Bank, 2020). It is important for policy makers to understand how the risk premium of bonds behaves to be able to put into place policies that consider how much it costs the South African government to borrow through issuing debt. This is particularly important since South Africa's fiscal issues have led to unfavourable outflows and penalisation from investors (Francis et al., 2020). For example, South Africa got removed from the World Global Bond Index (WGBI) in 2020, where country eligibility is determined by whether it meets the investability criteria as well as its market capitalization.

In addition, given the evolution of South Africa's credit rating together with the effects of the country being stricken off the WGBI, as highlighted by Broner et al. (2021), it is further important to understand what the country's issued debt looks likes from a risk premium perspective, as well as how much it costs in real terms for the government to issue debt in comparison with other comparable countries. The sovereign rating affects the credibility of the risk-free rate and other rates, and thus has an effect on the risk premium carried by South African assets (Eraslan, 2017).

Against this backdrop, this study aims determine whether there is a pattern followed by the returns in the SAGB market in times of crises, starting from 2010 when South Africa joined the group of large emerging market economies (BRICS) in an attempt to boost the country's growth and advance collaborative foreign policies so as to attract investment(Kahn, 2011), through to the Covid-19 pandemic. Additionally, the study seeks to determine how South Africa's risk premium compares to other major emerging markets. Although previous research of this manner exists, the studies were done on US Treasuries ((He et al., 2021), (Du et al., 2018)), and there is a gap in the literature that covers emerging markets and South Africa in particular.

From a risk management perspective, historical data ought to be utilized for analysis and to gain an understanding of what to expect in the future. As such, it is important to understand the behaviour of the risk associated with the South African markets during crises, as well as understand how South Africa compares to other major emerging markets and draw lessons from the past for informed decision making in the future. The comparison to other emerging markets will allow for policy makers, the South African Reserve Bank and South African government to be able to spot whether South Africa is trailing behind or whether there are looming risks. Moreover, results from this study may prove useful to policy makers and government for spotting early signs of pressure so as to allow them to act promptly and appropriately after taking cues from these signs.

In times of crisis, the risk premium increases, and one seeks to observe consistency and determine how far ahead of the crises peaks this premium increases and to what thresholds. This is achieved through determining how the SAGB nominal yields differ from synthetically formed (through entering into cross currency swap contracts to hedge for currency risk) ZAR yields paid by foreign governments compare. We also run a regression on the sample to determine and note the existing relationships between risk premia during periods of pressure and the supply of SAGBs.

The study adds to pre-existing research in that it captures how the South African government is regarded as a debt issuer or how it ranks in speciality vis-à-vis the rest of the BRICS member countries.

1.3 Research objectives

The research objectives are as follows:

- To quantify the convenience yield (and thus risk premium) of SAGBs
- To investigate the behaviour of the convenience yield during crisis periods (pre-GFC to post-Covid19), as well as identify the main factors driving the evolution in risk premiums.
- Quantify the convenience yield (and thus risk premium) differential between South African government bonds and bonds issued by foreign governments (BRICS countries).

1.4 Research aims

By carrying out the research objectives, this study aims to determine whether there is a pattern followed by the returns in the SAGB market in times of crises, starting from June 2010 when South Africa joined the group of large emerging market economies (BRICS) in an attempt to boost the country's growth and advance collaborative foreign policies so as to attract investment(Kahn, 2011),12 when South Africa was initially included in the world government bond index (WGBI), through to the Covid-19 pandemic. Additionally, the study seeks to determine how South Africa's risk premium compares to other major emerging markets.

1.5 Delimitations of the study

Given the vastness of bond markets, there are aspects linked to this topic that the study does not investigate due to data and resource constraints. More specifically:

- The study does not necessarily compare countries of comparable credit ratings or similar credit quality, but rather of a class based on the size of the economy among other factors.
- The behaviour of the proposed estimation for the SAGB premium is not compared to other measures that capture the liquidity and safety value of SAGBs.
- The study does not directly investigate the possible existence of arbitrage in bond markets (mostly repo market) during crisis periods (specifically during covid).

- A further delimitation is examining the beta of SA government bonds to extend on the interactions between the South African bond spread with macroeconomic fundamentals as reported by Fedderke (2021) and to form a trend.

Chapter 2: Literature Review

The IMF World Economic Outlook (June 2020) highlighted that South Africa is among the economies whose debt profile is expected to account for more than 84% of GDP in 2021, placing the country in the same band as economies like Brazil. Therefore, understanding the cost of debt is pivotal. In addition to the research previously cited in the document, the following literature contributes to the body of knowledge regarding how risk premia can be captured and whether their behaviour during a crisis can form part of the early indicators of stress periods for policy makers.

2.1 The US Treasury Premium

Bonds are viewed as being a safe form of long-term investment, with government bonds being the safest and most liquid due to being backed by the sovereign. The yield of a bond, however, does not equate to the risk-free rate, and this excess return is seen to represent a premium paid to investors for holding bonds. A vast body of literature exists on what gives rise to the risk premium of bonds, however the majority focuses on developed markets (more so US Treasuries).

Although US Treasuries are considered safe-haven bonds, Jiang & Tong (2016) show that the uncertainty of monetary policy (MPU) leads to a risk premium in the US Treasuries. Jiang & Tong (2016) use the news-based measure for monetary policy uncertainty as specified in Baker, Bloom, and Davis (2016) to capture the uncertainty that emanates from monetary policy, and they find that monetary policy uncertainty forecasts significantly influence the monthly excess returns of US Treasuries.

The study by Nagel (2014) answers the following questions: what determines the size of the liquidity premium of US Treasuries? Does it vary over time? If so, why? In this research piece, Nagel (2014) highlights that recent work emphasized that previous work focused on an asset-supply perspective, however he is of the belief that it is the opportunity cost of money rather than the supply of near-money assets that determines the premium on near-real money assets.

To work out the relationship between the opportunity cost of money and liquidity premium, Nagel develops a model in which households acquire cash from Treasury Bills as well as non-interest-bearing deposits.

Government bonds are considered near-money assets, and our study closes the gap in literature of what determines the premium on SAGBs and thus considers Nagel (2014)'s conclusions when decomposing the SAGB premium.

The study by Du et al. (2018) contributes to the literature on the price premium of bonds by quantifying the difference in the convenience yield of US Treasuries and the bonds issued by developed sovereigns. In the paper, Du, Im and Schreger measure a US Treasury premium to be the divergence from covered interest parity between yields of government-issued bonds, where for each foreign country a positive premium suggests a higher convenience yield of US Treasuries in comparison to that of a foreign country. This approach is relevant and will be used in the study, as the benchmarking process provides relative comparativeness between different countries.

Du et al. (2018) calculate the convenience yield on US Treasury bonds vs the bonds issued by developed sovereigns, and proceed to argue that the premium of the benchmark US Treasury measures the relative convenience yield of government-issued bonds if all government securities are free of default risk and the swap market is free of frictions. They further explore different ways of measuring the premium that adjust for the differences in the credit risk of sovereigns using credit default swaps (CDS) and the frictions observed in the FX swap market by expanding on the proxies (deviations from CIP for the observed proxies of the risk-free rate) suggested by Du et al. (2018). In addition, a general regression is used to determine whether an association exists between the US Treasury premium and the relative limited supply of sovereign debt in the US at the time vs other developed countries.

Du and Schreger (2016a) establish the "local currency credit spread" and postulate that "it largely captures sovereign default risk on nominal debt in emerging markets". The "US Treasury premium" is formulated in the same manner as the "local currency credit spread" in these aforementioned papers but is interpretated differently. The paper states that this is because the risk of a government defaulting is arguably negligible in G10 member countries, and therefore, factors such as the liquidity premium differential and frictions in financial markets most likely play more critical roles in explaining the US Treasury premium vis-à-vis in government debt issued by G10 countries.

The main findings of the research include the fact that before the Global Financial Crisis (GFC), US Treasuries were earning a positive convenience yield relative to the government bonds of other developed markets. Post the GFC however, medium-term and long-term US Treasuries lost their specialness relative to the sovereign bonds of the other sovereigns of comparable credit quality. Meanwhile however, the short-term US Treasury Bills remained special. In addition to this, this paper finds that the US Treasuries premium moves together with the amount of government debt in the system, in line with the researchers' theory that when there is a higher density of US Treasuries in the market or when the amount of foreign government debt declines, investors assign a lower value to the liquidity premium as well as the safety premium of US Treasuries relative to foreign government bonds. The body of research only focuses on US treasuries and other developed markets, and there is a gap in the literature for the case of developing or emerging markets. African bond markets have developed since inception, and South Africa is one of the largest economies on the continent, thus quantifying the risk premium of SAGBs for policy implications and risk management is necessary. The aforementioned authors compare G10 countries with the United States (US), while we compare South Africa to other major emerging market economies. Therefore, we expect our interpretation and results to be different, as the emerging market currencies behave differently and often act as shock absorbers. Put differently, emerging market assets carry a higher default risk than G10 assets.

Not all of Du et al. (2018) methodology is applicable in a practical manner however, as the authors assume that there is a possibility of default by a country, which is considered impossible.

2.2 Treasury inconvenience yields during the COVID-19 crisis

Investors value US Treasuries due to the liquidity and safety feature that US Treasuries possess. Furthermore, investors are willing to forego the so-called convenience yield to hold US Treasuries over bonds issued by private entities Krishnamurthy and Vissing-Jorgensen (2012). This section hones in on the possible existence of an inconvenience yield using a capital asset pricing model, as well as observe the behaviour of the yield during the Covid-19 crisis.

FIn this model, the traders who are subject to regulatory balance sheet constraints come in the middle of demand/supply shocks from habitat agents and extend repo financing to strained market participants.

The researchers document that the prices of US Treasuries fell sharply in contrast to previous crisis periods, with wider bid-offer spreads and deteriorating limit order book depth signalling market illiquidity in the US Treasury market. Thus, the main goal of the paper is to provide insight on what the surprising US Treasury price movements could be attributed to, in both an empirical and theoretical manner.

As a starting point, the authors characterize the major features of asset price movements during the peak of the COVID-19 crisis in March 2020. They further show within a model how supply shocks combined with intermediation frictions may result in disturbances in the Treasury market. Furthermore, the model presents other empirical predictions about the behaviour of spreads between different swap rates, repo rates and US Treasury yields that are later examined. This is achieved by using an extension of the model used by Greenwood and Vayanos (2014), where they separate the arbitrageurs into hedge funds and traders/dealers and further introduce a repo market in which the dealers lend to the hedge funds.

Further to the price changes, the researchers proceed with the event study approach and record substantial changes in the ownership of US Treasuries and short-term accumulation of US Treasury and reverse repo positions in the balance sheets of dealers during the March 2020 period. This however will not apply for the South African case, considering how illiquid the reverse repo market is. That is, the South African market (and African markets at large) is one which is largely short of cash, and so the approach for recording the shifts in reverse repo positions on the balance sheets of primary dealers will not be applicable in our study. As such, only the SAGB premium is calculated and monitored.

2.3 An analysis of the risk-free rate in the South African capital market

South Africa is an emerging market economy whose capital market has become deeper over time since 2008 when it gained its independence. Capital markets are a vital part of the development of an economy and long-term growth, as they provide the basic financing and necessary resources for future projects as well as research and development. As such, it is

important for one to understand the yield of South African government bonds as well as how these deviate from the risk-free rate.

Burger (2012) conducts the study through a literature review approach and a desktop-based analysis of the market price-based yield curve. The main objective is to compare the risk-free rate implied by the capital market in South Africa against the theoretical risk-free rate contained in the Bond Exchange of South Africa (BESA) projected yield curve. While the literature review approach is a good one, a much deeper analysis may have been required.

The research is conducted using data obtained from the JSE and captured market prices on the 1st of September 2012, and then developing a yield curve using yield to maturities developed through the equation $Y(t) = \left(\frac{1}{P(t)}\right)^{\frac{1}{t}}$ as specified by Brigo & Mercurio (2001). Although the equation for determining yield used here is from a 2001 paper, it is still relevant, as the relationship between yield and price has not changed – they are inversely related. This yield curve is assumed to be reflecting the practical yield curve as recognized by investors, both private and foreign/non-resident. The BESA Actuaries yield curve was acquired from the publications at BESA on the 1st of September 2012.

The yield to maturities of the bonds issued by the sovereign were contrasted with the yields that were calculated for current maturities in order to assess the difference in the perceptions about the growth of interest rates in the future. The BESA-obtained yield curve and the market-based yield curve were compared in terms of the shape of the respective curves. The research outcomes are then discussed in the context of the liquidity premium theory and the market segmentation theory (among other theories of yield curves). The differences in the shape of the sovereign yield curve and the yield to maturities as calculated by BESA as well as by the researcher were used to evaluate and quantify the difference in the theoretical risk-free rate and the actual risk-free rate in South Africa. The risk-free rate plays an important role in the investment choices of foreign/non-resident investors as it encapsulates the rate of return that is available in the market on an investment that possesses no risk of default. This methodology will prove useful and relevant to our study as it provides a different means to calculate the risk premium or how much the yield of SA government bonds is made up of risk or carries a premium. Furthermore, it solidifies the existence of a risk premium.

Secondary research was undertaken by examining and critically analysing the different components of bond markets, which include the risk-free rate as employed by the capital asset pricing model, the theory of arbitrage pricing, as well as modern portfolio theory.

Chapter 3: Research Methodology

In this chapter, the algorithm, as well as the methodology followed in investigating the research objectives, is laid out in detail.

3.1 Research design and approach

Previous studies on this research area have been explored extensively by esteemed researchers from a US Treasury perspective, and for this study, we follow the methodology deployed by Du et al. (2018) and Burger (2012). The study relies on historical data, and thus take an empirical approach, deploying mainly quantitative research methods to investigate the behaviour of the risk premium embedded in SAGBs in times of crisis, in an attempt to assist policy makers in identifying looming risks and responding accordingly ahead of time. The research further mimics the work of Du et al. (2018) and compares South African government bonds to other emerging markets' government bonds through a benchmarking process of convenience yields. The emerging markets being compared to South Africa are those belonging to BRICS, namely Brazil, Russia, India, and China. Out of these countries, only China does not belong in the B-rating band. According to Fitch[5], China has an A+ credit rating. By ranking, the BRICS member countries are rated: China (A+), Russia (BBB+), India (BBB-), South Africa (BB-), Brazil (BB-). Further to the SAGB premium over BRIC, the study continues to compare the yields of the G20 countries to South Africa's government bond yields.

When making comparisons, 10-year local currency bonds are taken as the benchmark bonds for the respective countries (Savas, 2015).

The assumptions made in the study are:

- Local currency government bonds are risk-free and international financial markets are frictionless (Du et al., 2018). This assumption has its limitations however, since there is sovereign risk and liquidity risk carried by emerging markets, and markets are generally not frictionless with transfer costs and time delays.
- Investors are rational, risk-averse, and have a variety of investment choices (Burger, 2012)

[5] As at February 2021

- An underlying assumption is that government bond markets and FX markets are integrated and priced by a global investor.

3.2 Algorithm and methodology

3.2.1 Defining the South African Government Bond premium

This section lays out the methodology used to compare yields in different currencies, which follows the mechanisms proposed by Du and Schreger (2016a) and Du et al. This involves utilizing cross-currency swap rates to convert the government bond yields into synthetic ZAR yields. The SAGB premium is thus defined as the difference between the synthetic ZAR yields paid by the respective foreign governments and the yields presented by SAGBs. A positive/negative SAGB premium would indicate that the South African government pays less/more (in real terms) for issuing debt compared to foreign governments.

The derivation process for the synthetic ZAR yields is as follows (using the Brazilian Real (BRL) as an example):

i. Let: t = time,
n = tenor,
ZAR = the South African Rand, and
BRL = the Brazilian Real.

ii. Assume a market participant pays the BRL interest rate swap rate, denoted by i_t^{BRL}, to convert the fixed BRL cashflow into a floating BRL one.

iii. Then, the market participant converts the floating BRL cashflow into a floating ZAR one by paying the cross-currency basis swap, denoted by $r_t^{BRL/ZAR}$.

iv. Lastly, the market participant receives the ZAR interest rate swap rate, i_t^{ZAR}, and utilizes it to convert the floating ZAR cashflow into a fixed ZAR one.

Therefore, the fixed-for-fixed cross-currency swap rate from BRL to ZAR is the net of the payments and receipts taking into account both time and tenor, and is equal to

$$\theta_{nt}^{BRL/ZAR} = i_{nt}^{BRL} + r_{nt}^{BRL/ZAR} - i_{nt}^{ZAR}. \quad (1)$$

Supposing that the nominal yield on the Brazilian government bond is denoted by y_{nt}^{BRL}, then its synthetic ZAR yield is equal to the nominal BRL yield less the fixed-for-fixed cross currency swap rate (BRL to ZAR) and is shown as

$$y_{nt}^{BRL,ZAR} = y_{nt}^{BRL} - \theta_{nt}^{BRL/ZAR}. \quad (2)$$

$y_{nt}^{BRL,ZAR}$ is termed the synthetic ZAR yield since it is the ZAR yield that a market participant would earn from purchasing a BRL denominated government bond and converting all of its promised BRL cashflows into ZAR[6].

Letting y_{nt}^{ZAR} denote the SAGB yield and subtracting this from both sides of Eq. 2, we can decompose the differential in the nominal yield offered by the Brazilian government bond and the nominal yield offered by the South African government bond into two components in the following manner:

$$y_{nt}^{BRL} + = \theta_{nt}^{BRL/ZAR} + y_{nt}^{BRL,ZAR},$$

$$y_{nt}^{BRL} - y_{nt}^{ZAR} = \theta_{nt}^{BRL/ZAR} + (y_{nt}^{BRL,ZAR} - y_{nt}^{ZAR}),$$

$$\therefore \quad y_{nt}^{BRL} - y_{nt}^{ZAR} = \theta_{nt}^{BRL/ZAR} + \phi_{nt}^{BRL/ZAR} . \quad (3)$$

Equation 3 states that the differential in the nominal yield offered by the Brazilian government bond and the nominal yield offered by the South African government bond is made up of two components: $\theta_{nt}^{BRL/ZAR}$ which reflects the currency risk between BRL and ZAR, and $\phi_{nt}^{BRL/ZAR}$ which is the synthetic ZAR yield differential between the Brazilian government bond and the South African government bond. The aforementioned synthetic ZAR yield differential, $\phi_{nt}^{BRL/ZAR}$, is termed the SAGB premium compared to Brazil, which can also be represented as

$$\phi_{nt}^{BRL} \equiv y_{nt}^{BRL} - y_{nt}^{ZAR} - \theta_{nt}^{BRL/ZAR} . \quad (4)$$

[6] This is subject to the issuing sovereign not defaulting.

More generally, letting y_{nt}^{i} denote the yield of the n-year government bond issued in country i and $\theta_{nt}^{i/ZAR}$ denote the n-year fixed-for-fixed cross currency swap rate, the SAGB premium vis-à-vis country i is defined as

$$\phi_{nt}^{i} \equiv y_{nt}^{i} - y_{nt}^{ZAR} - \theta_{nt}^{i/ZAR} . \quad (5)$$

3.2.2 A decomposition of the SAGB premium

In line with Du et al. (2018), this section comprises of a decomposition of the SAGB premium defined by Equation 5. Here, the SAGB premium is decomposed into three components, namely credit risk, mispricing in the swap market, and liquidity. Assuming that the (government) bond markets and foreign exchange markets for the sample countries are integrated and priced by a global investor, the three components suggest that the SAGB premium exists due to the following (Du et al., 2018; He et al., 2021):

i. credit risk: in the case of the government not being regarded as completely default-free, the yield of the government bond will be higher than the theoretical risk-free rate. Therefore, as a country becomes less safe, the premium might increase.
ii. mispricing in the swap market: no market is perfect, and frictions in the swap market result in big differences in the theoretical risk-free rate and the observed respective swap rates. Subsequently, since the observed swap rates are the cost of hedging currency risk, the aforementioned difference directly enters into the calculation of the SAGB premium.
iii. liquidity: since the yield of a government issued bond can possibly be lower than the theoretical risk-free rate if there are positive liquidity benefits to holding the government bond (Frank van Steenbergen & Tuinhof, 2009), then the proposed SAGB premium is also affected by the liquidity premium differential between government bonds issued in the foreign country and South Africa's sovereign bonds (Du et al., 2018).

3.2.2.1 The price of a South African government bond

Suppose that we have a bond issued by the domestic government (South Africa), and with * indicating that a respective variable is a South African variable, let:

L^*_{t+1} = the default loss,

Λ^*_{t+1} = the liquidity benefit at time t+1,

$\mathbb{E}^*_t$ = the risk-neutral expectation at time t, with the ZAR case as the benchmark.

Then, the price of a single period SAGB may be given as

$$P^*_t = e^{-\tilde{y}^*_t}\mathbb{E}^*_t[(1 - L^*_{t+1})(1 + \Lambda^*_{t+1})] . \quad (6)$$

According to Litterman & Scheinkman (1991), the relationship between a bond's yield or rate of return and its price is a negative one. Therefore, from equation 6, the respective yield on the SAGB is

$$y^*_t = \tilde{y}^*_t - ln\,[\mathbb{E}^*_t[(1 - L^*_{t+1})(1 + \Lambda^*_{t+1})]] ,$$

$$y^*_t = \tilde{y}^*_t - ln\,[\mathbb{E}^*_t(1 - L^*_{t+1})\mathbb{E}^*_t(1 + \Lambda^*_{t+1}) + Cov^*_t(1 - L^*_{t+1}, 1 + \Lambda^*_{t+1})]$$

$$y^*_t = \tilde{y}^*_t - ln[\mathbb{E}^*_t(1 - L^*_{t+1})] - ln[\mathbb{E}^*_t(1 + \Lambda^*_{t+1})] - ln\,[1 + \frac{Cov^*_t(1 - L^*_{t+1}, 1 + \Lambda^*_{t+1})}{\mathbb{E}^*_t(1 - L^*_{t+1})\mathbb{E}^*_t(1 + \Lambda^*_{t+1})}] ,$$

$$\therefore \quad y^*_t = \tilde{y}^*_t + \alpha^*_t - \gamma^*_t - \xi^*_t . \quad (7)$$

Equation 7 depicts that the yield of the domestic government bond is made up of the theoretical ZAR risk free rate $\tilde{y}^*_t$ plus a default premium α^*_t, less the premium from the liquidity benefit γ^*_t, less the covariance between the liquidity and the risk of default ξ^*_t. Equation 7 is similar to (Du et al., 2018) and is derived in an identical fashion, however under the assumption of default-free governments, the default premium and thus covariance fall away. That is, $\alpha^*_t = 0$ and $\xi^*_t = 0$, and thus equation 7 becomes

$$y^*_t = \tilde{y}^*_t - \gamma^*_t . \quad (8)$$

Therefore, under the assumption of a default-free domestic government (here being South Africa), the SAGB yield can be less than the theoretical ZAR risk-free rate if it has liquidity advantages over the risk free rate (Burger, 2012).

3.2.2.2 The price of a foreign government bond

The price of a bond issued by a foreign government is derived in a similar yet analogous fashion. That is, suppose that we have a bond issued by a foreign government i, and with a superscript i indicating that a respective variable is a foreign government i variable, let:

L_{t+1}^{i} = the default loss,

Λ_{t+1}^{i} = the liquidity benefit at time t+1,

$\mathbb{E}_{t}^{i}$ = the risk-neutral expectation at time t, with the respective foreign currency case as the benchmark.

Then, the price of a single period foreign government bond may be given as

$$P_t^i = e^{-\tilde{y}_t^i}\mathbb{E}_t^i[(1 - L_{t+1}^i)(1 + \Lambda_{t+1}^i)] . \tag{9}$$

From this, the respective yield on the foreign government bond is

$$y_t^i = \tilde{y}_t^i - ln\,[\mathbb{E}_t^i[(1 - L_{t+1}^i)(1 + \Lambda_{t+1}^i)]] ,$$

$$y_t^i = \tilde{y}_t^i - ln\,[\mathbb{E}_t^i(1 - L_{t+1}^i)\mathbb{E}_t^i(1 + \Lambda_{t+1}^i) + Cov_t^i(1 - L_{t+1}^i, 1 + \Lambda_{t+1}^i)]$$

$$y_t^i = \tilde{y}_t^i - ln[\mathbb{E}_t^i(1 - L_{t+1}^i)] - ln[\mathbb{E}_t^i(1 + \Lambda_{t+1}^i)] - ln\,[1 + \frac{Cov_t^i(1 - L_{t+1}^i, 1 + \Lambda_{t+1}^i)}{\mathbb{E}_t^i(1 - L_{t+1}^i)\mathbb{E}_t^i(1 + \Lambda_{t+1}^*)}] ,$$

$$\therefore \quad y_t^i = \tilde{y}_t^i + \alpha_t^i - \gamma_t^i - \xi_t^i . \tag{10}$$

Equation 10 depicts that the yield of the domestic government bond is made up of the theoretical foreign currency risk free rate $\tilde{y}_t^i$ plus a default premium α_t^i, less the premium from the liquidity benefit γ_t^i, less the covariance between the liquidity and the risk of default ξ_t^i. Equation 10 is similar to (Du et al., 2018) and is derived in an identical fashion, however under the assumption of default-free governments, the default premium and thus covariance fall away. That is, $\alpha_t^i = 0$ and $\xi_t^i = 0$, and thus equation 10 becomes

$$y_t^i = \tilde{y}_t^i - \gamma_t^i . \tag{11}$$

Therefore, under the assumption of a default-free foreign government i, the bond yield can be lower than the theoretical foreign currency i risk-free rate if it has liquidity advantages over the currency i risk free rate.

Now, the relationship between the theoretical ZAR risk-free rate $\tilde{y}_t^*$ and the theoretical currency i risk-free rate $\tilde{y}_t^i$ may be represented by

$$\tilde{y}_t^i = \tilde{y}_t^* + \tilde{\theta}_t^i, \tag{12}$$

where $\tilde{\theta}_t^i$ is the theoretical forward premium or fixed-for-fixed swap rate in a frictionless market given by the covered interest parity relationship between the two risk-free rates. Consequently, equations 10 (the yield on the foreign government i's bond with a possibility of default) and 11 (the yield on the foreign government i's bond under the assumption that government i is default-free) may be represented as

$$\therefore \quad y_t^i = \tilde{y}_t^* + \tilde{\theta}_t^i + \alpha_t^i - \gamma_t^i - \xi_t^i \tag{13}$$

and

$$y_t^i = \tilde{y}_t^* + \tilde{\theta}_t^i - \gamma_t^i \tag{14}$$

respectively. That is, similar to the argument made by Du et al. (2018) under the assumption that government i is default-free, the yield on the foreign government i's bond can differ from the theoretical ZAR risk-free rate $\tilde{y}_t^*$ due to currency risk and the liquidity benefit.

3.2.2.3 Swap market frictions

The derivation for the swap market frictions follows the exact method that Du et al (2018) employ. This follows from the fact that markets are not perfect or gaussian, and thus a frictionless market does not really exist in practice.

As per equation 1, the observed fixed-for fixed cross currency swap rate, $\theta_{nt}^{BRL/ZAR} = i_{nt}^{BRL} + r_{nt}^{BRL/ZAR} - i_{nt}^{ZAR}$, is a combination of interest rate swaps and the cross-currency basis, with Brazil used as an example for illustrative purposes. Frictions in the swap rates may potentially

result in big differences between the observed fixed-for-fixed cross currency swap rate and the hypothetical or theoretical one.

Letting the hypothetical fixed-for-fixed cross currency swap rate in a frictionless market be the sum of the observed fixed-for-fixed cross currency swap rate plus a wedge due to swap market frictions, we have that

$$\tilde{\theta}^{\,i}_{t} = \theta^{\,i}_{t} + \tau^{i}_{t}\,, \tag{15}$$

where τ^{i}_{t} represents the wedge.

By equation 12, we have that $\tilde{\theta}^{\,i}_{t} = \tilde{y}^{i}_{t} - \tilde{y}^{*}_{t}$, and therefore

$$\tau^{i}_{t} = \left(\tilde{y}^{i}_{t} - \tilde{y}^{*}_{t}\right) - \theta^{\,i}_{t}\,, \tag{16}$$

and is equal to the deviation from the covered interest parity condition.

Most researchers use interbank rates to test the covered interest parity condition.

3.2.2.4 Decomposition

The rigorous decomposition of the SAGB premium into an adjusted version that caters for the swap market frictions, liquidity and default risk is covered below.

By substituting equation 15 into equation 13, we write the yield of the foreign government bond as

$$y^{i}_{t} = \tilde{y}^{*}_{t} + \theta^{\,i}_{t} + \tau^{i}_{t} + \alpha^{i}_{t} - \gamma^{i}_{t} - \xi^{i}_{t} \tag{17}$$

From this, the SAGB premium, ϕ^{i}_{nt}, may be decomposed to be:

$$\phi^{i}_{t} \equiv y^{i}_{t} - y^{*}_{t} - \theta^{\,i}_{t}$$

$$\phi^{i}_{t} = (\tilde{y}^{*}_{t} + \theta^{\,i}_{t} + \tau^{i}_{t} + \alpha^{i}_{t} - \gamma^{i}_{t} - \xi^{i}_{t}) - (\tilde{y}^{*}_{t} + \alpha^{*}_{t} - \gamma^{*}_{t} - \xi^{*}_{t}) - \theta^{\,i}_{t}$$

$$\phi^{i}_{t} = \tau^{i}_{t} - \hat{\alpha}^{i}_{t} + \hat{\gamma}^{i}_{t} + \hat{\xi}^{i}_{t},$$

where $\hat{x} = x^{*} - x$.

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Now, assuming that the difference in the covariances between liquidity risk and currency risk is negligible, we have that $\hat{\xi}_t^i = 0$.

This leads to

$$\phi_t^i = \tau_t^i - \hat{\alpha}_t^i + \hat{\gamma}_t^i \quad (18)$$

Therefore, by equation 18, the SAGB premium may be decomposed into:

1. a spread from the swap market frictions or CIP deviations,
2. the difference in the risk of default,
3. the difference in the liquidity premiums

3.3 Population and data sampling

The data on government bond yields, interest rate swap rates and cross currency basis swap rates is sourced from Bloomberg PLC, and the population is made up of G20 countries[7], which include South Africa. South Africa first joined the important bloc of emerging markets in December 2010. Other significant events in South Africa's sovereign bond market are the inclusion in and exclusion out of the World Government Bond Index[8] (WGBI) (Arslanalp et al., 2020). The data is sampled from 01 June 2010 to 1 June 2021, which is an 11-year period and spans through the aforementioned events as well as the Covid-19 crisis and the "post-Covid" era. For summary statistics, this period is divided according to the financial and economic crises experienced by the BRICS members since June 2010[9]. However, due to the

[7] The G20 was established in 1999 with the intent of achieving financial stability on an international scale. It was formed as an attempt at finding a solution to economic and financial conditions that were observed globally post the GFC in the period spanning 1997-1999, and this was carried out through the involvement of middle-income countries and having systemic economic influence (https://g20.org/about-the-g20/, last accessed January 2022). The G20 member countries (in alphabetical order) are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, United Kingdom, United States and The European Union, and these include BRICS countries.

[8] The World Government Bond Index (WGBI) measures the performance of sovereign-issued fixed-rate bonds which are denominated in local currency and are of investment grade, and it is used as a benchmark for the government-issued bond market globally. It includes all fixed-rate bonds which have a time to maturity equal to or than a year and outstanding amounts greater than 25 million USD.

[9] 2014: Russian financial crisis, 2015: Chinese stock market crash, 2014 – 2017: Brazilian economic crisis, 2020: Covid-19 pandemic.

unavailability of yields for Saudi Arabia for this period, it is excluded from the data sample. Furthermore, since the Eurozone is represented by Germany in Bloomberg, the Eurozone is also left out of the sample to avoid duplication. The government bonds used for the remaining sample countries (namely Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, South Africa, Turkey, United Kingdom and the United States) are the 10-year bonds, and this is due to the 10-year maturity being the most commonly referenced and liquid point of sovereign bond curves. Inherently, the interest rate swaps and cross currency basis swaps are referenced for the 10-year point. However, due to data unavailability for a number of the economies, we make an assumption that investors go through the US first before swapping their cashflows into ZAR, and thus use the South African cross currency basis as a reference in the calculation for the actual respective basis[10].

Additionally, credit default swap (CDS) spreads are also obtained from Bloomberg, and they are based on senior unsecured credit default swap contracts denominated in US dollars. Due to the unavailability of data for the majority of the sample, and thus use South Africa's 10-year contract.

[10] This is a reasonable approach since the study is from a South African perspective. This is also a practical assumption for the market.

Chapter 4: Research findings

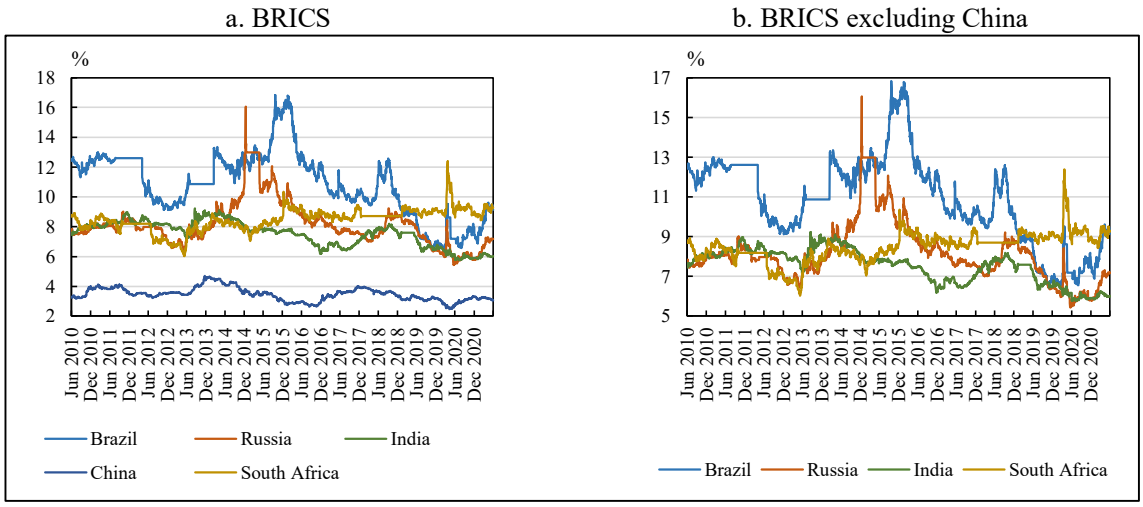
This section shows the main results from the data, through descriptive statistics and stylized facts.

4.1 Main results and key findings

4.1.1 Local currency bonds issued by the BRICS member countries

Figure 1 is a plot of nominal local currency 10-year yields for bonds issued by Brazil, Russia, India, China and South Africa (i.e., the BRICS member countries).

Figure 1: Nominal local currency 10-year government bond yields



Notes: China's yields are significantly lower than the pool of five countries due to China being the largest emerging market economy in the sample in terms of GDP size. and to remove a possible distortion from China's lower yield, figure 1b shows the yields without China.

Table 1 displays the summary statistics of the nominal local currency 10-year yields for bonds issued by the BRICS member countries.

Table 1: Descriptive stats for nominal local currency 10-year government bond yields

	BRAZIL	RUSSIA	INDIA	CHINA	SOUTH_AFRICA
Mean	10.827	8.117	7.536	3.473	8.463
Median	10.876	7.915	7.739	3.462	8.581
Maximum	16.839	16.060	9.237	4.711	12.383
Minimum	6.396	5.430	5.759	2.472	6.020
Std. Dev.	2.188	1.477	0.846	0.437	0.735
Skewness	0.009	1.338	-0.433	0.329	-0.213
Kurtosis	2.853	5.654	2.182	2.923	5.092
Jarque-Bera	2.640	1698.961	169.452	52.569	544.762
Probability	0.267	0.000	0.000	0.000	0.000
Sum	31072.055	23294.810	21627.296	9967.425	24288.019
Sum Sq. Dev.	13740.952	6256.130	2054.932	548.410	1551.970
Observations	2870	2870	2870	2870	2870

Notes: this table displays the summary statistics of the nominal local currency 10-year yields for bonds issued by the BRICS member countries.

From figure 1, it is seen that South Africa's nominal 10-year generic government bond yield was similar to that of Russia and India in the 2010 – 2013 band within an 8% - 10% range, while China's yields were the lowest within a 3% - 4% range. Brazil's yields were highest during that period. In 2014, Russia overtook Brazil at offering the highest yields, and this was during the Russian financial crisis, which meant that investors wanted more compensation for holding the then riskier Russian bonds. For the 2014-2017 period however, Brazil remained the country with the highest yields, as the country went through an economic crisis. Interestingly, South Africa's yields tracked Brazil's yields during this period – this is particularly interesting as it correlates with the period where South Africa was seen to be following Brazil on a downward spiral due to economic headwinds which were largely self-caused and increased by bad politics and idiosyncratic factors caused by the lack of structural reforms. This meant that Brazilian and South African assets performed poorly, which was reflected by high yields (conversely, low bond prices).

By observation, the other crises did not have any spillover effects onto the 10-year bonds of other BRICS members. Unlike the other isolated crises however, the Covid-19 pandemic had an impact on all the countries' 10-year bonds, with the Brazilian, Russian and South African yields increasing by 900. India and China's yields declined by 172 basis points and 200 basis

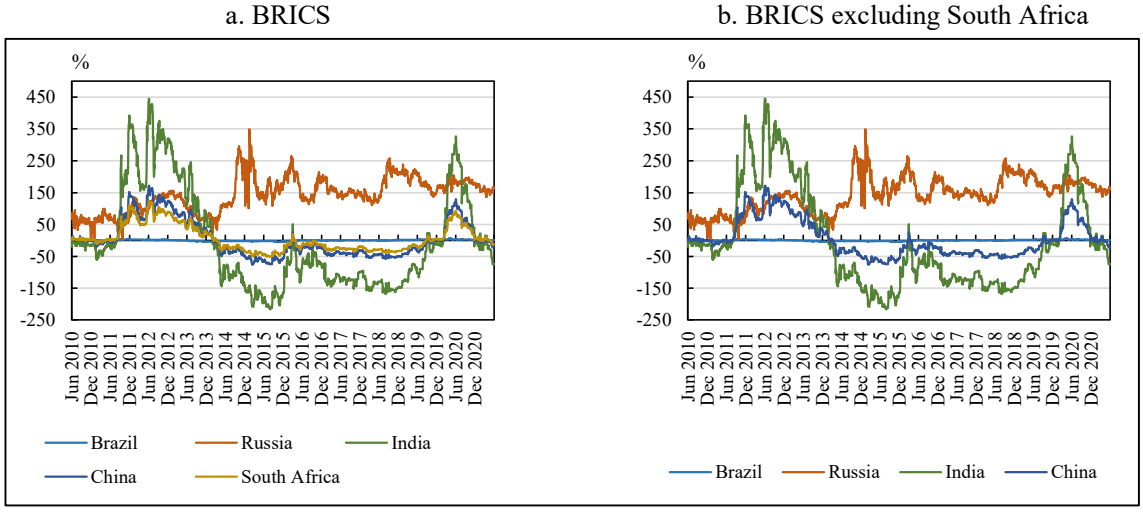
points at the time, and this was as the two countries were seen to already be dealing decisively with the pandemic and were thus viewed positively by investors. For the sample period overall, South Africa's yields were in an unfavourable position, being the second highest on average (Table 1). As expected, China, having become a unicorn emerging market, was of the country to have been offering the lowest yields with a maximum observed yield of 4.7%.

From this, the South African government and policy makers should expect increased borrowing costs in times of crisis as the market would be in tight conditions.

4.1.2 Synthetic ZAR yields

Figure 2 is a plot of the synthetic ZAR 10-year yields for bonds issued by the BRICS member countries, and these are constructed using equations 1 and 2. More specifically, the synthetic yields are obtained by combining the respective country i's nominal yield with a fixed-for-fixed cross currency swap to hedge the expected cashflows from currency i into ZAR.

Figure 2: Respective synthetic ZAR yields of 10-year government bonds



Notes: Figure 2a shows all 5 BRICS economies. In the South African case, the synthetic yield is consequently just the nominal yield for the South African 10 year government bond minus the relevant basis. ie. the "cross currency" swap rate would be $= i_{nt}^{ZAR} + r_{nt}^{\frac{USD}{ZAR}} - i_{nt}^{ZAR}$.

However, under the rational reasoning that an investor or market participant will not enter into swaps from a fixed ZAR yield to a fixed ZAR yield, South Africa was removed from the picture in figure 2b. Unlike in figure 1, figure 2 does not need to remove China's potential effect on the image.

Table 2 displays the summary statistics of the synthetic yields, which are the ZAR yield that a market participant would earn from purchasing a foreign currency denominated government bond and converting all of its promised foreign currency cashflows into ZAR.

Table 2: Descriptive statistics on synthetic ZAR yields of 10-year government bonds

	BRAZIL	RUSSIA	INDIA	CHINA	SOUTH_AFRICA
Mean	0.194	142.536	-2.214	4.090	5.542
Median	0.450	144.290	-36.874	-8.666	-3.306
Maximum	9.879	349.618	444.458	171.574	124.187
Minimum	-7.478	3.245	-215.672	-76.253	-51.797
Std. Dev.	2.074	53.590	154.432	57.473	40.969
Skewness	-0.097	0.044	0.943	0.941	0.930
Kurtosis	3.204	2.699	2.852	2.857	2.841
Jarque-Bera	9.495	11.719	427.827	426.272	416.992
Probability	0.009	0.003	0.000	0.000	0.000
Sum	557.592	409079.681	-6354.923	11739.083	15906.263
Sum Sq. Dev.	12335.494	8239502.703	68423228.582	9476568.233	4815564.737
Observations	2870	2870	2870	2870	2870

Notes: This table displays the summary statistics of the synthetic yields, which are the ZAR yield that a market participant would earn from purchasing a foreign currency denominated government bond and converting all of its promised foreign currency cashflows into ZAR.

Unlike Du et al. (2018), who sample US Treasuries vis-à-vis other AAA+ developed economies and find that the synthetic USD yields are lower than the respective nominal yields, figure 2 shows that the synthetic ZAR yields of the foreign emerging markets are higher. These higher synthetic yields mean that overall it is more beneficial for the foreign governments in the sample to receive their bond cashflows in ZAR. The synthetic yields are however more compact. During the 2013 – 2019 period, it became cheaper in real terms for South Africa to pay China and India's cashflows in ZAR, as these presented negative synthetic yields.

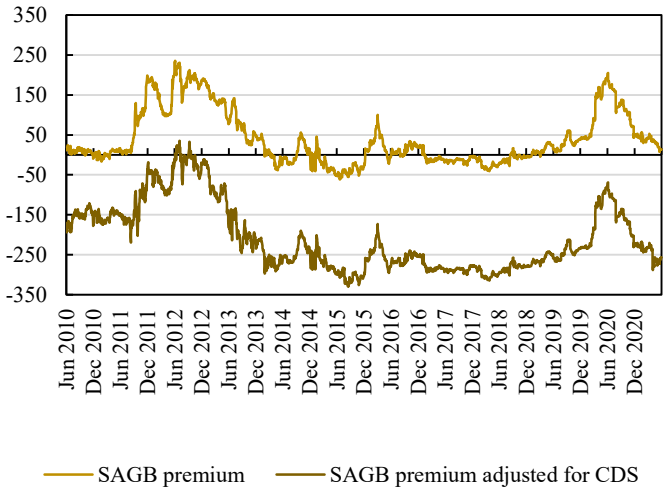
As per table 2, Russia is on average the biggest beneficiary, with a mean synthetic ZAR yield of 142, compared to India which has a negative synthetic ZAR yield on average. Said differently, on average it is expensive for India to enter into cross currency swaps so as to receive the bond cashflows in ZAR terms. Throughout the sample period (2010-2021), Russia maintains a positive synthetic ZAR yield, with the minimum earned synthetic yield of 3.45% being the maximum observed minimum among the rest of the BRICS member countries. Brazil is however an outlier. Although both the Brazilian Real and the Chinese Yuan are stronger than

the South African rand, Brazil diverges from China and its synthetic ZAR yield remains anchored around the zero level, suggesting that there is no benefit for Brazil to strive to earn their cashflows in ZAR terms.

4.1.3 The South African government bond premium over emerging markets

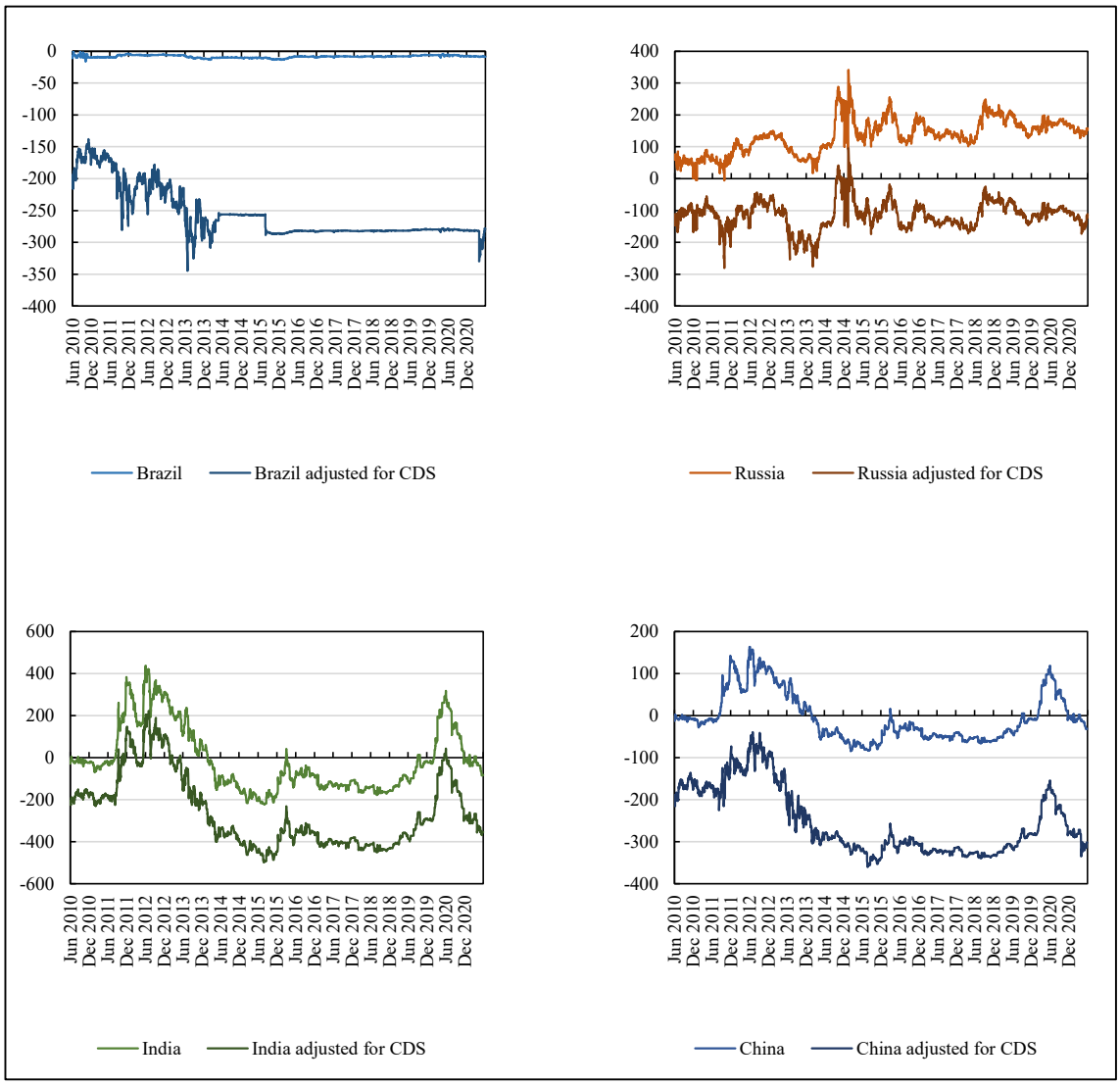
Figure 3 shows the SAGB premium over an average of the countries. This was calculated by equation 5. That is, by letting y_{nt}^{i} denote the yield of the 10-year government bond issued in country i and $\theta_{nt}^{i/ZAR}$ denote the 10-year fixed-for-fixed cross currency swap rate, the SAGB premium vis-à-vis country i was calculated as $\phi_{nt}^{i} \equiv y_{nt}^{i} - y_{nt}^{ZAR} - \theta_{nt}^{i/ZAR}$, with all the countries' points aggregated.
The SAGB premium was also then adjusted for the 10-year CDS spreads between the United States of America and South Africa.

Figure 3: Adjusted and unadjusted SAGB premium vis-à-vis BRIC average



Notes: Unlike Du et al (2018) however, the premium adjusted for swap market frictions as reflected by deviation is not considered, and this is due to the lack of interbank rates for some of the chosen countries for the sampled tenor.

Figure 4: Adjusted and unadjusted SAGB premium per BRIC country



Notes: Figure 4 is an extension of figure 3, and here we plot the SAGB premium vis-à-vis each foreign country as per equation 5. That is, by letting y_{nt}^{i} denote the yield of the 10-year government bond issued in country i and $\theta_{nt}^{i/ZAR}$ denote the respective 10-year fixed-for-fixed cross currency swap rate, the SAGB premium vis-à-vis foreign country i was calculated as $\phi_{nt}^{i} \equiv y_{nt}^{i} - y_{nt}^{ZAR} - \theta_{nt}^{i/ZAR}$.
The individual SAGB premiums were also then adjusted for the 10-year CDS spreads between the United States of America and South Africa.

Table 3 shows the summary statistics of the 10-year unadjusted SAGB premium per country. Since an original and more realistic assumption of this study (and by Say et al. (2018)), is that bonds issued by the sovereign are risk-free, summary statistics are only examined for the unadjusted SAGB premium (i.e., the SAGB premium isn't adjusted for default risk under summary statistics).

Table 3: Descriptive statistics of the unadjusted SAGB premium per country

		2012-2014	Russia fin crisis	Brazil econ crisis	Pre-Covid	Covid	Post-Covid	Entire period
		N = 1044	N = 153	N = 782	N = 565	N = 175	N = 151	N = 2870
BRAZIL	Mean	-7.812	-9.940	-9.551	-7.524	-6.391	-8.044	-8.268
	Median	-6.931	-9.861	-8.775	-7.739	-6.246	-8.096	-8.292
	Maximum	1.133	-9.272	-7.406	-5.518	-3.967	-6.902	1.133
	Minimum	-15.443	-10.870	-13.354	-9.536	-9.853	-8.972	-15.443
	Std. Dev.	2.378	0.385	1.565	0.969	0.953	0.501	1.996
	Jarque-Bera	8.802	10.154	93.777	35.167	8.539	4.085	13.636
	Probability	0.012	0.006	0.000	0.000	0.014	0.130	0.001
RUSSIA	Mean	81.448	173.688	158.488	168.919	174.801	153.763	134.074
	Median	72.560	166.167	147.995	166.986	174.570	151.241	136.002
	Maximum	150.325	288.329	342.250	249.066	198.418	181.618	342.250
	Minimum	-5.041	94.430	93.847	101.561	143.585	127.143	-5.041
	Std. Dev.	33.267	65.325	36.288	34.394	10.280	11.569	53.362
	Jarque-Bera	44.375	16.982	416.380	27.594	9.010	2.465	9.476
	Probability	0.000	0.000	0.000	0.000	0.011	0.292	0.009
INDIA	Mean	113.867	-119.602	-129.640	-105.542	188.260	-20.903	-10.677
	Median	95.137	-115.595	-131.212	-131.702	194.088	-22.965	-45.537
	Maximum	436.271	-77.903	41.582	92.447	317.462	65.757	436.271
	Minimum	-152.510	-170.900	-223.884	-176.602	65.760	-84.710	-223.884
	Std. Dev.	146.816	25.080	51.140	59.701	66.095	30.662	154.669
	Jarque-Bera	76.818	7.448	9.482	73.855	10.613	0.939	430.344

	Probability	0.000	0.024	0.009	0.000	0.005	0.625	0.000
CHINA	Mean	42.068	-44.892	-48.779	-39.716	69.919	-8.282	-4.372
	Median	34.803	-43.468	-49.637	-49.788	72.269	-8.877	-17.298
	Maximum	163.387	-28.663	15.583	34.252	118.936	23.767	163.387
	Minimum	-57.404	-66.329	-83.820	-65.946	23.592	-32.078	-83.820
	Std. Dev.	54.790	9.856	19.136	22.128	24.921	11.363	57.707
	Jarque-Bera	77.213	8.356	9.894	76.871	10.541	0.923	433.105
	Probability	0.000	0.015	0.007	0.000	0.005	0.630	0.000

Notes: Table 3 shows the summary statistics of the 10-year unadjusted SAGB premium per country.
The output is separated according to the different periods around crises, namely: Post GFC: June 2010 – May 2014; Russia financial crisis: June 2014 – December 2014; Brazil economic crisis: January 2015 – December 2017; Pre-Covid: January 2018 – February 2020; Covid-19: March 2020 – October 2020; Post-Covid: November 2020 – June 2021.

It is immediately observable from figure 3 that the adjusted premium tracks the unadjusted premium, with the effect that adjusting for default risk reduces the SAGB premium. From equation 5, a positive SAGB premium implies that the foreign country's yield is higher than the domestic country's yield, ceteris paribus.

The analysis of the SAGB premium is generally grouped into the following periods of crisis:

- Post-GFC: June 2010 – May 2014
- Russia financial crisis: June 2014 – December 2014
- Brazil economic crisis: January 2015[11] – December 2017
- Pre-Covid: January 2018 – February 2020
- Covid-19[12]: March 2020 – October 2020
- Post-Covid: November 2020 – June 2021

For the SAGB premium over the averaged BRIC countries however, it is futile to look specifically at the Russian financial crisis and the Brazilian economic crisis as these affected only a fraction of the sample countries. As such, focus is placed on post-GFC and the periods surrounding the Covid crisis.

[11] Note: this crisis started in mid-2014, however to avoid overlapping periods and for much better clarity this was taken to January 2015. This is reasonable since it means I've given the crisis time to manifest itself.
[12] Note: this is the height of the crisis; original wave of the contagion.

Post GFC: The unadjusted SAGB premium over an average of the BRIC economies fluctuated tightly around the zero level for the most part, showing that post the GFC, none of the sample countries found it necessarily cheaper to issue debt. During this period however, the SAGB premium widened for some time (by up to 217 basis points) and later declined back to zero. This reflects that from December 2011 to December 2012, it was temporarily cheaper for South Africa to borrow in real terms, compared to Brazil, Russia, India and China on average. Adjusting for the possibility of default risk, the premium declines, shifting into negative territory. This is plausible, as it shows that factoring in the possibility of the sovereign defaulting makes it more expensive to borrow or issue debt.

Covid-19: Leading up to the Covid-crisis, the premium began to trend upwards, and increased by 95 basis points on a net basis. That is, by the proposed definition of the SAGB premium, it became cheaper for South Africa to borrow in real terms compared to the other countries. At the height of the Covid-19 crisis, the premium continued to trend upwards, increasing by a further 100 basis points to reach a maximum of 188 basis points. However, as Central Banks across the globe, South Africa's advantageous position receded by 174 basis points to end the sample period at 14 basis points post-Covid. That is, post-Covid it became less cheaper for South Africa to issue debt. The adjusted SAGB premium curve follows a similar trend, except remaining within the negative realm for the entire sample period. This postulates that a decline on this particular adjusted premium means it is more expensive for South Africa to borrow in real terms, while an increase reflects that it is less expensive (and not necessarily cheaper) for the local sovereign to issue debt.

Figure 4 is an extension of figure 3, and here we plot the SAGB premium vis-à-vis each foreign country as per equation 5. That is, by letting y_{nt}^{i} denote the yield of the 10-year government bond issued in country i and $\theta_{nt}^{i/ZAR}$ denote the respective 10-year fixed-for-fixed cross currency swap rate, the SAGB premium vis-à-vis foreign country i was calculated as

$$\phi_{nt}^{i} \equiv y_{nt}^{i} - y_{nt}^{ZAR} - \theta_{nt}^{i/ZAR}.$$

The individual SAGB premiums were also then adjusted for the 10-year CDS spreads between the United States of America and South Africa. It is also immediately observable here that the each adjusted premium tracks its respective unadjusted premium. Brazil displays an anomaly

or deviation from the rest of the sampled countries, and this will be discussed later in the document.

Furthermore, one thing is common for both the adjusted and unadjusted premiums of the foreign countries (barring Brazil): the SAGB premium increases during the Covid-19 period, implying South Africa pays less to borrow in real terms (i.e., vis-à-vis the respective countries).

The observed trends per country are discussed below.

Table 3 shows the summary statistics of the 10-year unadjusted SAGB premium per country. The output is separated according to the different periods around crises as previously specified, namely:

- Post GFC: June 2010 – May 2014
- Russia financial crisis: June 2014 – December 2014
- Brazil economic crisis: January 2015[13] – December 2017
- Pre-Covid: January 2018 – February 2020
- Covid-19[14]: March 2020 – October 2020
- Post-Covid: November 2020 – June 2021

Entire period refers to the pre-defined period, June 2010 – June 2021.

As observed in the analysis of nominal yields and synthetic ZAR yields, the Russian financial crisis and the Brazilian economic crisis do not necessarily have spillover effects into the economy. Additionally, these crises overlapped, and it is thus prudent to assume that each of the two crises mainly affected its home-country the most. The Covid-19 pandemic however, affected all parts of the global economy, with careful observation of the periods prior, peak and post the pandemic being critical to observe for all countries.

The SAGB premium against Russia, India and China follow a similar trend to each other: although the other parts differ somewhat, the unadjusted premium increases leading up to the Covid-19 crisis, and declines as government interventions come into play and post the peak of the crisis. That is, in the time of crisis, it becomes relatively cheaper for South Africa to borrow

[13] Note: this crisis started in mid-2014, however to avoid overlapping periods and for much better clarity this was taken to January 2015. This is reasonable since it means I've given the crisis time to manifest itself.
[14] Note: this is the height of the crisis; original wave of the contagion.

in real terms, under the assumption that sovereign bonds are risk-free or default-free. The adjusted premium for each country tracks its respective unadjusted premium, although lower. Said differently, adjusting the premium for default risk necessitates that it is less cheap for South Africa to borrow in real terms. Brazil's trend in diverges from this, and this is explored in a later part of this section.

Brazil: The unadjusted SAGB premium is anchored around zero for the entire period, albeit maintaining a negative bias. The zero point implies that the cost for South Africa to borrow vis-à-vis Brazil is similar or breaks even. The average unadjusted premium for the entire period is 8 basis points, which is less expensive for the South African sovereign than during the Brazilian economic crisis (during the crisis, the minimum premium is negative 13 basis points, while the maximum was negative seven basis points). On average, the SAGB premium for this specific period is just shy of negative 9.6 basis points.

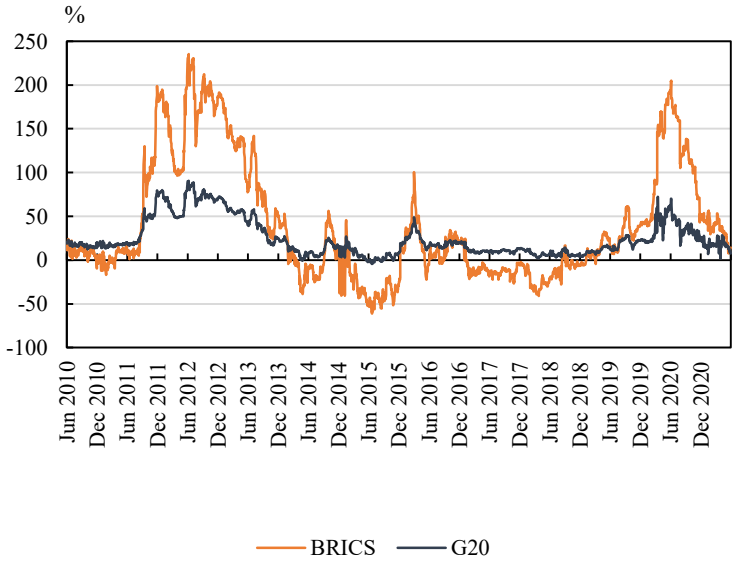
The premium adjusted for default risk however, is outright negative throughout, and it has become even more negative since the start of the sample period. As expected, the adjusted premium shows that it is more expensive for SA to borrow funds or issue debt vis-à-vis Brazil. During the sample period, it has become more expensive for the South African government to borrow in real terms when assuming that there is a possibility of the South African government defaulting. Interestingly, ever since the inception of the Brazilian economic crisis, the unadjusted premium remained fairly constant at approximately negative 290 basis points. Post-Covid, the premium became even more negative, having declined by approximately 40 basis points.

The SAGB premium vis-à-vis Brazil is the only one in the sample's output that does not trace the unadjusted premium at all.

4.1.4 BRICS vs G20 comparison

Figure 5 below compares the unadjusted SAGB premium as formulated for BRICS countries, against the SAGB premium formulated against the G20 sample. In terms of the G20 sample however, some member countries were excluded due to data constraints.

Figure 5: SAGB premium vis-à-vis BRICS and G20 countries



This section compares the unadjusted SAGB premium as formulated for BRICS countries, against the SAGB premium formulated against the G20 sample. In terms of the G20 sample however, some member countries were excluded due to data constraints.

From this, it is observed that the G20 SAGB premium is less volatile and trades within narrower ranges. It is also evident that it costs South Africa less to borrow in real terms when it is against BRICS member countries (i.e., purely emerging markets) vis-à-vis when it is against G20 member countries (which involve even developed economies). This is due to the G20 basket including countries with currencies that are substantially stronger than the South African rand.

Chapter 5: Conclusion

5.1 Introduction

We construct a measure of the SAGB premium, which is defined as the difference in the convenience yield of South African government bonds (SAGBs) and the bonds of other major emerging market economies. The difference is quantified by the gap between the South African rand (ZAR) yield (implied by entering into foreign exchange swaps) paid by foreign governments and the nominal South African Rand (ZAR) yield on South African government bonds. Similar to Du et al. (2018) and Valchev (2020) we argue for the potential drivers of the convenience yield differential by decomposing the SAGB risk premium into three parts: the differential between the sovereign credit risk of the respective foreign country and that of South Africa, the mispricing observed in the swap market through the deviations from covered interest rate parity (CIP) for interbank funding instruments (Du et al., 2018), and a residual term which is mainly made up of a loosely used liquidity term.

5.2 Summary of key findings

From this study, it is found that while the yields of the South African government bonds are sensitive and move extensively with almost all the times of crises, of late it is more beneficial for the other BRICS member countries to receive their cashflows in the South African Rand (ZAR), as reflected by high synthetic ZAR yields. This represents a potential high demand for ZAR. Ignoring idiosyncratic issues (political, fiscal, judicial), this would be a positive factor for South Africa's potential for attracting investments, and thus advancing South Africa's desire for greater foreign investment when the SA government became a BRICS member. Additionally, the sovereign bond yields increase overall in times of distress, more so for the country experiencing an idiosyncratic issue. That is, the behaviour of yields communicates that investors demand higher compensation for holding sovereign emerging market bonds in times of crisis, mores if the respective country is experiencing major idiosyncratic challenges or internal crises.

Furthermore, the SAGB premium or risk premium measure as we have defined here increases leading up to stress periods and in times of crisis, highlighting that South Africa pays less to borrow in real terms vis-à-vis Brazil, Russia, India and China during times of distress. This shows that despite South Africa's dire state of affairs on the political and fiscal front, there is

a superiority of the South African sovereign as a debt issuer compared to the other major emerging markets, and investors are better off receiving their cashflows in ZAR terms during stress periods. South Africa's advantage is however diminished when compared to the basket of G20 countries.

5.3 Recommendations for further research

While the research conducted in this study provides insight on how the yield curve and the SAGB premium has evolved during times of crisis, further research could be conducted to further advance the literature. Recommendations for further research on this topic may include investigating the term structure of the SAGB premium vis-à-vis each individual country in the sample. Additionally, considering how flush the market is with SAGB, it may be worth it to investigate how the supply of government bonds affect the SAGB premium, and the research could take the following format: To capture the supply (or alternatively scarcity) of government-issued debt, two measures are considered by Du et al (2018). The first being the ratio of the outstanding nominal amount of government bonds to nominal GDP, and the second one the ratio of net purchases by central banks to nominal GDP. Similar to Du et al (2018), the data on the net central bank purchases would be obtained from the respective countries' websites. Unlike Du et al. (2018) however, data on the outstanding government debt and GDP for the respective countries would be more suitably sourced from Bloomberg.

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