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AN ECONOMETRIC ANALYSIS OF FACTORS THAT INFLUENCE THE PERFORMANCE OF GREEN BONDS IN EMERGING MARKETS

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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This Research Project has been submitted for examination with my approval as the Supervisor.

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ABSTRACT

Developing nations are the most vulnerable to the effects of Climate change. This acts as a hindrance in the fight against poverty and improving the livelihoods of their citizens. Green bonds were created to finance projects that fight climate change. They are intended to help developing countries fight climate change while they grow their economies. The performance of green bonds in developed markets has been analyzed in numerous studies but there exists a deficiency in the emerging market space. This study involves econometrically analyzing factors that influence the performance of green bonds in emerging markets. The countries used in this study are Brazil, Mexico, and South Africa as they have successfully issued these securities. These factors include macroeconomic and stock market conditions as the independent variables. The number of active green bonds acts as the dependent variable. The macroeconomic conditions include short term interest rates, exchange rates, industrial output, and inflation. The macroeconomic conditions are represented by Treasury bill rates, Real Broad Effective Exchange Rate, the Industrial Production Index, and Consumer Price Index of the selected countries. The stock market conditions are represented by the countries' stock indices. Panel data regressions are used. The model used to evaluate the factors that influence the performance of green bonds in the selected countries was found to not be jointly significant given the macroeconomic conditions specified in the regression. The Consumer Price Index is the only significant macroeconomic variable. The second model sought to identify the implications of stock market conditions on the performance of green bonds in the selected countries. It was found that stock market conditions have a positive but insignificant influence on the overall green bond market in the selected countries. Green bonds issued by corporates are found to be the most popular in developing countries, but higher amounts are issued by agencies, and Municipal bonds are seen to pay higher coupons.

1 INTRODUCTION

1.1 Background information

Climate change is a situation that arises when the earth registers unpredictable weather patterns that are extended for a long period. Climate change affects everyone especially those who reside in low-income nations as they tend to be the most vulnerable due to their geographical position. Developing nations like Kenya are extremely vulnerable to the effects of climate change, environmental shifts, and associated social effects. In 2020, the World Population Review stated that developing nations are those that are ranked higher than less economically developed countries and have the potential for high economic growth.

The green bond market was created to seamlessly align the financial system to tackle the issue of Climate Change. Green investments such as green bond securities are long-term securities that support economic growth and can act as a means of combating climate change. This initiative encourages the efficient use of resources and a reduction of pollution in industries. The security enables investment in firms and sectors that are incorporating sustainability in their operations. There exists a great potential for African countries to combat this issue using this type of investment product. For instance, Osano (2019) documented that "Kenya's pension sector is valued at about 1.2 trillion Kenyan shillings". This just shows that a lot of capital can potentially be channeled to this investment product and hence generate economic growth cleanly and sustainably. Numerous emerging economies have been able to successfully incorporate green bonds in their economy.

The proposed study will focus on Brazil, Mexico, and South Africa as they are a part of developing countries in the emerging market space as documented by the International Monetary Fund's World Economic Outlook Database International Monetary Fund (2020). Countries like Kenya can also gain a few insights into how they have aligned the green bond security in their markets given various macroeconomic trends.

It would be very essential to be able to understand how green bond securities perform in various macroeconomic conditions. This is because having a clear picture of what to expect given market and economic conditions would aid in increasing investment in green bonds and hence aid in

combating the issue of climate change. Those who are expected to benefit include future investors, potential issuers, governments of developing and emerging economies, and all other interested parties. These macroeconomic conditions are to be represented by variables such as Inflation, Gross Domestic Product, Treasury bill Rates, and Real Exchange Rates. A nation's Gross Domestic Product signifies its macroeconomic stability and growth. Hence it is likely to influence how long-term debt securities like green bonds perform given the state of the economy. Studies have been done to showcase the effect of exchange rates on bond prices. For instance, Ngaruiya (2016), found that "there exists a positive and insignificant relationship between exchange rates and the bond price". This implied that an increase in exchange rates leads to an increase in bond prices though not significantly. The Treasury Bill interest rates represent the rate at which short-term government securities are traded in the market. A rise in the Treasury Bill Interest Rate is expected to decrease the price of bonds issued in the market as it could be a sign of participation in a risky market. Therefore, short term bonds are expected to prevail in situations where this interest rate rises. The inflation rate acts as a key influence on the maturities of green bonds. Various studies such as the one conducted by Flaherty (2016), established that there exists an inverse relationship between long-term bonds such as green bonds and the inflation rates.

The stock market conditions that are to be evaluated in this study include periods in which most of the prices of the traded stocks experience an upward or downward trend. Indices of the prominent stocks in these markets can act as indicators of these trends in the market since they include the most attractive stocks in these markets. Stock markets have a higher risk than bond markets which is where green bonds are issued. Hence it can be concluded that there exists higher volatility in stock markets and investors can use bonds to mitigate their risk. Hansen (2008) documented that "whenever the stock market experiences a downturn, the bond market flourishes". It would be interesting to see if there exists a relationship between movement in the stock market and the green bond securities in emerging economies.

A comparison of how issuers in emerging markets perform in the green bond securities market would act as an aid in knowing and understanding which issuers in developing countries have been successful in the market and help potential issuers to gain insight into what can be done on

their part to obtain a similar outcome. Given the macroeconomic conditions that prevail in these countries.

1.1.1 Green Bonds in Brazil, Mexico, and South Africa

The Climate Bonds Initiative (CBI) was launched to increase investments that will aid nations in transitioning to a low-carbon and climate-resilient economy. They have also established a database that has a repository of green bond policies from around the globe. Brazil and Mexico have put-up policies that are contained in the repository to increase investment in green bond securities.

Brazil has issued 23 green bonds worth a total of 5.230 Million Brazilian Real (1.018 Million USD) since 2016. According to the Climate Bonds Initiative (2020), the issuers for these bonds are all corporates such as Attend Ambiental, Enel Green Power Manicoba Eolica, and 17 other corporates. The source of funds includes European investors who have taken an interest in the country's bond market. Brazil's national development bank established a Sustainable Energy Fund in December 2016 dedicated to investing in green bonds. The Brazil Green Finance Initiative (BGFI) was also established and consists of representatives from native pension funds, insurance firms, banks, major industry sectors, and investors, who are working to reach the goal of strengthening the development of the green finance market and attract capital from the international economy to finance the development of Brazil's future green economy. As of 2019, Brazil had a GDP of 1.840 Trillion USD which has increased by 44 billion since the issuance of the first green bond. In 2016 their inflation annual stood at 8.74% and as of 2019, the value had significantly decreased to 3.73%. The country's real effective exchange rate decreased from 73.03 to 69.63 from 2016 to 2019. The treasury bill real interest rate reduced significantly from 13.46 % to 6.18 % from when the first issuance occurred to the year 2019. Hence an increase in investment in green bonds can be attributed to the changes experienced in the nation's Inflation, Gross Domestic Product, and Treasury bill rate. However, the negative change in the real effective exchange rate index affects the performance of green bonds negatively.

Mexico has issued 9 green bonds worth 22.64 Billion Mexican Pesos (1.02 Billion USD). The issuers for these bonds include corporates and agencies like Grupo Rotoplas SAB de CV, Nacional Financiera S.N.C Institucion de Banca de Desarrollo, Fondo Especial para

Financiamientos Agropecuarios, and six other corporates. According to the Climate Bonds Initiative (2020), Mexico has set up the Green Bonds Principles that include sector-specific eligibility criteria for green projects. The Mexican Securities Exchange market, which is also known as the Bolsa Mexicana de Valores formed a Climate Finance Advisory Council with the mandate of boosting the development of a green bonds market in Mexico and the facilitation of funding for projects that involve the reduction of carbon used to aid in the fight against climate change. The Inter-American Development Bank (IDB) and the Clean Technology Fund (CTF) closed the first phase of a 125 Million Dollar deal for the financing of energy efficiency projects developed by Mexican energy service companies. According to the World Bank data depository as of the end of 2019, Mexico had a GDP of 1.26 Trillion USD and the value has significantly increased by 180.383 Million USD since the issuance of their first green bond in 2016. In 2016 their inflation annual stood at 2.82% and as of 2019, the value had significantly increased to 3.64%. Mexico's real effective exchange rate increased from 79.02 to 83.65 from when the first issuance occurred to the year 2019. The treasury bill rate increased from 4.15 % to 7.84 % from 2016 to 2019. Therefore, a drop in investment in green bonds can be attributed to the changes experienced in the nation's Inflation and Treasury bill rate. The change in real effective exchange rate index and Gross Domestic Product is meant to have affected the performance of green bonds positively.

South Africa is the highest African issuer with about 11 green bonds worth a total of 8.06 Billion South African Rand (491 Million USD) as recorded by an NGO known as the Climate Bonds Initiative. The issuers of these bonds are Corporates such as Nedbank Limited and Growthpoint Properties Limited. Other issuers non-corporate issuers include the Johannesburg Metropolitan Municipality and the City of Cape Town. The nation had a GDP of 351.43 Trillion USD which has increased by 54.55 Billion since 2014 which is when the country's first green bond was issued. In 2014, their annual inflation was at 6.14% as of 2019 the inflation rate had decreased to 4.12%. The country's real effective exchange rate had a very slight decrease from 77.03 to 77.94 from the year 2014 to 2019. The treasury bill interest rate increased significantly from 5.8% to 7.083% from when the first issuance occurred in 2014 to the year 2019. Hence increase in investment in green bonds can be attributed to the changes experienced in the nation's Inflation and Gross Domestic Product. The change in real effective exchange rate index and Treasury bill rate affects the performance of green bonds negatively.

1.1.2 Stock Market Conditions and Performance of Green Investment Bonds

In a stock market, volatility can be used to signify movements and conditions in the market. These movements can be upward or downward in nature. For instance, when the stock market rises and falls at over one percent for an extended period. The market may be termed as volatile.

The selected countries have issued a significant number of green bonds and to see whether there exists a relationship between the issuance of green bonds and the stock market conditions one can look at the indices of the respective stock market. This has been done by researchers like Reboredo (2018) who analyzed whether there exists a dependent relationship between green bonds and the related financial markets like the stock market and the national bond market. Stock market indices can act as representatives of the stock market. The volatility of this index can be calculated as the standard deviation of the returns of the index.

The Brazilian Stock Market has grown significantly in terms of market capitalization since its inception on August 23, 1890. To obtain a picture of how the Brazilian stock market has been shifting since the issuance of the first green bond in the country, the volatility of the returns of indices that contain the most traded equities in the market can be used. For instance, the volatility of the Brasil 50 which comprises the 50 most traded equities at the Brazilian Stock Exchange and Over-the-Counter Market can be used. The returns for the index were obtained from investing.com and the volatility of the index since the issuance of the first green bond to the end of 2019 was calculated to be 0.01237 this shows that the market is not very volatile and hence the green bond market is either affected poorly or not at all.

The Mexican Stock Exchange also known as Mexican Bolsa Mexbol is the second-largest stock exchange in Latin America. The market has 13 indices obtained from the prices of stocks. The main stock index is known as the Mexican Stock Exchange Index (IPC MEXBOL) and is the broadest indicator of the Bolsa Mexicana de Valores (BMV)'s overall performance. The volatility of the index since the issuance of the first green bond in 2016 to 2019 was calculated to be 0.0086872 this shows that the market is not volatile. Therefore, the green bond market is either affected poorly or not at all.

The Johannesburg Stock Exchange is the largest equities exchange in Africa. The index used in the market is known as the Johannesburg Stock Exchange Domestic Company Index as found on the JSE website. The volatility of the index from 2014 to 2019 was calculated to be 0.010416 this shows that the market is not volatile. Thus, the green bond market did not affect the stock market.

1.1.3 Comparison of Green Bonds Performance in selected countries

According to the data obtained from the Thomson Reuters data portal, the countries selected in the study have issued a total of 43 green bonds. Brazil and Mexico have one of the most recurring green bond issuers in the Latin American region. South Africa is the highest issuer of green bonds in Africa.

Brazil has issued 23 green bonds all of them being of corporate nature. This is the highest so far out of all the countries selected. All the issued green bonds are active. Those that have the earliest maturity are set to mature in the year 2021. Their coupon rates range from 3.50 to 8.47 percent. The proceeds of these bonds are towards Alternative Energy, Energy Efficiency, and Industrial Development.

South Africa is the first African country that has issued green bonds. As of today, it has issued 11 green bonds in total. The issuers range from corporates to external governments. None has matured so far. The earliest expected maturity is in April 2022. Their coupon rates range from 5.33 to 13.48 percent. The proceeds of these bonds are towards clean transport, Energy Efficiency, and eligible green projects. South Africa is the only country here that has issued green government bonds. It is worth noting that Cape Town's municipality green bonds have been seen by issuers and investors as a success. The bond was transparent as it outlined projects involved in electric buses, construction of energy-efficient buildings, development of water management alternatives, sewage effluent treatment systems, and the rehabilitation and protection of coastal structures.

Mexico has issued 9 green bonds with only one being an agency-issued bond the rest are corporate bonds. Only one matured on the 28th of June this year. Their coupon rates range from

5.83 to 9.93 percent. The proceeds of these bonds are towards Alternative Energy, Energy Efficiency, land preservation, green construction, and water and sewerage Development.

1.2 Problem Statement

Kenya like most of its developing countries counterparts have faced numerous challenges in incorporating Inclusive Green Investments. Murai (2015) mentioned that "the challenges Kenya has faced in incorporating Inclusive Green Investments include having an institutional investor market is highly fragmented, the existence of a great lack of public awareness and the fact that there are relatively higher returns in traditional sectors and asset classes". Developing countries need to embrace these investments as an innovative and alternative way of raising finance from both domestic and external sources. These investments can be used to enable developing countries to reach the level of developed nations while also combating the issue of climate change as they are the most affected. It is worth noting that a good number of developing countries have issued these securities.

Flammer (2020) examined corporate green bonds in the American economy and documented that investors respond positively to their issuance announcement. The study also observed that companies that issue green bonds experience an increase in ownership by long-term investors and green investors after issuance when compared to traditional bond issuers. From this study, we can observe a positive response to the green bond security. This study however was based on the emerging markets and mainly focused on corporate green bonds.

Flaherty (2016) performed an econometric study that was based on finding out if the current macroeconomic environment has enabled the successful phasing in of green bonds. The study involved the construction of an empirical model that looked at the green bonds issued by different institutions with different maturities and included determinants of bond price such as the Treasury Bill rates, inflation, the market volatility indices, long US dollar futures indices, and a measure of macroeconomic stability that was the industrial production index (IPI). This study was limited to the green bonds issued by developed nations and did not touch on emerging economies.

There is a deficiency of studies that provide an econometric approach on the performance of green bonds in a largely dominated traditional bond market especially in the emerging market

economy. This proposed study will fill the gap and econometrically evaluate the performance of green bonds in emerging markets and whether there exist variables such as those used by Flaherty (2016) that determine and influence the performance of this specific long-term security.

The proposed study will focus on Brazil, Mexico, and South Africa. This is because these three countries fall in the range of developing countries as recorded by the International Monetary Fund's World Economic Outlook Database International Monetary Fund (2020). Brazil, Mexico, and South Africa have also registered significant economic growth and are part of the newly industrialized country's space as they have outpaced multiple of their developing counterparts. All these countries have also issued green bonds. Countries like Kenya can learn from their experience. Key macroeconomic variables to be investigated in the study that is based on the previous studies will include Real effective exchange rates, Treasury Bill rates, inflation, and the nation's current gross domestic product which can also be measured by the nation's Industrial Production Index.

1.3 Research Questions

1. What are the factors that influence the performance of green bonds in the selected countries?
2. How are the green bonds in selected countries and the conditions of the respective stock markets related?
3. How do green bonds issued by different issuers in selected countries perform when compared to each other?

1.4 Research Objectives

This study aims to establish the main and most significant determinant of the green bond performance in the issued market of the selected countries.

1.4.1 Specific Objectives

1. To examine factors that influence the performance of green bonds in the selected countries.

2. To identify the implications of stock market conditions on the performance of green investment bonds in the selected countries.
3. To determine how green bonds issued by different issuers in selected countries perform when compared to each other.

1.5 Significance of the Study

This study will be of great benefit to potential issuers of this specific type of security such as development finance institutions, pension funds, treasury departments, municipalities, and corporations that are in the emerging market space. This is because it will enable them to obtain a clear picture of how the green bond security adjusts to the economic conditions of similar countries. Hence guide them in the pricing of the security to ensure that its demand and supply is appropriate and desirable.

Investors and donors will benefit as obtaining clarity in how the green bond market behaves given various macroeconomic conditions would help them a great deal in knowing when and how to participate in this sustainable investment.

Governments and regulators of developing nations will also benefit from gaining an understanding of the performance of the green bond as this security can act as a means for them to raise financing for sustainable projects that will be of great aid in achieving the thirteenth sustainable development goal of climate action that is their central banks and their capital markets authorities.

The Climate Bonds Initiative is a Non-Governmental Organization that provides standards and guidance on the issuance of green bonds. The organization mainly works on mobilizing the bond market to provide climate change solutions. They will benefit greatly from the study as it will show whether the green bond security is influenced significantly by key factors in the emerging markets and aid in understanding whether green bonds are being incorporated smoothly in the bond market when compared to the other securities. This understanding will aid in knowing whether more policies are required to be put in place to increase its popularity in the financial market.

The comparison of the issuers of green bonds in the countries selected in the study will help the public, interested academics, and researchers to obtain an understanding of where countries in the emerging markets space lie in terms of a green bond investment.

2 LITERATURE REVIEW

2.1 Introduction

This chapter contains theoretical and empirical literature regarding the factors that influence the performance of green bonds in the selected countries, the existence of a relationship between green bonds in selected countries and their respective stock markets, and the comparison of the performance of green bonds issued by different issuers in the selected countries.

2.2 Theoretical literature

The Efficient Market Hypothesis (EMH) was developed by Fama (1970) and is concerned with the concept that prices at any point in time fully reflect all available information. This means that it is impossible for investors to easily beat the market by obtaining riskless profits consistently since market prices will only react to new information. Therefore, as documented by Malkiel (1989), "capital market prices are guided by the information that is available to the general public". There exist three forms of this hypothesis and they include the weak, semi-strong, and strong form hypothesis. The weak-form hypothesis asserts that the price of a bond already reflects all information that can be obtained through the examination of market data such as historical prices. The semi-strong form hypothesis states that all publicly available information based on an institution's expectations must be reflected in the price of an asset. The strong form hypothesis states that market prices reflect all information based on the company including information that is only available to the company's insiders. If indeed the market is efficient then this theory is observable in the green bond market and hence the performance of the green bond security can be shown to move with macroeconomic factors that influence the pricing of bonds by issuers such as Gross Domestic Product, short term interest rates, inflation, and the exchange rates. The evidence of this theory could also stipulate that indeed there exist a relationship between green bonds in selected countries and the respective securities markets as the issuance of these long-term securities is expected to be fully reflected in the stock market that is related to the issuer given that all information regarding the stock prices is available to the public. In 2020, Karginova-Gubinova spearheaded a study that worked on linking the hypothesis with the green bond market.

Green bonds are different from regular bonds as they act as a sign to the public that the company is committed to sustainability and the environment in general. This reasoning is where the signaling theory comes in. The theory was set by Spence (1973) whereby, if one party conveys information that makes itself credible to another party, they can perform well due to this credibly. In this case, whenever a company issues green bonds they provide a credible signal of being committed to tackling the issue of climate change and thus companies can easily attract investors who are mindful of the long-term well-being of the natural environment as documented by Flammer (2020). The study done by the author found that green bond issuers experience an increase in ownership by investors that are mindful of climate change and long-term investors. It would be fascinating to compare the performance of green bonds issued by different issuers to observe whether the theory was held in their case and understand which one was affected the most by the signaling theory.

The pecking order theory that was made popular by Myers in 1984 is based on institutions following a specific order when issuing various sources of financing for their firm. As explained by the Corporate Finance Institute (2015), "the order starts from the firm's retained earnings, their debt, and finally their equity financing. Debt issuance signals that a company's stock price is undervalued and that the board believes has a strong belief that the investment will be profitable. Alternatively, the issuance of shares acts as a negative signal that the stock is overvalued." Flammer (2020) found that the results based on the stock market reaction to the issuance of securities are consistent with the pecking order theory which shows that the stock market responds negatively to conventional bond issues, but shows no significant reaction to bond issues. The findings of this study may fail to be consistent with the theory as green bonds can be interpreted as some sort of Corporate Social Responsibility as they are issued to combat climate change.

Studies on green bonds have been heavily linked to corporate social responsibility (CSR) and the socially responsible investing (SRI) literature. The green bond security acts as a sign of commitment to taking environmental responsibility and hence this enhances the stock performance of the issuer. Luo (2009) used corporate social performance (CSP) to refer to a corporation's accumulating involvement in CSR and as a notion that gives a company a competitive edge in the industry. Hence the theory can be used to stipulate that issuers of green

bonds are given a competitive advantage due to the issuance of the sustainable security that is the green bond.

2.3 Empirical literature

Flaherty (2016) looked at the performance of green bonds with different maturities issued by different institutions and how they are influenced by variables that determine the issuance of long-term traditional bonds by constructing an empirical model. The specification of green bonds issuers was such that the dependent variable was the bond price for individual green bonds and the independent variables included determinants of bond prices, like the Treasury Bill rate which represented short term interest rates, inflation, the Chicago Board Exchange Market Volatility Index (VIX), the long US dollar futures index and the industrial production index (IPI) which was a measure of macroeconomic stability. The regression showed the relationship between the explanatory variables and the price of green bonds. Flaherty (2016) conducted Panel study tests for the random effect model following the log transformation for several variables. The data used in the analysis was monthly panel data of active bonds, from October 2013 to January 2016, and was sourced from the Bloomberg database. The monthly data on VIX, CPI index, and the Treasury Bill Rate were obtained from the US Federal Reserve Bank database. The IPI was gathered from the OECD database and the dollar value was obtained from the Yahoo Finance portal. They used pooled panel data as this method enabled the simultaneous effect on the bond price issued by different groups of issuers that include government agencies, private institutions, and supranational organizations to be evaluated. Pooled panel data also worked when the performance of green bonds of different maturity bonds was to be evaluated. This would be relevant to the study as the use of a similar regression will allow the evaluation of whether there exists a relationship between the green bonds of the different selected countries and macroeconomic factors. It will also enable the countries to be evaluated separately for comparison as Flaherty (2016) was able to categorize the bonds based on their issuer.

The paper done by Pham (2016) analyzed the volatility behavior of the green bond market using data on the daily prices of the S&P green bond indices between April 2010 and April 2015 from the S&P website. The data used was of a time series nature. They applied the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) modeling technique to study the green

bond market's volatility. The results obtained show that the green bond market experienced large volatility clustering while the pattern of volatility clustering is weaker in the non-green bond segment of the market. It was also found that a shock in the overall traditional bond market tended to spill over into the green bond market. This spillover effect was set to vary with time. This paper relates to the proposed study despite it focusing on the bond market of a developed economy and not the stock market as it looked at a link of two financial markets.

Reboredo (2018) used a methodological approach through a multivariate dependence model to investigate the dependence relationship that existed between green bonds and financial markets. This structure of dependence was characterized by the joint distribution of their error terms. It was represented in the form of a copula function. That enabled a lot of modeling flexibility to take place as it allowed for the separate modeling of marginals and dependence structures. Reboredo (2018) also found that "the copulas provide a specific representation of dependence when the joint distribution is non-elliptical and documents the joint behavior of variables in the tails of the distribution called tail dependence. Tail dependence can measure the dependence between variables during extreme upward or downward market movements". The marginal distribution functions and the copula function were specified to characterize the structure of dependence through copulas. Maximum likelihood (ML) estimation was used to separately obtain the parameters of the marginal models. The copula pseudo-sample observations were used to obtain the copula parameters. The number of lags in the mean and variance equations was chosen through the Akaike information criteria (AIC). Copula models were evaluated using the Akaike information criteria which were adjusted for small-sample bias. The data involved 4 green bond indices sourced from Bloomberg. The study used daily from 14 October 2014 to 31 August 2017. The Barclays Global Aggregate Corporate Index and the Bloomberg Barclays Global Treasury Total Return Index represented the fixed-income market. The MSCI World Index represented the global stock market. The S&P GSCI Energy Spot CME represented the commodity market. Data for the financial market indices were obtained from Bloomberg. The data they used was of time series form. It is worth noting that using this multivariate model is cumbersome and would limit one's data to large sample size. It may fail to work for specific developing countries as they have become issuers of green bonds in the recent past. Another setback is that their economies are not advanced to have indices for every market. The analysis done is however very intuitive as it does not specify the relationship between the market for

green bonds and traditional financial markets which will be key to highlight in this study. The study observed that an increase in interest rates harms green bonds issued by government agencies and private companies, the effect increases with maturity. Inflation has a negative sign that is significant for bonds issued by supranational institutions.

Zerbib (2018) had the goal of identifying the factors affecting the costliness of a green bond. The theory behind the study was that Corporate Social Responsibility (CSR) affects the spread of new corporate bonds issued. The analysis was performed on the yield spread of 110 green bonds issued from July 2013 to December 2017 as obtained from Bloomberg. A matching method was used to calculate the yield of an equivalent synthetic traditional bond for each green bond issued before December 2017. A counterfactual traditional bond with the same issuer, maturity, currency, rating, structure, collateral, and coupon type, close issue date, and size was used. The residual liquidity difference between green bonds and their traditional counterpart that was used to obtain a green premium was controlled through running a fixed-effects panel regression. The green premium is the unobserved specific effect of the regression of the yield differential on the bonds' liquidity differential and is essentially what was used to identify the effect of pro-environmental preferences. An omitted variable bias was eliminated using a panel regression as opposed to a cross-sectional regression. The factors affecting the cost of a green bond were identified by explaining the green premiums according to the specific characteristics of the bonds. It was found that there existed a small significant negative green bond premium of about -2 basis points (bps) in the sample taken. The data used was panel cross-sectional in nature. The sector and rating were significant drivers of the premium as the negative premium is greater for financial bonds and low-rated bonds. This study done by Zerbib (2018) is related to the proposed study as it evaluates the factors that determine the cost of a green bond and also identified that there exists variability in the performance of green bonds when it comes to the specific issuer.

Karpf (2018) compared green and conventional bonds with similar characteristics through their yields. The analysis was done on 1,880 green bonds issued from 2010 to 2016 in the municipal bonds market. The data was sourced from the Bloomberg database. The data used was of time series form. The comparison of their yield curves of these bonds observed that green bonds on average have lower interest rates and thus have more lucrative financing conditions than conventional bonds. A quantitative analysis based on the Oaxaca-Blinder decomposition showed

that this spread could be explained by the characteristics of the issuing entity and not the green nature of the bond. This comparison done in the study by Karpf (2018) shows that the variation of the yield obtained from bonds varies due to the different issuers and not the green nature, this then leads to the matter that the proposed study aims to address which involves conducting a comparison of the performance of green bonds issued by various issuers in the selected emerging economies.

The objective of the study done by Baulkaran (2019) was to evaluate the stock market's reaction to green bonds issued by publicly traded corporations. The standard event study methodology was used. The study was linked to literature based on Corporate Social Responsibility (CSR) and Socially Responsible Investing (SRI). Announcement dates for green bonds issued by publicly listed corporations were collected from company press releases. Stock prices were obtained from the FactSet database. The sample used in the study involved 54 firms most of which were corporate green bonds issued by corporations from Europe. The data used was cross-sectional. It was found that the Cumulative Abnormal Returns (CAR) in the market were positive and significant. Regression analysis done showed that green bonds with higher coupon rates also had a negative reaction by the investors. Firm size, Tobin's Q, and growth were positively related to the CAR however the operating cash flow was negatively related to the CAR. The paper used cross-section analysis to identify bond and firm characteristics that explain the market reaction to green bond issuance. This paper relates to the proposed study as it aims at finding out whether there exists a relationship between stock markets of the selected countries and their green bond market.

Bachelet (2019) adopted an exact matching method to identify the specific green bond characteristics by comparing them to their most similar conventional bond based on their yields, liquidity, and volatility. They also considered the role of factors such as the institutional characteristics of the issuer, the private characteristics of the issuer and the existence or absence of green bond verifications. A synthetic bond was created using a linear combination of two different bonds so to meet the matching conditions. The data set used included daily data on the ask price, bid price and the redemption yield of 1 January 2013 to 31 December. They were downloaded from DataStream. The data was cross-sectional. The findings of the paper strongly suggested that green bonds have a negative premium and hence they may tend to be financed at a

discount. This paper is study focuses on the bond market and not the stock market as it looks at variables that drive the pricing of the green bond.

Broadstock (2019) sought to find out whether the market for green bonds was affected by macroeconomic factors such as Financial market stability and economic activity. Dynamic conditional correlations were estimated between green and traditional bond prices to identify market-level determinants of the estimated correlations and to document how their importance varies over time. Correlations are a direct measure in terms of interpretation. Dynamic model averaging methods were applied to establish the determinants of these correlations. To understand how the performance of green bond and regular bond indices correspond with each other, time-varying correlation between these series were estimated. The data used was daily time-series data from November 2008 to August 2018 of 3 stock indexes, a volatility index, an economic activity index, and oil prices. Evidence from the study shows that there exists a connection between green and black bonds to macroeconomic factors such as changes in financial market returns and volatility, economic policy uncertainty, daily economic activity, oil prices, and uniquely constructed measures of positive and negative news-based sentiment towards green bonds. The economic significance of these findings showed that macroeconomic conditions play a role in reinforcing the progress towards the growth of the green investment bond market. The proposed study picks up from this by seeking to verify whether these macroeconomic conditions are in any way closely linked to the performance of the prices of the issued green bonds in the selected countries.

Flammer (2020) compiled corporate green bonds from Bloomberg's fixed income database that have been issued from 2013 to 2018 and performed an empirical analysis study of how the stock market responds to the issuance of green investment bonds. Based on the event study methodology used, it was found that the stock market responds positively in a short time frame near the announcement of green bond issues. The data used was cross-sectional. The Cumulative Abnormal Return (CAR) was found to be 0.49%, which is significantly different from zero at the 5% level. The CARs were larger for green bonds that are certified by independent third parties, and for first-time issuers of green bonds. The results were also consistent with the signaling theorem as it was found that corporate green bonds indeed provided a positive signal of a firms' commitment to the environment, as they experienced a positive stock market reaction to the

announcement of green bond issuance, a stronger response for green bonds, and a stronger response for first-time issuers. This research was heavily firm based and it would be interesting to see if the same outcome occurred in the overall green bond market as postulated in this upcoming study.

The study done by Tu (2020) involved a multi-dimensional analysis that used an analytic hierarchy process (AHP) method with the aim of identifying and ranking factors that influence the development of the green investment bond markets. The AHP method was selected in the study due to the complex nature of the problem of expanding the green bond market. The method is also able to evaluate the problem in detail and organize them by their importance. The case study was on Vietnam's Green Bond market development. 10 experts with extensive experience in the study of green bond markets carried out the comparisons through an AHP questionnaire given through email in February 2020. The data collected was of qualitative form. The maximum value of eigenvector, consistency index (CI), consistency ratio (CR), and normalized values for each criterion were determined. If their maximum values were at an optimal level, then the values were normalized. If they were not, then the values were normalized again until they were within the desired range. The findings in the study revealed that legal infrastructure, green bonds' interest rates, and their economy's stability are the most important factors directly affecting green bond market expansion. The study done by Tu (2020) is like the proposed study as it investigates the macroeconomic factors that influence the issuance of green bond markets but with a knowledge-based approach.

2.4 Overview of the literature

From the literature given above various authors have examined the performance of green bonds from the perspective of developed markets. Most of the studies on green bond securities have also compared the green bond security with those that have been issued in the conventional bond market save for Flaherty (2016), who examined whether there exists a dependent relationship between the green investment bond market and the financial market. The study also used econometric analysis to investigate whether the macroeconomic trends affect the overall green bond market. The study did not specifically target emerging markets. Studies on green bonds and the stock market have looked at the stock market of the specific issuer such as what Flammer (2020), observed who observed that issuing green bonds aligned with the signaling theory as

companies provided a signal of credibility by showing their commitment towards the environment.

The proposed study will look at factors that influence the performance of green bonds in the selected countries. These factors are the macroeconomic trends that were also highlighted by Flaherty (2016) and Broadstock (2019). It will also aim to identify the implications stock market conditions have on the performance of green investment bonds in the selected countries. These two goals will follow on whether the Efficient Market Hypothesis holds in the green bond market as they will show whether the macroeconomic environment is conducive for the issuance of green bonds. This would be critical as it would aid in suggesting green bond policies in today's market. The comparison of green bonds issued by different issuers in selected countries will be tied to questioning whether there are firms that are affected by the signaling theory and corporate social performance (CSP) more prominently than their counterparts. It will also show whether pecking order theory failed to be observed when it came to the issuance of green bonds.

The variables included in the empirical work done by Flaherty (2016) were key determinants for bond prices such as the treasury bill rates, inflation, a Volatility Index, a futures index, and a measure of macroeconomic stability that was the industrial production index. This study shall include macroeconomic conditions that are represented by variables such as Inflation, Gross Domestic Product, treasury bill rate, and Real effective exchange rate index and the selected countries' respective stock market index which will act as a proxy for the stock market conditions. The data to be used will be pooled panel data as it will include Green bonds that have different times to maturity and different dates of issuance. The study will aid in filling the research gap by identifying whether macroeconomic trends and stock market conditions have been conducive for the entry of green bonds in the markets for Brazil, Mexico, and South Africa. The comparison of the different issuers will fill the gap in the existing literature by identifying issuers in emerging economies that have successfully issued the security given the state of the economy of their respective countries.

3 METHODOLOGY

3.1 Introduction

This chapter contains a detailed description of the models that will be used in this econometric study, the economic theory behind it, and how the data involved in this study will be used to identify the most significant factor driving the performance of the green bond security in the green bond market.

3.2 Theoretical Model

This study involves identifying whether green bonds are influenced by short-term interest rates, exchange rates, the economic level of a country, and inflation. The issuance of a Green bond, treasury bill rates, real exchange rates, the nation's industrial production index, and consumer price index will be the variables in use for each of the selected countries. Stock indices will be used to establish whether there is any influence or link between the stock exchange of the selected nations and the green bonds issued in their respective native markets. The different issuers will enable a comparison to be done. The theoretical model that will aid in understanding whether there is a factor that influences the performance of the green bond security would be the Arbitrage Pricing Theory (APT) which defines the expected returns on assets with the use of a linear factor model. The model uses multiple macroeconomic variables to price assets. These factors capture systematic risk as stipulated by Ross (1976).

Using the Arbitrage pricing theory, the expected return of a given asset can be denoted as follows,

$$E[R]_{asset} = R_f + \lambda_1\beta_{i1} + \lambda_2\beta_{i2} + \lambda_3\beta_{i3}$$

R_f is the risk-free return.

$\lambda_1, \lambda_2, \lambda_3$ act as the risk premiums related to the risk factors 1, 2, and 3, respectively.

$\beta_{i1}, \beta_{i2}, \beta_{i3}$ acts as the pricing relationship between the risk premium and the asset.

This model can be used in this study acts as it shows how macroeconomic factors influence the return and performance of an asset which is in line with the objective of the study. The study's model aims to look at factors that influence the performance of the green bond security. This involves performing regressions to finding out whether green bonds are influenced by short-term interest rates, exchange rates, the economic level of a country, and Inflation.

3.3 Empirical Model

The econometric model selected will be dynamic as it will consider the time factor and the variables used in this study are all economic processes and functions of time. It will also be of reduced form since the study aims at evaluating the relationship between green bond performance and the macroeconomic variables. The data is longitudinal as green bonds issued every month will be used. Since the data in use is of panel data from the econometric model to be used will either be a fixed-effects panel regression or a random-effects model. The specific model to be used will be determined by the Hausman test.

The random-effects model involves examining whether differences exist in error variance components across individuals or periods. The method of estimation can be either the Generalized Least Squares (GLS), the Feasible Generalized Least Squares (FGLS), or the estimated generalized least squares (EGLS) and this is determined by whether the covariance structure of composite errors is known or unknown. In this model, intercepts are constant and individual effects are assumed to be uncorrelated with regressors.

The model is specified as follows,

Equation 1: Random Effects first regression

$$y_{it} = \alpha + \beta_2 X_{it} + \beta_3 X_{it} + \beta_4 X_{it} + (\mu_i + v_{it})$$

where $\mu_i \sim IID(0, \sigma_\mu^2)$, and $v_i \sim IID(0, \sigma_v^2)$

The specification is defined as, y_{it} being the dependent variable which is the number of active green bonds of each of the selected countries and X_{it} representing the independent variables which are the selected macroeconomic factors. The coefficients which are $\beta_1, \beta_2, \beta_3, and\ \beta_4$ represent the coefficients of the Treasury Bill Rates, Real Exchange Rates, the selected nation's Industrial Production Index and Consumer Price Index, respectively.

The fixed effect model will examine whether the intercepts vary across time. The method of estimation can either be the Least Squares Dummy Variable model (LSDV) or the "within" estimation. The Least Squares Dummy Variable model uses dummy variables whereas the within" estimation does not. In this model, intercepts vary across the groups selected and the error variances and slopes are constant.

Equation 2: Fixed Effects first regression

$$y_{it} = (\alpha + \mu_i) + \beta_1 X_{it} + \beta_2 X_{it} + \beta_3 X_{it} + \beta_4 X_{it} + v_{it}$$

The specification is defined as y_{it} being the dependent variable which is the number of active green bonds of each of the selected countries. X_{it} represents the independent variables which are the selected macroeconomic factors. The coefficients which are $\beta_1, \beta_2, \beta_3, and\ \beta_4$ represent the coefficients of the Treasury Bill Rates, Real Exchange Rates, the selected nation's Industrial Production Index and Consumer Price Index, respectively.

The different coefficient estimates for each bond will enable the comparison of each green bond issued to be done. This model estimation will be done three times for each of the selected countries in the study as the green bond security was first introduced in these countries at different times.

A similar model with one dependent variable shall be computed to evaluate whether stock market conditions influence the green investment bond. If the random effect model will be used it will appear as follows,

Equation 3: Random Effects second regression

$$y_{it} = \alpha + \beta_1 X_{it} + (\mu_i + v_{it}),$$

$$\text{where } \mu_i \sim IID(0, \sigma_\mu^2), \text{ and } v_i \sim IID(0, \sigma_v^2)$$

y_{it} acts as the dependent variable which is the number of active green bonds in each of the selected countries and X_{it} represents the independent variable which is the stock market index of the selected countries. The coefficient for the stock market index is β_1. If the fixed effect model will be used it will appear as follows,

Equation 4: Fixed effects second regression

$$y_{it} = (\alpha + \mu_i) + X_{it}\beta_1 + v_{it}\ ,$$

y_{it} acts as the dependent variable which is the number of active green bonds of each of the selected countries and X_{it} represents the independent variable which is the stock market index of the selected countries. The coefficient for the stock market index is β_1. Each country shall have its specific estimation as the green bond security was first introduced in these countries at different times.

3.4 Definition of Variables

Previous studies have used bond yields and bond prices however it is worth noting that this study is unique as it has incorporated the use of the number of active green bonds. The variables for each of the selected countries is Brazil, Mexico, and South Africa are described in Table 1.

Table 1: Variables for the first-panel regression

Variable	Definition	Scale of Measurement	Expected Relationship with Dependent variable	Authors
Active green bonds	The study uses the number of active green bonds at a given month to see how changes in Treasury bill rates, Real Broad Effective Exchange Rates, Industrial production index, and Consumer price index influence the number of green bonds issued in USD.	It is a numeric value. It is a discrete variable. This is given by the number of green bonds issued in USD.	The variable acts as the dependent variable.	Flaherty (2016) looked at the validity of such relationships using bond prices.
Treasury bill rates	The study uses monthly treasury bill rates to see how changes in short-term interest rates influence green bond performance.	It is measured in percentages. It is a discrete variable.	A negative relationship is expected.	Flaherty (2016) looked at this relationship.
Real Broad Effective Exchange Rate	The study uses monthly Real effective exchange rates to see how changes in exchange rates influence green bond performance.	It is an index measured relative to the base year 2010 which is 100. It is a discrete variable.	A positive relationship is expected if the value of the currency is increasing.	Flaherty (2016) looked at this relationship.
Industrial Production Index	The study uses the monthly Industrial Production Index to see how changes in macroeconomic output influence green bond performance.	It is an index measured relative to the base year 2015 which is 100. It is a discrete variable.	A positive relationship is expected.	Flaherty (2016) looked at this relationship.
Consumer Price Index	The study uses the monthly Consumer price index to show whether a change inflation influences green bond performance.	It is a statistical estimate made using the collected prices of a sample of items whose prices are collected periodically. It is a discrete variable.	A negative relationship is expected.	Arellano (2013) looked at the relationship between long term bonds and this Index

The currencies for Brazil are the Brazilian Real, for Mexico is known as the Mexican Peso and South Africa's is the South African Rand. Another objective is to compare green bond performance with the stock market conditions the variables for each of the selected countries are described in the table below.

Table 2: Variables for the second-panel regression

Variable	**Definition**	**Scale of Measurement**	**Expected Relationship with Dependent variable**	**Authors**
Active green bonds	The study uses the number of active green bonds at a given month to see how changes in the stock market indices influence the performance of green bonds.	It is a numeric value. It is a discrete variable. This is given by the number of green bonds issued in USD.	The variable acts as the dependent variable.	Baulkaran (2019) looked at the validity of such a relationship using coupon rates.
Stock Indices	The study uses monthly returns of stock indices to show changes in stock market indices influence green bond performance.	It is measured in percentages. It is a discrete variable.	A negative relationship is expected.	Baulkaran (2019) looked at such a relationship.

Monthly returns of stock indices act as representatives of the overall stock market conditions in the selected countries. The stock indices include Brasil 50 for Brazil, Mexican Stock Exchange Index (IPC MEXBOL) for Mexico, and the Johannesburg Stock Exchange Company index for South Africa. Issuers are those that have taken part in the green bond market for each of the selected countries. They include corporates, agencies, and governmental bodies.

3.5 Data types and Sources

The data used is unbalanced panel data since green bonds were introduced in the selected countries at different times hence the periods used will not be consistent. For instance, Brazil

contains 45 periods, Mexico 44 periods, and South Africa 72 periods. The data involves the number of active bonds issued from 9th June 2014 to 30th June 2020. That is obtained from the Thompson Reuters data portal. The data portal also contains data on the specific issuers of green bonds. The exchange rates, the Industrial Product Index, and Consumer Price Index will be sourced from the Federal Reserve Bank of St. Louis. Stock indices and the treasury bill rates will be sourced from the investing.com website.

3.6 Data analysis

Since a panel regression model will be used, various tests need to be conducted to ensure the analysis done is accurate, stable, and capable of reaching the objectives of the study.

The existence of nonstationary in the regression results may lead to a great level of unpredictability. It is important to perform a unit root test before estimating the regressions. Im-Presario-Shin (IPS) and Fisher unit-root tests can be used as the study involve panel data. The null hypothesis will be that the panels contain a unit root, and the alternative will be that the panels are stationary which is the desired outcome If there exists a unit root, differencing will make the panel data stationary.

Cointegration tests will be performed when the data is nonstationary. To determine whether there exists a long-run relationship the test that will be conducted is the Kao cointegration test: The null hypothesis is that there is no cointegration. The existence of cointegration means that an error correction model should be used.

Autocorrelation or serial correlation is the degree of correlation that exists in the variables' values across the observations in the data set. The Wooldridge test for autocorrelation is used to investigate for autocorrelation. In this test, the null hypothesis is that the data have no autocorrelation structure whereas the alternative is that the data possesses autocorrelation. Either the Panel Corrected Standard Error (PCSE) or the Feasible Generalized Least Squares (FGLS) can be used to correct for autocorrelation.

Heteroscedasticity makes the estimates of coefficients less precise it also increases the variance of coefficient estimates. This can lead to a model that is statistically significant when it is not significant. Breusch-Pagan test can be used to test for heteroskedasticity. In this test, the null

4 RESULTS AND ANALYSIS

4.1 Descriptive Statistics

The summary of the variables used in the analysis of Green bond performance in South Africa, Brazil, and Mexico is as follows.

Table 3: Descriptive Statistics of variables in use

	Number of active bonds	*Treasury bill rates*	*Real Broad Effective Exchange Rate*	*Industrial Production Index*	*Consumer Price Index*	*Stock Indices*
Mean	4.3698	7.3238	79.8088	97.5634	110.3569	0.0014
Standard Deviation	5.0170	3.0041	7.9469	6.5796	9.0638	0.0704
Kurtosis	2.9279	0.5178	1.0159	16.1623	-1.1339	6.1782
Skewness	1.6079	0.8547	0.1660	-3.1319	-0.1834	-0.3626
Minimum	0	2.2309	55.64	50.3958	91.8378	-0.3977
Maximum	23	15.3218	101.99	111.79068	125.6790	0.3092
Count	219	219	219	219	219	219

From Table 3 above, the number of active bonds has a mean of 4.3 this means that the average number of active bonds at any given month is about 4. The standard deviation is 5.0170 and as a measure of dispersion, this implies that the values in the sample deviate from the mean by 5.0170. The number of active bonds has a kurtosis value of 2.9 which implies that the distribution plot of this variable has heavy tails and possess some outliers. The number of active bonds has a skewness value of 1.6 which implies that the data set is highly skewed to the right. Thus, the right tail distribution is longer. The minimum value that is 0 showcases that there are months that had no active green bonds. This inactivity is the reason why the final data set used is unbalanced. The maximum value of 23 shows the highest number of active bonds in each month. The frequency of the data in use is 219.

The treasury bill rates have an average rate of 7.3% in all the selected countries. The minimum and maximum values are at 2.23% and 15.3% respectively. Treasury bill rates have a skewness value of 0.5 which implies that this variable is positively and moderately skewed. Treasury bill rates have a kurtosis value of 0.8 which implies that the distribution of this variable has heavy

tails. The treasury bill rates from the sample used in this study deviate from the mean by 3. The variable has 219 entries.

Real Broad Effective Exchange Rate has a mean of 79.808 this implies that for every United Dollar 79.808 of the local currency is required. The standard deviation of 7.9 implies that the values in the sample deviate from the mean by 7.9. The Effective Exchange Rate has a kurtosis value of 1.02 which implies that the distribution of this variable has heavy tails. The Effective Exchange Rate has a skewness value of 0.166 which implies that the variable has an approximately symmetric distribution. The minimum value is 55.64 while the maximum value is 101.99. The variable has a frequency of 219.

The Industrial Production Index has an average of 97.56 in all the selected countries. The minimum and maximum values are at 50.3958 and 111.79, respectively. This shows that there has been a significant change in the production levels of the selected countries. The Industrial Production Index has a skewness value of -3.13 which implies that this variable is highly negatively skewed. The Industrial Production Index has a kurtosis level of 1.02 this implies that the distribution of the variable has heavy tails or more outliers. The index deviates from the mean by 6.58. The data has 219 entries.

The Consumer Price Index has a mean of 110.3569. The standard deviation is 9.0638. The Consumer Price Index has the lowest kurtosis of -1.1339 this implies that it has light tails or lacks outliers. This can be explained by the fact that the countries used in this study pose a similar level of the average change over time in prices of a fixed basket of goods and services and that it has not changed drastically in the sample period hence there are no outliers. The skewness level of the Consumer Price Index is at -0.1834 which implies that the distribution of this variable is moderately skewed. The minimum value is 91.8378 whereas the maximum value is 125.679. The frequency of the variable is 219.

Stock Indices have an average return of 14% which implies that the returns obtained from investing in the stock market of the selected countries are not significantly high. The minimum value is at -39.77% implying that there are instances that investors experience losses or negative returns. The maximum value is 30.92%. The Stock Indices have a skewness of -0.36 which

implies that this variable is approximately symmetric. Stock Indices' returns have a measure of kurtosis that is 6.178, this implies that the distribution of this variable has heavy tails. The stock indices' returns used in this study deviate from the mean by 0.0704. The variable also has 219 entries.

4.2 Pre-estimation tests

Before conducting a unit root test, a cross-sectional dependence test needs to be done to identify which unit root test suits the data in use. Pesaran's (2004) Cross-sectional Dependence allows the following hypothesis to be tested:

H_0: cross-sectional independence

Conducting this taste gave the following result.

Pesaran's test of cross-sectional independence = -0.047, P_r = 0.9625
The average absolute value of the off-diagonal elements = 0.191

Since the probability is greater than 0.05 hence there is no cross-sectional independence. Since the statistic is less than 0.05 hence there is no cross-sectional independence. This means that a first generational unit root test needs to be done. The test was conducted in the Fisher unit-root tests since the data set is unbalanced as the selected countries began issuing green bonds at different years.

Table 4: Results of Fisher's Stationarity test

VARIABLE	TEST STATISTIC		P-VALUE	LEVEL OF INTEGRATION	P-VALUE
Number of active bonds	P	2.5056	0.8678	1	0.0000
	Z	1.1666	0.8783	1	0.0000
	L*	1.1396	0.8657	1	0.0000
	Pm	-1.0087	0.8434	1	0.0000
Treasury bill rates	P	16.855	0.0098	0	0.0098
	Z	-2.6665	0.0038	0	0.0038
	L*	-2.6908	0.0072	0	0.0072
	Pm	3.1335	0.0009	0	0.0009
Real Broad Effective Exchange Rate	P	17.435	0.0078	0	0.0078
	Z	-2.5823	0.0049	0	0.0049
	L*	-2.7375	0.0065	0	0.0065
	Pm	3.301	0.0005	0	0.0005
Industrial Production Index	P	37.754	0.0000	0	0.0000
	Z	-4.8123	0.0000	0	0.0000
	L*	-6.1612	0.0000	0	0.0000
	Pm	9.1665	0.0000	0	0.0000
Consumer Price Index	P	25.189	0.0003	0	0.0003
	Z	-3.7178	0.0001	0	0.0001
	L*	-4.1029	0.0003	0	0.0003
	Pm	5.5395	0.0000	0	0.0000
Stock Indices	P	67.577	0.0000	0	0.0000
	Z	-7.0608	0.0000	0	0.0000
	L*	-11.067	0.0000	0	0.0000
	Pm	17.776	0.0000	0	0.0000

Key
Inverse chi-squared (6) – (P)
Inverse normal – (Z)
Inverse logit t (19) – (L*)
Modified inv. chi-squared – (Pm)

As reported in table 4 above, all variables in use in the analysis were found to be stationary at the 5% level of significance as they all had a P-value of less than 0.05 except the number of active bonds. Differencing was done to transform the number of active bonds transform to stationary variables. The results from the stationarity test on this variable are as follows.

Autocorrelation is the degree of correlation that exists in the variables' values across the observations in the data set. The Wooldridge test for autocorrelation is used to investigate for

autocorrelation. In this test, the null hypothesis is that the model has no first-order autocorrelation whereas the alternative is that the model possesses the first-order autocorrelation.

The results obtained for the first model that involves establishing the macroeconomic determinants of green bond performance using the number of active green bonds are as follows.

H0: no first-order autocorrelation

F (1, 2) = 0.072

Prob > F = 0.8137

Therefore, it is safe to conclude that at a 5% level of significance, we fail to reject the null hypothesis. This means that there is no panel autocorrelation in the residuals.

The second model involves the identification of the implications of stock market conditions on the performance of green investment bonds in the selected countries. The p values obtained are as follows.

H0: no first-order autocorrelation

F (1, 2) = 1.742

Prob > F = 0.3177

Hence the null hypothesis is rejected. This means that there exists a problem of first-order serial correlation in the panel data.

Heteroscedasticity makes the estimates of coefficients less precise it also increases the variance of coefficient estimates. This can lead to a model that is statistically significant when it is not significant. According to the Breusch and Pagan multiplier test, a P-value of less than 0.05 shows that there is a heteroskedasticity problem. It is observed that there is no heteroskedasticity in the model that contains the number of active green bonds and macroeconomic variables. The statistics obtained for the first model are as shown below.

chibar2(01) = 0.00

Prob > chibar2 = 1.0000

There is heteroskedasticity in the model that involves identifying the influence the stock indices have on the performance of green bonds in the selected countries. The statistics obtained for the second model are as shown below.

chibar2(01) = 6.21

Prob > chibar2 = 0.0063

The Shapiro Wilk test of normality was conducted on all the variables used in the analysis. It was found that none of the variables in use were normally distributed. The results are shown in Table 5 below.

Table 5: Shapiro Wilk Test of Normality

Shapiro-Wilk W test for normal data					
Variable	Obs	W	V	z	Prob>z
dactivebonds	158	0.83231	20.402	6.855	0.00000
activebonds	161	0.86703	16.441	6.371	0.00000
Tbills	161	0.89859	12.539	5.754	0.00000
erates	161	0.95262	5.859	4.023	0.00003
IPI	161	0.65636	42.49	8.531	0.00000
CPI	161	0.94574	6.709	4.331	0.00001
indices	161	0.89884	12.508	5.749	0.00000

The Hausman specification test is conducted to determine the most suitable method of estimation for the first model that involves establishing the macroeconomic determinants of green bond performance. It was found that the Prob>chi2 is 0.0148 it is less than 0.05. The null hypothesis of no correlation is therefore rejected; hence the individual effects are said to be significantly correlated with at least one regressors in the model and thus the fixed effect model is to be used in the analysis of green bond performance being influenced by macroeconomic factors.

The Hausman specification test was also done to determine the most suitable method of estimation for the second model that involves the identification of the implications of stock market conditions on the performance of green investment bonds in the selected countries. The variables that will be used are the number of green bonds and stock market indices. The null hypothesis of no correlation is not rejected when looking at the influence stock market indices

have on green bond performance. This is because the Prob>chi2 is 0.7270 since it is greater than 0.05 a random effect model is favoured. The analysis was conducted on Stata 13.

4.3 Regression Analysis Results

4.3.1 Establishing the Macroeconomic Determinants of Green Bond Performance

The main research hypothesis is to establish the main and most significant determinant of the green bond performance in the issued market of the selected countries.

The first regression Table 6 reports the results of the fixed effects regression which was tested and found to be the best model. It reports on the factors that influence the performance of green bonds in South Africa, Brazil, and Mexico.

Table 6: Fixed Effects regression of macroeconomic factors' influence on green bond issuance

VARIABLES	(1) Fixed Effects
Tbills	-0.0369
	(0.0449)
Erates	-0.00156
	(0.0118)
IPI	0.0131
	(0.00873)
CPI	0.0153**
	(0.00745)
Constant	-2.374*
	(1.308)
Observations	158
Number of country index	3
R-squared	0.037

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The number of observations used in the analysis is 158 in the 3 panels used. From the regression done the probability of the Wald Chi-squared test is given as 0.2147 indicates that the explanatory variables that are short-term interest rates (Tbills), exchange rates (erates), Industrial Production Index (IPI), and the Consumer Price Index (CPI) are not sufficient in explaining the

variation of the issuance of green bonds. The R^2 which is the coefficient of variation is at 0.0374 for the Fixed-effects (within) estimation meaning that only 3.74% of the variation in the number of active bonds in the emerging economies can be explained by short term interest rates, exchange rates, Industrial Production Index, and the Consumer Price Index. This indicates that the model estimated is not the best at looking at factors that affect the green bond issuance as the variables that have been used make the model jointly insignificant. The coefficients of short-term interest rates and exchange rates indicate that they have a negative relationship with the dependent variable that is the number of active bonds issued. The Industrial Production Index and the Consumer Price Index have a positive relationship with the dependent variable that is the number of active bonds issued. It is worth noting that the P-values of the short-term interest rates, real broad exchange rates, and the Industrial Production Index are all insignificant at a level of 10%. The constant term and the Consumer Price Index are the only significant variables.

The estimated equation is as follows.

Equation 5: Results for first regression

$$Green\ Bonds_{it} = -2.3741 - 0.0369Tbills_{it} - 0.00156erates_{it} + 0.0131IPI_{it} + 0.0153CPI_{it}$$

The coefficients of short-term interest rates indicate that a unit increase in short-term interest rates decreases green bonds by 0.0369. This implies that the issuance of green bonds is negatively influenced by a positive change in short-term interest rates. This inverse relationship corresponds to the results obtained by Flaherty (2016). Their study involved variables that represent risks such as the short term Treasury Bill rate, inflation rates using the Consumer Price index, the Chicago Board Exchange Market Volatility Index, the long US dollar futures index, and the Industrial production index. This relationship is however insignificant. This can be explained by the fact that an increase in the market risky and volatility pushes investors to purchase green bonds which are long-term securities while also selling short-term securities such as treasury bills. This relationship is however insignificant.

A unit increase in exchange rates decreases green bonds by -0.00156. This implies that the issuance of green bonds is negatively influenced by a positive change in exchange rates. This relationship is however insignificant. The inverse relationship is not in line with the results gathered by Flaherty (2016). This could be explained by the fact that the study used green bonds

that were issued in their native currencies hence exchange rate risk plays a huge role. Flaherty (2016) used bonds that were denominated in the United States Dollar from the onset of their issuance hence the relationship that was depicted was positive.

A unit increase in the Industrial Production Index leads to a 0.0131 increase in the number of green bonds issued. This implies that the issuance of green bonds is positively influenced by an increase in the Industrial Production Index which signifies the development of the countries' industries. Hence the growth of production in industries leads to an increase in the issuance of green bonds. This increase is however insignificant. Flaherty (2016) use this variable as a measure of macroeconomic stability and was able to establish that there exists a positive relationship between the Industrial Production Index and the performance of green bonds. Their findings is consistent with the findings of this study.

A unit increase in the Consumer Price Index leads to a 0.0153 increase in the number of active bonds issued. This implies that an increase in the price changes for a predetermined basket of goods and services in the selected countries increases the issuance of green bonds. This relationship is significant at a level of 5%. According to Arellano (2013), there is a negative relationship between long-term bonds and inflation rates. This does not correspond to the results of this study.

4.3.2 Identification of The Implications of Stock Market Conditions on Green Bond Issuance

The second regression analysis seeks to analyze the effect of stock market indices on green bond issuance. The stock market indices are the only independent variable in the model. Table 7 reports the results of the Random Effects regression that reports the influence of conditions of the respective stock markets on the issuance of green bonds in South Africa, Brazil, and Mexico.

Table 7: Random Effects regression of stock market's condition's influence on green bond issuance

	(1)
VARIABLES	Random Effects
indices	0.200
	(0.804)
IPI	0.00276
	(0.00778)
Tbills	-0.0269
	(0.0384)
Constant	0.172
	(0.706)
Observations	158
Number of country index	3

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the second regression, the probability of the Wald Chi-squared test is 0.9126 and this indicates that the explanatory variable that is the stock market index is not sufficient in explaining the variation of the issuance of green bonds as it is greater than the 10% level of significance. The R^2 which is the coefficient of variation is at 0.6473 meaning that 64.73 % of the variation in the number of active bonds in the emerging economies can be explained by the stock market indices. The model has two control variables that are Treasury Bill rates and the Industrial Production Index. The inclusion of these variables helps to account for the fact that the effect stock indices have on green bond performance can also be attributed to other markets such as the short securities' markets and the overall economic condition of the selected countries. It is seen from the coefficients of stock market indices that the stock market indices which represent the stock market conditions influence the issuance of green bonds positively. This implies that the green bonds performance is not tied to the stock market conditions of the selected countries.

The estimated equation is as follows.

Equation 6: Results for the second regression

$$Green\ Bonds_{it} = 0.172 + 0.200indices_{it} + 0.00276IPI_{it} - 0.0269Tbills_{it}$$

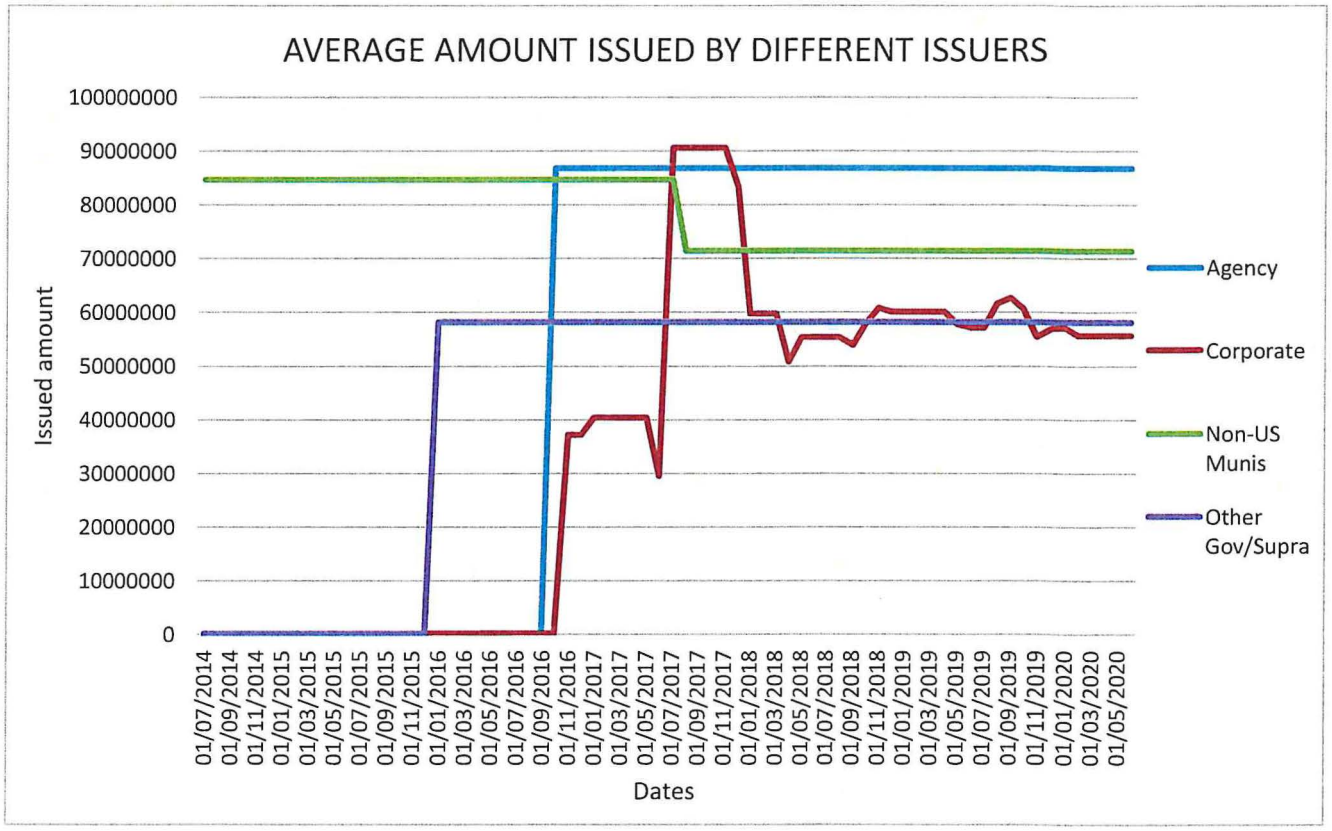
The coefficients of stock market indices indicate that a unit increase in stock market indices increases the number of green bonds by 0.2 units. A high performing stock market leads to an increase in the issuance of green bonds however the effect is not significant.

The results of this study are inconsistent with those obtained by Baulkaran (2019) their study involved 72 green bonds that were issued by corporates and the stock market conditions of their industries. Their results could be explained by the fact that bond markets tend to have an inverse relationship with stock markets as stocks tend to prevail more when an economy is booming.

4.4 Comparison of green bond issuers

The graph 1 showcases the average amount of active green bonds issued by different issuers in the selected countries perform when compared to each other. The active bonds in Brazil, Mexico, and South Africa were issued by 1 agency, 24 corporates, 2 issued by the country's municipals, and 1 issued by a supranational union. The issued amount is in the United States Dollar and it ranges from 1.960,247 USD to 260,320,628 USD.

Graph 1:Average amount issued by different issuers in the selected countries.



From Figure 1 above, the green bonds issued by the agency are of a higher amount than those issued by corporates, municipals, and the supranational union. The average amount of green bonds issued by the agency increases in September 2016 to 86,773,542 USD. The average amount of green bonds issued by the corporates used in the study increased from September 2016 to July 2017 it then began to decrease from July 2017 it then proceeds to fluctuate to reach the value of 55,786,968 USD. The average amount of green bonds issued by Municipals (Non - Us Munis) decreases from 84,619,849 USD to 71.329,077 USD in July 2017. The average amount of green bonds issued by the Supranational union remained at the same level from the issuance in February 2016.

The fluctuating amount issued by corporates can be explained by the fact that 90% of green bonds issued in the selected emerging economies are issued by corporates. Agencies are seen to be issuing green bonds at a higher amount than all the green bond issuers used in this study. This implies that agencies seek a greater amount of funds to finance sustainable investments than the other issuers.

According to the study conducted by Flaherty (2016), the issued amount of green bonds issued by agencies such as Kommunalbanken, Export-Import Bank of Korea, Export Development Canada, and Overseas Private Investment Corporation ranges from 47,300,000 USD to 500,000,000 USD, the amount issued by corporates or the private sector firms like Bank of America, Regency Centers, Vornado Realty, and Anstock Limited ranges from 250,000,000 USD to 500,000,000 USD and that issued by supranational firms such as The International Bank for Reconstruction and Development (IBRD), the African Development Bank, International Finance Corporation and the African Development Bank ranges from 5,000,000 USD to 1,000,000.00 USD. This shows that Supranational unions issue green bonds at higher amounts than corporates who issue higher amounts than agencies. Their study observed that supranational unions seek higher funds to finance sustainable investments than agencies and corporates. This is inconsistent with evidence from this study as the graphical representation showcases that agencies on average issue green bonds at higher amounts.

Graph 2 depicts the average coupon rate of active green bonds issued by different issuers in the selected countries perform when compared to each other. The coupon rate is the rate of interest the bond pays annually. The coupon rate ranges from 10.18% to 3.8% for the selected countries.

Graph 2: Average coupon rate charged by different issuers in the selected countries.

The coupon rate specified by municipals is significantly higher than those of the agency, corporates, and the supranational union. Hence the rate of interest paid by bond issuers on the bond's face value to its purchasers is high for municipals.

The average coupon rate charged on green bonds issued by the agency increases in September 2016 to 6.05 %. The average coupon rate charged on green bonds issued by the corporates used in the study increased from September 2016 to July 2017 it then began to decrease from July 2017 it then proceeds to fluctuate to reach the value of 5.6548%. The average coupon rate charged on green bonds issued by Municipals (Non -Us Munis) stays constant at 10.18% in July

2017. The average coupon rate charged on green bonds issued by the Supranational union remained at the same level from the issuance in February 2016.

The fluctuating coupon rates of green bond issued by corporates is because they are the majority issuers of green bonds in the selected countries. Municipal bonds are seen to pay higher coupons than all the issuers in this study. This implies that bondholders who have obtained green bonds from municipals have been receiving higher interest payments throughout the life of the bond.

According to Flaherty (2016), the coupon rates of green bonds issued by government agencies ranges from 0.75 % to 3.28%, the coupon rates issued by corporates in the private sector ranges from 1.35% to 3.75%, and that coupon rates issued by supranational firms ranges from 0.75% to 1.83%. This shows that Supranational unions issue green bonds at lower coupon rates than agencies that issue at lower amounts than corporates. Corporates are seen to pay higher coupons to the bondholders throughout the life of the green bond. This is inconsistent with evidence from this study as the graphical representation showcases that agencies on average issue green bonds at coupon rates. Municipals were not included in Flaherty's studies. It should be noted that the Supranational unions used in this study have higher coupon rates than those observed by Flaherty.

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The need for sustainability in emerging economies is paving the way for new business opportunities that involve Clean Transport, Energy Efficiency, and Alternative Energy. It is thus very crucial to consider the economic, regulatory, and reputational risk that could be faced when issuing green bonds in these economies. Economic risk is covered in this study using macroeconomic factors and stock market conditions to evaluate how they influence the issuance and performance of green bonds. Understanding the potential economic risk could enable institutional investors such as supranational organizations, governments, and pension funds to consider these securities when making portfolio investment decisions.

The analysis done in this study has established that the Consumer Price Index is the only significant macroeconomic variable that influences the green bond performance in the issued market of the selected countries. This implies that the price changes for a predetermined basket of goods and services in the selected countries act as the most significant factor that affects the issuance of green bonds. The relationship is positive, and this does not correspond to the results of the study conducted by Arellano, (2013) who observed that the performance of green bonds is influenced negatively by the Consumer Price Index.

The stock market conditions have no significant implications on the performance of green investment bonds in the selected countries. The results in the estimation that involves short term interest rates are inconsistent with the results obtained by Baulkaran (2019). This is because Baulkaran (2019) found that the effect that the stock market conditions have on green bond issuance is significant and negative.

The graphical comparison of the green bond issuers demonstrates that Green bonds issued by corporates are the most popular in developing countries. However higher amounts are issued by agencies. Municipal bonds are seen to pay higher coupons whereas agencies pay the least coupons. Agencies and supranational unions have issued the least green bonds.

5.2 Recommendation

Green bond issuers such as corporates, government agencies, supranational unions, and municipals in emerging economies such as those selected in this study should note that the macroeconomic variable that influences green bonds greatly is the Consumer Price Index. Issuers can use inflation rates as a monitoring mechanism of the performance of green bonds in the economies of the selected countries. High and manageable inflation rates mean that more green bonds can be issued. The issuers of green bonds can price the green bond security in a manner that ensures that its demand and supply are appropriate and desirable as it has been observed that the security is not significantly affected by stock market conditions. This because they are the. Corporates are leaders of green bond issuers in these economies and hence potential issuers may benefit from observing how they were able to successfully issue the green bond security.

Investors in emerging economies greatly benefit from understanding that the Consumer Price Index is the main macroeconomic variable that influences green bonds. They can use inflation rates as a means of knowing when and how to participate in this sustainable investment. High and manageable inflation rates mean that more green bonds are being issued hence those that are interested in investing in this security can use inflation rates as a means of establishing when to venture into this market. The stock market does not significantly affect green bond issuance the stock market's condition may not be a concern to investors. Municipal bonds are seen to pay higher coupons. Hence investors who are interested in high coupon payments could opt for green municipal bonds.

Regulators benefit from understanding that the Consumer Price Index is the macroeconomic variable that has a significant influence on green bond issuance. This means that monitoring inflation rates to ensure that more green bonds are issued in these economies will help in achieving the thirteenth sustainable development goal of climate action. This can be done through lowering costs of borrowing, lowering income tax, and increasing government spending as this can increase inflation rates and raise green bond issuance.

Agencies issued green bonds at higher amounts than the other issuers in the countries selected in this study. This means that entrepreneurs and firms that are leading projects that are sustainable

but require higher funding can obtain this funding from agencies. This observation is beneficial to firms that are seeking financing for eco-friendly and environmentally conscious projects.

Since green bonds are relatively new securities in the financial markets especially in emerging economies researchers have a lot to gather to establish a more concrete relationship between green bonds and macroeconomic variables and green bonds and stock market indices. It is worth noting that this study is limited in numerous ways such as by the fact that green bonds have not been issued for a great period. Hence this can explain why most of the results are tending to be insignificant. Other variables that could be used to signify the issuance of green bonds could potentially lead to better results however due to the short existence of green bonds this has not been possible. With time more information on green investment bonds will be available to the public for analysis of the kind of economic risk that could potentially affect green bond security.

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