Stockholm School of Economics

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Commodities and stock markets in Sub-Saharan Africa

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Abstract

This thesis studies stock returns and commodity returns in a set of commodity-dependent Sub-Saharan African countries, differentiating between returns of main-export commodities and a general commodity index and allowing for time-variation. This is done by using forecasting regressions of stock returns over lagged commodity returns and two macroeconomic variables. Results show that commodity returns do not forecast stock returns on any given day, but in some cases when commodity returns are strictly positive or negative. GDP changes and exchange rate are used for control, and their forecasting power over stock returns varies depending on commodity returns. Evidence thus supports a relationship between commodity prices and stock markets in these countries, with implications for both investors and policy-makers.

Keywords: *Commodities; Forecasting; Development; Africa; Stock Markets*

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Contents

1 Introduction

Commodity dependency has long been an issue for many, if not most, of the countries in Sub-Saharan Africa, and as such has been well-studied, particularly on its relationship with the domestic economy. While some countries, such as Norway - with 77% commodity dependency, mostly oil & natural gas (UNCTAD, 2018), yet listed as the 7th richest country in the world in 2020[1] and ranked first in the Human Development Index (HDI, 2019) - manage to turn their natural resource abundance into benefits, many do not.

There are several examples of countries where poor handling of natural resources has lead to economic downfall, the so-called "resource curse". But not all negative impact of commodity dependency on African economies can be attributed to wilful negligence, according to Deaton (1999), who argues that the lack of knowledge about commodity price movements, and poor forecasting abilities of their prices, lead to difficulties in enacting good policy. Although this does not lend all African leaders a guilt-free verdict regarding their policy-making, it is an argument in favour of a cleaner relationship between commodity price movements and economic growth.

Economic growth, however, is not contingent only on commodity dependency and their price variations, even in heavily commodity-dependent countries. In an IMF working paper, Yartey & Adjasi (2007) review stock markets in Africa and their importance to economic growth. While results are not completely conclusive on the relationship between the two, they find that stock markets have been beneficial to financing large companies' growth and that there has been some positive impact of traded stock market value on economic growth. They stress the need for policy-making on developing the stock markets, and increased integration, among other things.

Connecting the two, commodities for economic development and evolved stock markets for the same, we must also understand the changing nature of commodities as traded securities over the past decade or so. A phenomenon referred to as the financialisation of commodities refers to the increase in investments in commodities as a financial asset, as opposed to a good, and has lead to higher correlation between commodities and stock markets ((Zaremba, 2015), (Basak & Pavlova (2016), and many others).

On the other side of the spectrum, we have the development of stock markets in Sub-Saharan Africa. A 1995 paper by Bekaert discusses that while there are diversification benefits to market segregation, it also often goes hand in hand with high investment barriers. And thus in concordance with Yartey & Adjasi (2007) it should certainly be deemed beneficial to have a higher degree of global market integration

[1] https://www.gfmag.com/global-data/economic-data/richest-countries-in-the-world, accessed 2020-12-03

for developing stock markets, and ergo contributing to economic growth. The only country in common with this thesis in Bekaert (1995) is Nigeria, and his results find no significant indication of integration. However, Boamah et al (2016), for instance, find that global market premiums are significant predictors of excess returns in all countries in this study - of differing magnitude, but all sizable. That data set covers 1997 to 2013, so while we don't have Bekaert's 1995 results for all countries in this study, a fair assessment is that global market integration has increased in the 21th century for African stock markets.

With that in mind, not only do there appear to be arguments in favour of looking at commodities and stock markets as a complement to economic parameters (i.e. does the effect on the economy of commodity price movements translate to the stock market). But due to the increased global market integration of Sub-Saharan African stock markets we should also be able to expect that some of the financialisation of commodities - and the subsequent increased connection between commodities and equities - might be present for these markets.

This thesis, then, seeks to improve the understanding of the relationship between commodity returns and stock markets in a set of commodity-dependent, developing countries. By employing different approaches to choices of variables, and allowing for time-variation in coefficients, it hopes to encourage a broader perspective of this relationship. The intent is to serve both the global investor who can utilise the results of this thesis in creating better forecasts, and the policy-makers who - as is argued by Deaton (1999) and Yartey & Adjasi (2007) - should strive to enact policy which helps countries both benefit from their commodities, and develop the stock market, respectively.

In order to do this, three commodity-dependent countries; Botswana, Nigeria, and Zambia were selected, as well as South Africa as a non-commodity dependent country with a more mature stock market for comparison. The following research questions are formulated;

1. Are country-specific commodity returns a significant forecasting predictor for stock returns of a given set of extremely commodity dependent countries in Sub-Saharan Africa?
2. Does controlling for macro-level changes in the domestic economy change the results to question (1)?
3. Does the impact of commodity returns as a forecasting variable change depending on whether the commodity in question experiences a positive or a negative return in a given day, ceteris paribus?
4. Is there a difference in the forecasting power of macro-level changes in the economy on stock returns depending on whether the main export commodity of a country experiences a positive or negative return in a given day?

5. Does answers to questions (1)-(4) change when using a general commodity index, as opposed to the main export commodity of a country?
6. Are there differences to questions (1)-(4) within the set of commodity dependent countries, or between this set and a not commodity dependent but geographically close country?

To answer these questions, nine forecasting regression models are run over three data sets - the full data set with all days during the sample period, one for days with positive commodity returns and one for days with negative commodity returns. Stock returns are forecasted over past stock returns, past commodity returns, lagged changes in exchange rate to the U.S. Dollar, and current-quarter changes in GDP. The commodity return variable consists either of the country's main export commodity (for the three commodity-dependent countries) or a general index (for all four countries). Due to the large number of regressions, results are vast, but can be summarised as follows. Commodity returns alone are not significant predictors of stock returns in either of these countries. However, coefficient significance and magnitude changes, in some cases drastically, when using the positive/negative commodity returns data sets. Results are discussed in more detail for differences between and within each country and the different variables. However, it can be concluded that this thesis does provide evidence for an existing relationship between stock markets and commodity returns in all four of these countries, to a varying extent. And that, for these countries, accounting for direction of price movements in commodity markets is important when forecasting stock returns.

The thesis will proceed as follows; first, a review on existing literature covering the general relevance of commodity exports to these economies, the relationship between commodities and stock returns in mature markets, the development of stock markets in Sub-Saharan Africa, and finally the relationship between commodities and stock markets in developing countries. After this, a section with brief background information on each country in the study is presented, including comments on the country's relationship with their main export commodity. Next, a presentation of the data used, divided into stock data, commodity data, and macro-level data. Following this, the theoretical framework behind the model is presented, followed by the nine regression models, with their variables explained. Then, the results from the regressions are shown; firstly the three countries with their main-export commodity used in the regression on the three main data set divisions, then the same for the four countries where a general commodity index is used. Finally, the last results section covers the differences between a foreign and domestic sub-index of the Botswanan stock market. The last chapter is the conclusion, which covers a summary of main results and their potential implications, some limitations of this study, and suggestions on further research on the topic.

2 Literature Review

2.1 Commodity Dependency in Sub-Saharan Africa

The issue of Sub-Saharan African countries and their dependency on a small number of primary commodities[2] is not a recent feature. In their 1995 paper, Deaton & Miller discusses the importance of understanding the economies of these countries in light of their commodity dependency, and the impact price fluctuations have on them. They examine potential reasons behind the negative impact of commodity price fluctuations on the economy of Sub-Saharan African countries, whether it is mainly due to the difficulty of predicting commodity prices, or failures in political and fiscal policy and action.

However the issue goes further back than this, in (Deaton, 1999) the author tells a story of a country where the leaders grow so excited of the incredible profits gained from their commodity exports that they start to invest, and borrow to do so, until prices suddenly fall and they find themselves unable to repay loans, and starting a cycle which would lead to violence. This story is not uncommon for the 20^{th} century. In this case, however, the story refers to Egypt and 150 years ago, during the time the Suez canal was built when cotton prices soared as a consequence of supply scarcity caused by the American Civil War (Deaton, 1999). In this paper, Deaton stresses the importance of understanding commodity price movements in order to be able to enact efficient policy. Taking partly a contrarian approach to part of the moral of the Egypt story - that leaders did not behave responsibly or sustainably when faced with price surges - Deaton provides some evidence that commodity prices and economic growth are overall positively linked.

Throughout this paper, commodity dependency is mainly referred to as commodity exports as share of total exports, with a threshold of 60% (UNCTAD, 2018). However, commodity dependency is a multifaceted issue, with individual households not only being indirectly affected (i.e. through the impact on their country's economy), but also directly affected by changes in prices of both those commodities they themselves buy, and those that are responsible for their income. Making commodity price fluctuations, all in all, an important factor for changes in national and household welfare of developing countries (Lederman & Porto, 2016). Rapsomanikis & Sarris (2008) find similar results for specifically Ghana and Peru. Within the same area, Addison et al (2016) considers nine Sub-Saharan African countries with a high dependency on agricultural commodities[3] and the impact of price changes on GDP per capita, but - in contrast to these two other studies - does not find much evidence that unexpected price movements

[2] I.e. commodities which have been through little, or no, processing. Implying a lack of value added by the exporting country and thus a lower ability to affect prices.

[3] The only UNCTAD commodity class not represented in this study (UNCTAD, 2018)

affect GDP per capita. Additionally, apart from direct effects on the economy, decreases in main export commodity prices have also been linked to the outbreak of civil war in Sub-Saharan Africa (Brückner & Ciccone, 2010).

Hegerty (2016) studies nine different emerging markets, of which only South Africa is common to this thesis, and the relationship between commodity price movements and several different macroeconomic indicators. Part of the motivation behind using a broad set of macroeconomic factors is trying to ascertain whether this "resource curse" that Deaton (1999) hints at is present, i.e. whether governments are able to conduct good policy in response to commodity price movements. Many of the more distinct results relate to countries with little connection to this thesis, but, for example, Hegerty (2016) finds that South Africa experiences a close connection between gold price movements and it's exchange rate and inflation.

2.2 Commodities & Stock Returns - Mature Markets

The financialisation of commodities is a topic which underlies the premise of this thesis. Generally speaking it refers to the increase of speculative investment in commodities, which has lead to the perception of them as financial assets ((Basak & Pavlova, 2016), (Zaremba, 2015)). Where once commodity assets were traded mainly by those with an interest in it as a good, the market has been filled with hedge funds, exchange traded funds, and specialised commodity investors (Zaremba, 2015). This has been associated with an increased correlation between commodity assets and stock markets, and many papers are written on the subject of commodities' role in portfolios, or their relationship to equity markets ((Black et al, 2014), (Delatte & Lopez, 2013), (Zaremba, 2015), (Lombardi & Ravazzolo, 2016), (Creti et al, 2013)).

However, while commodity securities may have become speculation assets for investors, the commodities themselves are still subject to changes in demand and supply. Basak & Pavlova (2016), for example, suggest a model which represents the financialisation of commodities, disentangling the impact of demand and supply.

Utilising the increased correlation between equity and commodity returns as is suggested by this financialisation, Lombardi & Ravazzoli (2016) employs a DCC-GARCH (Engle, 2002) approach to evaluate the implications for portfolio allocation, using a global index and the SP GSCI index. Their results indicate that commodity prices and stock prices jointly create a good forecast for stock returns. Christoffersen & Pan (2018) differ from the papers above in that they classify companies according to exposure to oil volatility. By employing a factor model, they find a large difference in average monthly return between low and high exposure firms, in the period classified as post-financialisation of commodities.

Providing evidence that the relationship between stock markets and commodity markets is time-varying,

Öztek & Öcal (2017) studies their integration and finds that the high volatility periods appear to be the main drivers for the high correlations they find. They employ two sub-indices of the SP GSCI, agricultural and precious metal, against the SP 500 as their stock market index. The relationship between stock returns and returns on the agricultural index appears to be most present during times of high market volatility, especially the Global Financial Crisis, whereas the correlation between precious metals and stocks seems to be of a more general upward trend (Öztek & Öcal, 2017).

2.3 Stock Markets in Sub-Saharan Africa

Market integration refers to the extent to which different markets move together. While two very highly integrated markets offer little diversification benefits of each other, there are benefits that come with some level of integration. Not least that a high degree of segmentation to global markets might be connected to high barriers to investment. This might both make investments in such markets impossible for many investors, and as a consequence of that also imply those countries lose out on lower capital costs and potential benefits to the economic welfare of the country (Bekaert, 1995).

Investigating market integration, Bekaert (1995) looks at 19 different emerging market countries, one of which is included in this thesis; Nigeria. Since the characteristics of these countries, with regions all across the world, are so different - it is deemed to be of less relevance to use results for other countries as reference. However, he also includes Zimbabwe, which is geographically close and has a main commodity in common with one of this thesis' countries (Zambia and copper). Bekaert (1995) runs a forecasting model of stock returns on U.S./local excess dollar returns, U.S./local dividend yield, and U.S. interest rate, without any significant results for Nigeria but with a decent significance for Zimbabwe, however the results seem to come mainly from the local factors.

Studying ten African countries over 1998-2007 and comparing to global markets, Agyei-Ampomah (2011) finds that much segmentation remains between African and global stock markets. Countries common to this study are South Africa, Nigeria, and Botswana. In an IMF working paper, Yartey & Adjasi (2007) discuss the economic importance of equity markets in Africa. Their findings indicate that stock markets have helped in financing company growth in some countries, but no conclusive evidence is found on the impact of the stock market on economic growth.

Boamah et al (2016) look at both regional and global integration of eleven African stock markets to world and emerging markets. They employ data between 1997 and 2013, and is one of few studies found which include Zambia (and also Botswana, Nigeria, and South Africa, i.e. covering all countries include in this thesis). The study creates a risk premium model to estimate excess expected returns contingent on market

premiums for a global index, an emerging market index, and a constructed African market index. They find that for all countries coefficients on global market premium are significant, positive, and of decent economic magnitude. For all countries except Zambia this is also true for the coefficient on an African market premium. South Africa also stands out from the rest with coefficients approaching/exceeding one.

2.4 Commodities & Stock Returns in Developing Countries

Trying to improve on stock market integration models for a set of commodity-dependent African countries, Peltomäki et al (2017) control for changes in commodity prices and test for integration of commodity-adjusted stock returns. The purpose is to understand whether emerging market equity can serve as a diversifying asset in a portfolio, especially if that portfolio already includes commodities. Additionally, whether this potential dependent nature of emerging market equity and commodities differ between countries. Their study considers eight Sub-Saharan African countries, out of which Botswana, Nigeria, and South Africa are common to this thesis. In testing for correlation between five GSCI commodity sub-indices (agriculture, energy, industrial, livestock) they find that Nigeria has only very small correlations (between -0.02 and 0.07) with any of the commodity sub-indices, whereas both Botswana and South Africa has decent-sized correlations with several indices. Botswana, for example, does not only have a correlation of 0.20 with precious metals, but also 0.22/0.26 respectively for energy and industrial. South Africa has even higher correlations, with agriculture of 0.27, energy 0.40, industrial 0.49 and livestock 0.30. I.e. suggesting some decent-sized co-movement between commodity markets and stock markets in these two countries. They then run regressions on same-period returns to measure integration, with and without controlling for commodity returns. The findings suggest that this adjustment for commodity dependency increases market integration substantially for both Botswana and South Africa, but not for Nigeria.

Boako & Alagidede (2016) investigates the potential diversification benefits of including African equity in a commodity portfolio. They find suggestions of a non-linear relationship between equity markets and global commodity returns, indicating that global investors behave differently towards African markets in good times versus in crises. However, their results also indicate the potential of lowering portfolio risk and increasing expected return by incorporating African equity in a diversified portfolio. The study includes eleven African countries, out of which South Africa, Botswana, and Nigeria are common to this thesis, between 2003 and 2014. As well as five commodity price indices, for gold, oil, silver, platinum, and cocoa. The commodities are chosen not primarily for their association to the countries in the study, but for their importance in global commodity exports. Additionally, the study employs a general commodity index. The study, as many other references in this thesis, employs a DCC-GARCH model (Engle, 2002).

Results show a significant connection between South Africa and gold, Nigeria and cocoa, and in the sub-sample period (post Global Financial Crisis) also Botswana and gold. One of their general takeaways is that African stock markets (under the assumption that the eleven sample countries are largely representative of stock markets for the whole continent) tend to have small correlations with commodity returns, and for these correlations to be highly volatile, especially during the Global Financial Crisis (Boako & Alagidede, 2016).

The relationship between emerging market equity returns and commodity prices is not only studied for the African market, for example Batten et al (2015) studies the level of integration between Asian stock markets and commodity markets. Using a CAPM-type model where market risk is represented by a commodity portfolio, they find a full-sample positive relationship for gold and rice. With variation over times of crisis (Asian Financial Crisis and Global Financial Crisis) where excess returns are negative and positive, respectively for each crisis. Turning specifically to India, Lagesh et al (2014) employ a DCC-GARCH model to investigate the relationship between four commodity indices and several financial asset classes, including equity returns. With a sample period between 2005, and 2011, they find that dynamic conditional correlation (DCC) is present but weak. It is also time-varying in that the correlation decreases in times of high equity volatility.

Following the large decline in the Zambian stock market in 2016 - which coincided with a decrease in international copper prices - Musawa & Mwaanga (2017) study what the impact of copper prices, as well as the exchange rate and interest rate, was on the stock market in a period from 2004 up until 2016. Applying auto regression distribution lag and cointegration analysis as well as the vector error correction model on the stock market versus copper and oil prices, interest rates, and exchange rates, they find that jointly those explanatory variables have a both short- and long-term impact on equity returns. Copper prices are individually significant both in the short- and long-term, joined by interest rates in the long-term and the exchange rate in the short-term. While, as will be discussed later in this thesis, copper is Zambia's main export, oil prices are assumed to be relevant due to its importance to manufacturing and constitutes around 14% of Zambian import at the time of this study (Musawa & Mwaanga, 2017). Continuing on that same track, where as in Musawa & Mwaanga (2017) the oil price commodities are viewed not primarily as exports but as variables with a potential macroeconomic impact on stock markets, Adjasi (2009) studies the impact on the Ghanan market of several variables; including oil/gold/cocoa prices, and among others the exchange rate and interest rates. Using an EGARCH model on the period 1991-2007, he finds a positive relationship between volatility in cocoa prices and interest rates to equity prices, and a negative relationship between gold and oil prices versus equity prices.

3 Country & Commodity Background

General

Tables 1 and 2 show details of commodity exports of the four countries included in this study. The data comes from an UNCTAD report in 2018 (UNCTAD, 2018) and is thus only available until 2017. This is, however, deemed the most reliable aggregated report available and thus changes that may have occurred until 2019, and between 1995 and 2013, are ignored. As the only data in these tables that is used in the regressions is the share of exports of Oil & Natural Gas for Nigeria (see the Data section), this was deemed acceptable. The data here rather serves as a tool to select which commodities to run the regressions against, and as background for which to understand the commodity dependency, as well as to enable some analysis on the part of differences in commodity dependency between the countries.

UNCTAD classifies export commodities into three categories - agricultural; fuels; and ores, metals, precious stones, and non-monetary gold. These countries cover all except agricultural. Nigeria exports oil and natural gas, Zambia exports mainly copper, and Botswana mainly diamonds. South Africa, as can be seen, first of all does not qualify as commodity dependent (UNCTAD, 2018) as it falls below the 60% of exports threshold. Secondly, their exports are more mixed. This is why South Africa is only included in those regressions which employs the general SP GSCI Total Return Index.

As seen in Table 1, Botswana, Nigeria, and Zambia all have commodities constitute near all of their export value; for Botswana and Zambia these numbers are also quite large for the share of GDP.

Botswana & Diamonds

Botswana's diamond exploitation stretches back to the 1970s, when the finding of diamonds enabled the newly independent Botswana to detach financially from Great Britain as well. During the 1970s and 1980s, the economy expanded and Botswana developed its industrial and social infrastructure. During this period additional diamond mines were opened, with favourable revenue terms to the government. In general terms, Botswana has been able to avoid the worst of the "resource curse" by, since early on, implementing good policy to capture the benefits of its diamond assets. Much of Botswana's diamond production belongs to the company DeBeers Group (not listed in Botswana), to some extent in partnership with the Botswanan government.[4] On average 90% of Botswana's commodity exports between 2013-2017 constituted of diamonds.

The Botswana Stock Exchange was established in 1989, though at the time it only existed as an informal market, consisting of five listed companies. It has since evolved, and from 2003 it exists as an independent

[4]Britannica; https://www.debeersgroup.com/reports/socio-economic-impacts/botswana

Commodity exports	1995	2013-2017	2017
Value (mn USD)			
- Botswana	1811	6601	5556
- Nigeria	12009	65612	43560
- Zambia	990	7301	7154
- South Africa	15014	48493	50723
As share of total merchandise exports			
- Botswana	85%	94%	94%
- Nigeria	97%	98%	98%
- Zambia	94%	87%	88%
- South Africa	54%	56%	57%
As share of GDP			
- Botswana	38.3%	42.2%	32.5%
- Nigeria	24.5%	13.9%	11.6%
- Zambia	26%	29.6%	27.8%
- South Africa	9.5%	14.4%	14.6%

Table 1: Commodity export details by country

entity. And in 2018, a three year process to turn the Exchange into a for-profit company was finalised, with owners being the government and stock brokers. As of the date of writing this thesis, 2020-12-05, there are 32 listed companies. Shares are available for trade only through contact with a licensed broker.[5]

Nigeria & Oil & Natural Gas

Petroleum was first discovered in Nigeria in 1956, and has since become the main source of revenue for the government. Natural gas is not sourced by itself, but rather produced as a by-product of the crude oil. However, production has often halted, as locals in the oil-producing regions protest to increase their share of the revenue. The Nigerian National Petroleum Company (NNPC), a state-owned company,

[5]https://www.bse.co.bw/

Exports by Commodity Group (*as share of total commodity exports*)	**1995**	**2013-2017**	**2017**
Agricultural Commodities			
- Botswana	4.0% (4.71%)	2.0% (2.13%)	2.0% (2.13%)
- Nigeria	5.0% (5.15%)	4.0% (4.08%)	5.0% (5.10%)
- Zambia	5.0% (5.32%)	13.0% (14.94%)	12.0% (13.64%)
- South Africa	13.0% (24.07%)	13.0% (23.21%)	13.0% (22.81%)
Fuels			
- Botswana	0.0% (0.00%)	0.0% (0.00%)	0.0% (0.00%)
- Nigeria	92.0% (94.85%)	93.0% (94.90%)	92.0% (93.88%)
- Zambia	2.0% (2.13%)	1.0% (1.15%)	1.0% (1.14%)
- South Africa	11.0% (20.37%)	10.0% (17.86%)	12.0% (21.05%)
Ores, metals, precious stones, and non-monetary gold			
- Botswana	81.0% (95.29%)	92.0% (97.87%)	92.0% (97.87%)
- Nigeria	0.0% (0.00%)	1.0% (1.02%)	2.0% (2.04%)
- Zambia	87.0% (92.55%)	73.0% (83.91%)	75.0% (85.23%)
- South Africa	30.0% (55.56%)	33.0% (58.93%)	32.0% (56.14%)

Table 2: Commodity export details by country, as share of merchandise exports

was founded in 1977. With an average production of approx. 2 million barrels daily (2019), Nigeria is the eleventh largest oil producer in the world. Main players outside of NNPC are some of the core oil companies in the world, such as Dutch Shell, ExxonMobil, Chevron and Equinor.[6]

The Nigerian Stock Exchange was founded in 1960 and has since gone through a great deal of changes. As of the day writing this thesis, the stock exchange consists of 162 listed companies.[7] Oil & Natural Gas constituted on average 80% and 10% of commodity exports between 2013-2017 (UNCTAD,2018).

Table 3: Botswana: Country Details

Population Size	**GDP/Capita 2010[a]**	**GDP/Capita 2019[a]**
2,324,000	6,435$	8,093$
Political State	**(Since when)**	**Last Change Head of State**
Multiparty Republic	1966	2018
Democracy Index	**Human Development Index**	**"Economic Freedom Index"**
Score: 7.81, Rank: 29	Score: 0.728, Rank: 94(+)	Score: 69.6(+), Rank: 40
(*"flawed democracy"*)	(*"high human development"*)	(*"moderately free"*)

[a]In constant 2010 U.S. Dollar. Web sources (link in subsection of References):

Britannica, World Bank, Heritage, EIU, HDR.

Table 4: Nigeria: Country Details

Population Size	**GDP/Capita 2010[a]**	**GDP/Capita 2019[a]**
200,788,000	2,292$	2,387$
Political State	**(Since when)**	**Last Change Head of State**
Federal Republic	1999	2015
Democracy Index	**Human Development Index**	**"Economic Freedom Index"**
Score: 4.12, Rank: 109	Score: 0.534, Rank: 158(-)	Score: 57.2(-), Rank: 116
(*"hybrid regime"*)	(*"low Human Development"*)	(*"mostly unfree"*)

[a]In constant 2010 U.S. Dollar. Web sources (link in subsection of References):

Britannica, World Bank, Heritage, EIU, HDR.

Zambia & Copper

Copper accounted for 77% of exported commodity revenue in Zambia on average between 2013-2017 (UNCTAD, 2018), and has been important for the domestic economy for a long time. The Zambian stock exchange, known as the Lusaka Stock Exchange, was established in 1993 and remains fairly small.[8]

South Africa

South Africa has only approximately 56% of its exports in commodities, compared to the other three countries which have between 87-98% (average numbers 2013-2017). Additionally, there is no one com-

[6]Britannica; https://www.statista.com/topics/6914/oil-industry-in-nigeria/

[7]http://www.nse.com.ng/

[8]Britannica; http://www.luse.co.zm/

Table 5: Zambia: Country Details

Population Size	**GDP/Capita 2010[a]**	**GDP/Capita 2019[a]**
17,318,00	1,489$	1,658$
Political State	**(Since when)**	**Last Change Head of State**
Multiparty Republic	1964	2015
Democracy Index	**Human Development Index**	**"Economic Freedom Index"**
Score: 5.09, Rank: 97	Score: 0.591, Rank: 143(+)	Score: 53.5(-), Rank: 147
(*"hybrid regime"*)	(*"medium human development"*)	(*"mostly unfree"*)

[a]In constant 2010 U.S. Dollar. Web sources (link in subsection of References):

Britannica, World Bank, Heritage, EIU, HDR.

Table 6: South Africa: Country Details

Population Size	**GDP/Capita 2010[a]**	**GDP/Capita 2019[a]**
58,955,000	7,329$	7,346$
Political State	**(Since when)**	**Last Change Head of State**
Multiparty Republic	1991	2018
Democracy Index	**Human Development Index**	**"Economic Freedom Index"**
Score: 7.24, Rank: 40	Score: 0.705, Rank: 113(-)	Score: 58.8(+), Rank: 106
(*"flawed democracy"*)	(*"high human development"*)	(*"mostly unfree"*)

[a]In constant 2010 U.S. Dollar. Web sources (link in subsection of References):

Britannica, World Bank, Heritage, EIU, HDR.

modity which accounts for a majority of those 56%. Thus in this thesis South Africa does not have a main-export commodity as the other countries, but is instead included only when utilising the GSCI. The stock exchange in South Africa; the Johannesburg Stock Exchange, was established in 1887 and has been a member of the World Federation of Exchanges since 1963. It is also the only of the stock exchanges in this study to offer commodity trade services.[9]

[9]https://www.jse.co.za/

4 Data

4.1 Stock Data

All stock index data is retrieved from Eikon, throughout the period 2010-01-01 to 2019-12-31. They are all All Share Price indices, from the main (or only) stock exchange in each country. Price levels are in the local currency for all countries except Botswana, for which only U.S. Dollar prices were available. Prices are not converted in order to avoid currency effects on the return variables, and are instead controlled for in the regressions where the exchange rate to U.S. Dollar is used as a forecasting variable. The time period was chosen in order to provide a sufficiently large sample, while avoiding the worst fluctuations of the 2008-2009 Global Financial Crisis. The choice was also made to do the cut-off at 2019-12-31 rather than continuing the sample period into 2020, to exclude the impact of the Sars-Cov-19 pandemic on either of the three data set groups (stocks, macro economy, and commodities). While it would certainly be interesting to study whether the effect of commodities on stock returns differ during times of crises - especially given the safe haven nature of many commodities in times of stock market recessions - this would be a topic for a different study.

	No. Obs	Mean	Variance	Skewness	Kurtosis	Min	Max	Stationarity [a]
Botswana	2607	0.00	0.00	-1.27***	71.36***	-0.04	0.04	|35.2|***
Botswana Foreign	2607	0.00	0.00	-1.79***	75.27***	-0.05	0.04	|34.6|***
Botswana Domestic	2607	0.00	0.00	25.95***	1146.79***	-0.05	0.14	|35.8|***
Zambia	2607	0.00	0.00	-1.18***	24.31***	-0.09	0.06	|35.5|***
Nigeria	2607	0.00	0.00	0.27***	5.01***	-0.05	0.08	|31.2|***
South Africa	2607	0.00	0.00	-0.17***	1.49***	-0.04	0.04	|37.7|***

Table 7: Statistics & Stationarity Tests Stock Returns

[a]Augmented Dickey-Fueller test, absolute value (*** if non-stationarity rejected). Kurtosis & Skewness, *** if statistically significant at 0.1% level, by Anscombe and Agostino tests respectively.

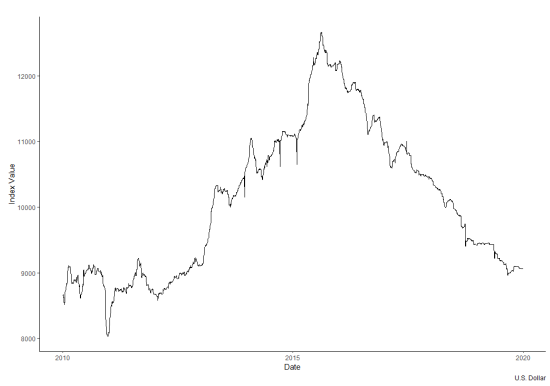
The four countries used in this study are Botswana, Nigeria, Zambia, and South Africa. Out of which the first three are deemed commodity dependent by a United Nations Conference on Trade and Development report (UNCTAD, 2018), whereas South Africa is not. South Africa will, consequently, serve as a sort of benchmark to which we can measure differences, if any, between the commodity dependent country and a country which is not. The choice was made to use South Africa rather than e.g. the U.S., or for that matter Norway - which has a high commodity dependency but is a vastly more developed economy -, in

order to evaluate differences between countries in the same region (Sub-Saharan Africa).

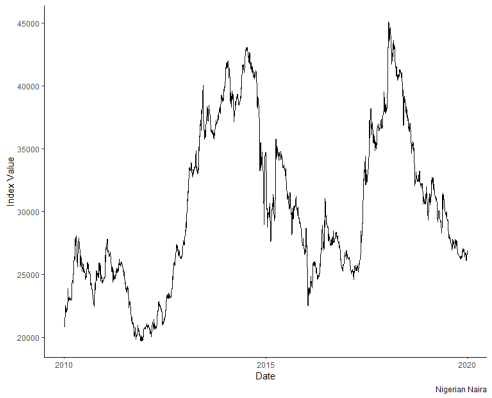
All the stock data sets include 2607 observations. This is not insufficiently small, however with regressions we generally prefer larger data sets to increase the statistical power of results. Thus we should be aware that it is very possible that we will not get models with a very close fit, and consequently we will be accepting p-values up to 10%, although of course lower values are preferable. Skewness implies that the data differs from a perfect normal distribution in that it is lightly skewed either up or down. Most of these returns series has a small, but significant, negative skewness - i.e. more negative returns than a normally distributed series would indicate. However, the domestic section of the Botswanan stock index has a very large positive skewness, indicating that it has a large portion of positive returns. We also see that the max return is much larger than for any other country. Likewise, the excess kurtosis of this index is more than ten times larger than the second highest. The excess kurtosis, i.e. a kurtosis different from 3, indicates whether the tails of a distribution differ from a normal distribution. A positive excess kurtosis indicates fatter tails, which we see for all the stock returns series, albeit of a differing degree. South Africa, which also has the most mature stock market and most developed economy (also the only non-commodity dependent country in this study) not only has a skewness that, while significant, is rather close to zero, and a much lower excess kurtosis than the other. Nigeria is not quite as close to normality as South Africa, but has a smaller skewness (slightly positive) and lower excess kurtosis than the other two commodity dependent countries in the study.

For Botswana, a separate Foreign and Domestic sub-index are available, which will be used to make an extension to the main results in sections 6.1-6.3. The reasoning behind this extension comes from the ambiguity concerning the extent and nature of the relationship between companies listed on the stock exchange and the main-export commodity for these countries. In absence of data on stock index constituents - which would allow for analysis on not only country of origin of listed companies, but also e.g. control for ownership of the companies - we instead make this one extension. Information on number of companies in each index is not available, however the Foreign sub-index is on average approx. five times at large in value as the Domestic sub-index. As we can see in Table 7 and Figures 1-3, these separate data sets differ quite a bit, from a purely quantitative perspective. By running regressions over them separately we look for evidence that they might differ in their relationship to commodity price movements, as well.

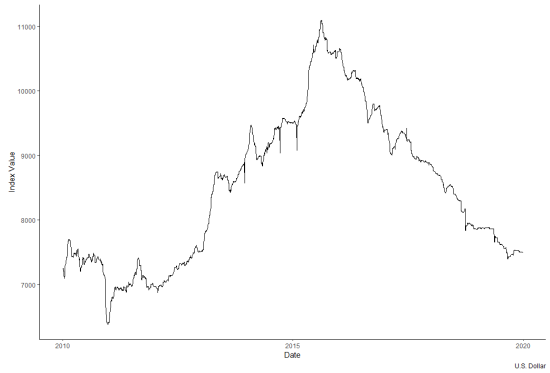
Figure 1 illustrates each country's stock market index value over time. As will follow with the subsequent two figures, we first see Botswana and Nigeria, then the two sub-indices for Botswana - Foreign and Domestic - and finally Zambia and South Africa. Please note that also the commodity section will follow



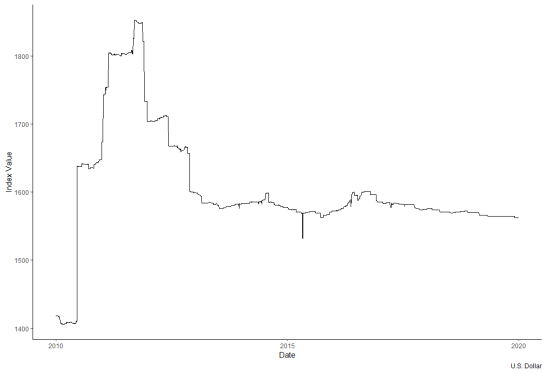
(a) Botswana



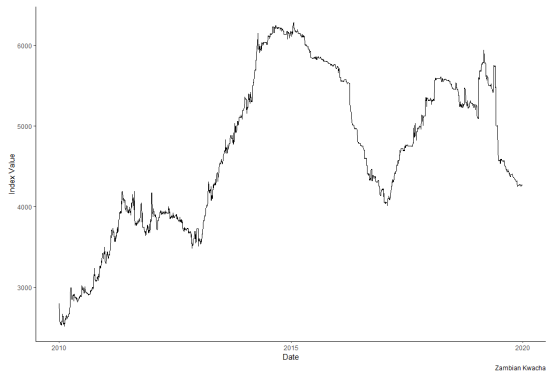
(b) Nigeria



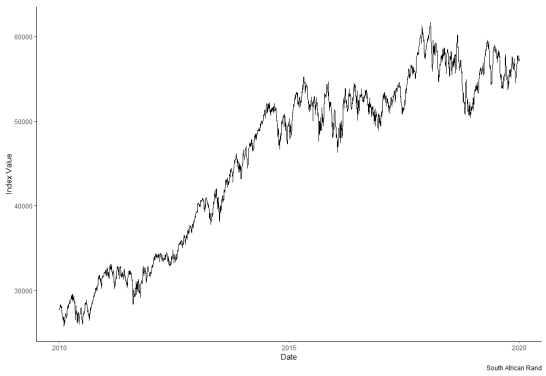
(c) Botswana Foreign Index



(d) Botswana Domestic Index



(e) Zambia



(f) South Africa

Figure 1: Stock Index Value

a similar pattern, with Botswana's main commodity (Diamonds) being presented first, Nigeria's (Oil & Natural Gas) second, Zambia's (Copper) third, and the general for which South Africa is included (GSCI) last. Results will also be presented in this order.

When observing the graphs in Figure 1, we can quickly note that South Africa's stock market shows much more of the shape we would expect - some volatility but in general an upward trend - than the other markets. Botswana perhaps being the more extreme example, with it's mountain-like shape, peaking in the middle of 2015, to then continue downward. This is mirrored in the Foreign sub-index, but not in the Domestic. As might be expected from observing this, we confirm that the Foreign sub-index constitutes a much larger portion of the combined index; roughly five times as large on average. The Domestic sub-index has a rather interesting shape to its graph, with extreme movements early on in the sample period, and much smaller movements as we proceed towards 2020. Nigeria and Zambia exhibit a similar trend to each other, albeit with different patterns, with large increases and decreases following one another.

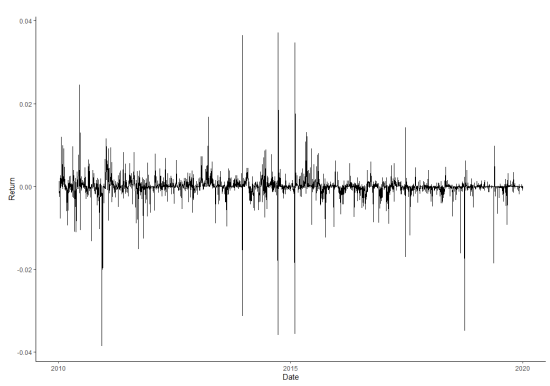
The main concern in observing the returns graphs (Figure 2) is that we do not want any trend in returns, as this would imply the series are not stationary. We have tested for this, as seen in Table 7, and confirmed the series are stationary. Viewing them is partly an additional aspect to this, but also allows us to observe the patterns in the returns data. While South Africa, and largely Nigeria apart from some more extreme movements in the middle of the sample, follow the pattern we would usually expect from a stock return series, the others do not. The Botswanan Domestic sub-index has the most extreme pattern in this. As the series are all stationary, this is not a hindrance to running the regression, but it is relevant to keep in mind that both index value and returns of these countries' stock markets behave differently to what we would expect when running regressions over mature market data.

In Figure 3 we consider the Autocorrelation Function (ACF) graphs of the returns series. We are mainly concerned with the second bar $(t-1)$ after the initial (t). The dotted line indicates statistical significance of the lag effect. As can be seen in these graphs, Nigeria shows a strong lag effect at $t-1$, Botswana's full market index and the Foreign sub-index shows a small, negative, lag effect at $t-1$, and the Domestic sub-index a small positive lag effect. Neither Zambia nor South Africa shows any lag effects at $t-1$, but small effects at later lags. Whether the $t-1$ lag effect is actually a useful predictor of returns at t will, however, be tested in regression model (1) in the Results chapter.

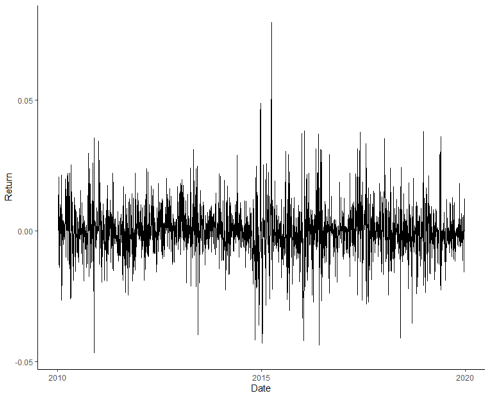
Data Manipulation

All stock returns are calculated as

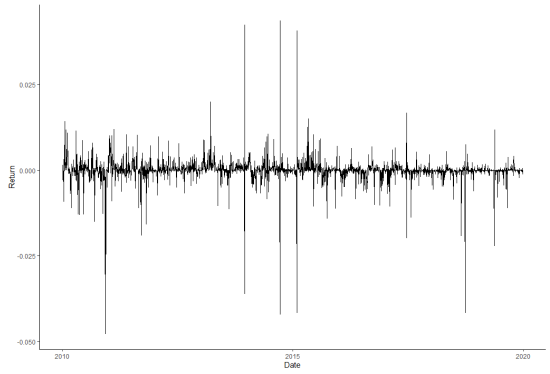
$$ln(\frac{IndexValue_t}{Indexvalue_{t-1}}).$$



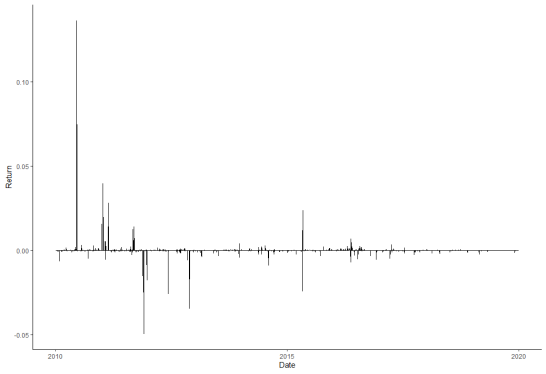
(a) Botswana



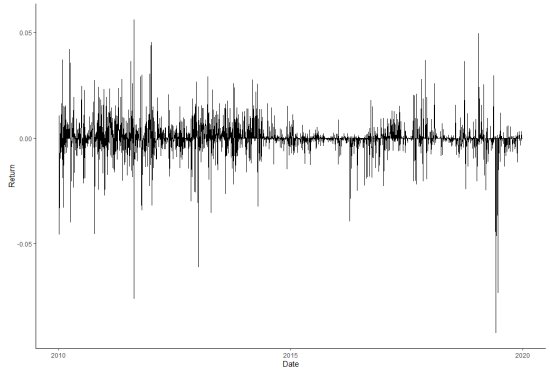
(b) Nigeria



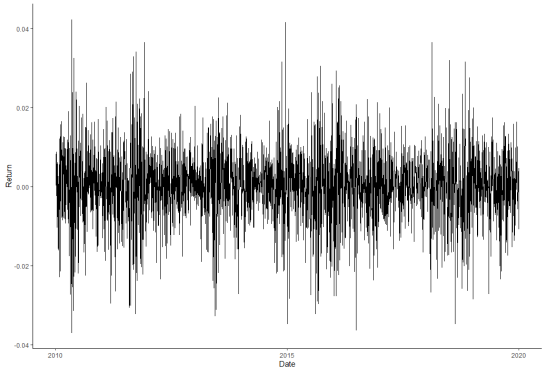
(c) Botswana Foreign Index



(d) Botswana Domestic Index

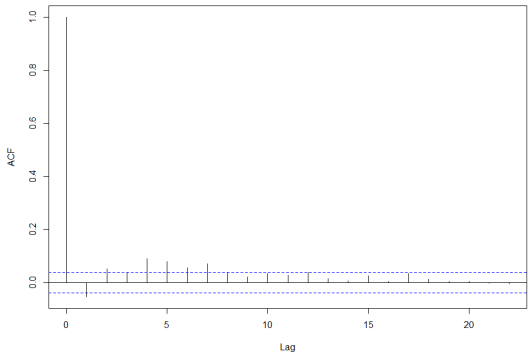


(e) Zambia

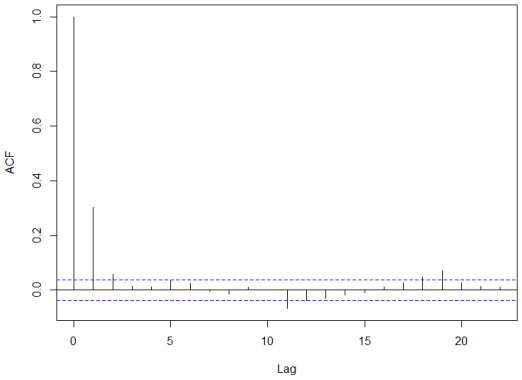


(f) South Africa

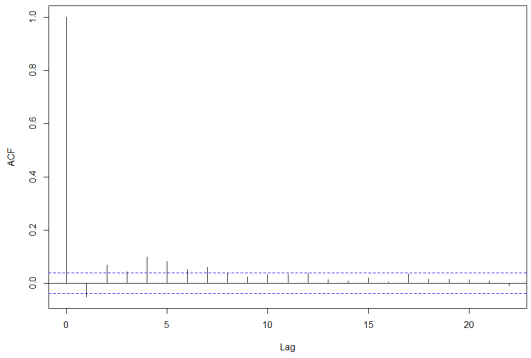
Figure 2: Stock Returns



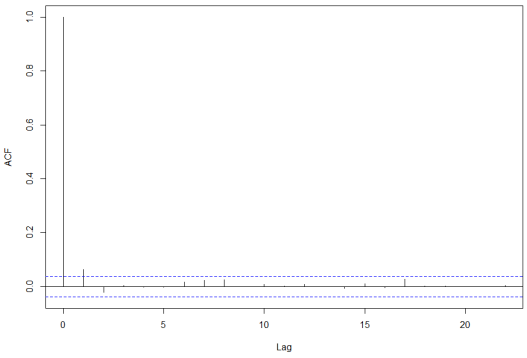
(a) Botswana



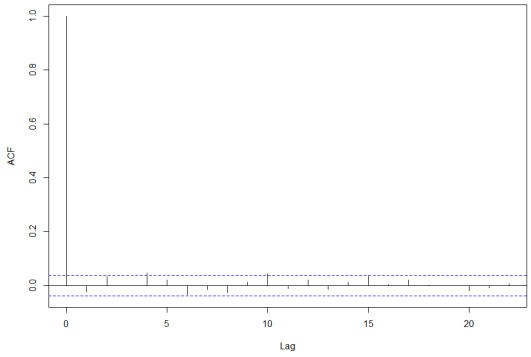
(b) Nigeria



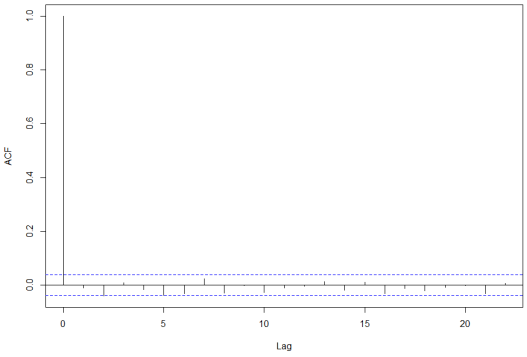
(c) Botswana Foreign Index



(d) Botswana Domestic Index



(e) Zambia



(f) South Africa

Figure 3: Autocorrelation Function Graphs

Stock Index Returns

As we only have data from 2010-01-01, this means that returns are available from the next trading day - 2010-01-04, and thus all data sets in the regressions begin then. Before continuing to the regressions, the return variable is lagged so as to provide the $t-1$ return, and consequently we also have to remove the 2019-12-31 observation as there is no r_{t-1} available for this date. The final data set, for all four countries and the two additional data sets for Botswana, thus consists of all trading days between 2010-01-04 - 2019-12-30.

4.2 Commodity Data

Details on selection of the commodity(ies) for each country are available in Chapter 3. In this section the data itself is presented and discussed. Commodity data is available for the same dates as the stock index data, i.e. between 2010-01-01 and 2019-12-31. All series have been retrieved from Eikon. The Diamonds series is a combined index of 20 different price series of diamonds of differing carat value and characteristics, in order to provide a more complete overview of the diamond market. The Oil prices are WTI, one of the main reference price indices of crude oil. The reasoning behind not using the Nigerian Bonny Light crude oil price is that this study takes on the perspective of a foreign investor, considering these three different stock markets in light of their relationship to their main exported commodity. The assumption is then that this investor, having no distinct interest in or specialised knowledge of Nigeria, does not actively follow the Bonny Light crude oil price, but rather one of the main oil price indices. The Copper index is a simple price series of Grade A Copper as traded on the London Metal Exchange. All commodity price indices are denominated in U.S. Dollar.

Nigeria is the only of the three commodity-dependent countries which has an index of two commodities rather than a single one as their variable. There are two key reasons for this; firstly Natural Gas constitutes a more significant share of commodity exports than there is for either Botswana or Zambia with a single commodity. Secondly, the Oil and Natural Gas production is closely linked in Nigeria, as is mentioned in Chapter 3, and thus from an export perspective a price change in either Oil or Natural Gas is likely to affect the same companies in a similar way. Shares in the index are constant at 89% crude oil returns and 11% Natural Gas returns, corresponding to the 2013-2017 average share of commodity exports that are crude oil (80%) and Natural Gas (10%) (UNCTAD, 2018).

The SP GSCI Total Return Index is a broad index meant to capture movement in global commodity markets[10]. The decision to use the GSCI in particular is motivated by its use in other research, such as Peltomäki et al (2017) and Black et al (2014). In the latter, in particular, they argue that it covering so

[10]https://www.spglobal.com/spdji/en/indices/commodities/sp-gsci/overview

many different types of commodities serves to make it more stable and less affected by short-term shocks to supply and demand. The index instead provides an overview of the complete commodity market.

	No. Obs	Mean	Variance	Skewness	Kurtosis	Min	Max	Stationarity [a]
Diamonds	2607	-0.00	0.00	0.57***	85.62***	-0.41	0.40	|45.6|***
Oil & Natural Gas	2607	-0.00	0.00	$0.00^{\text{n.s.}}$	3.59***	-0.10	0.12	|35.8|***
Copper	2607	-0.00	0.00	$-0.08^{\text{n.s.}}$	2.77***	-0.08	0.07	|36.7|***
GSCI	2607	-0.00	0.00	-0.19***	2.84***	-0.07	0.08	|36.1|***

Table 8: Statistics & Stationarity Tests Commodity Returns

[a]Augmented Dickey-Fueller test, absolute value (*** if non-stationarity rejected). Kurtosis & Skewness, *** if statistically significant at 0.1% level, by Anscombe and Agostino tests respectively.

In Table 8 we have the same statistics as in Table 7, here for the different commodity returns series. Mean and variance remain at approximately zero, although the means are on the negative side of the absolute zero. Only Diamonds and the GSCI have statistically significant skewness. The excess kurtosis is significant for all series, but only by a large value for the Diamonds series. This is also the series that experiences, by far, the lowest minimum and the highest maximum value. Additionally, all the returns series are stationary.

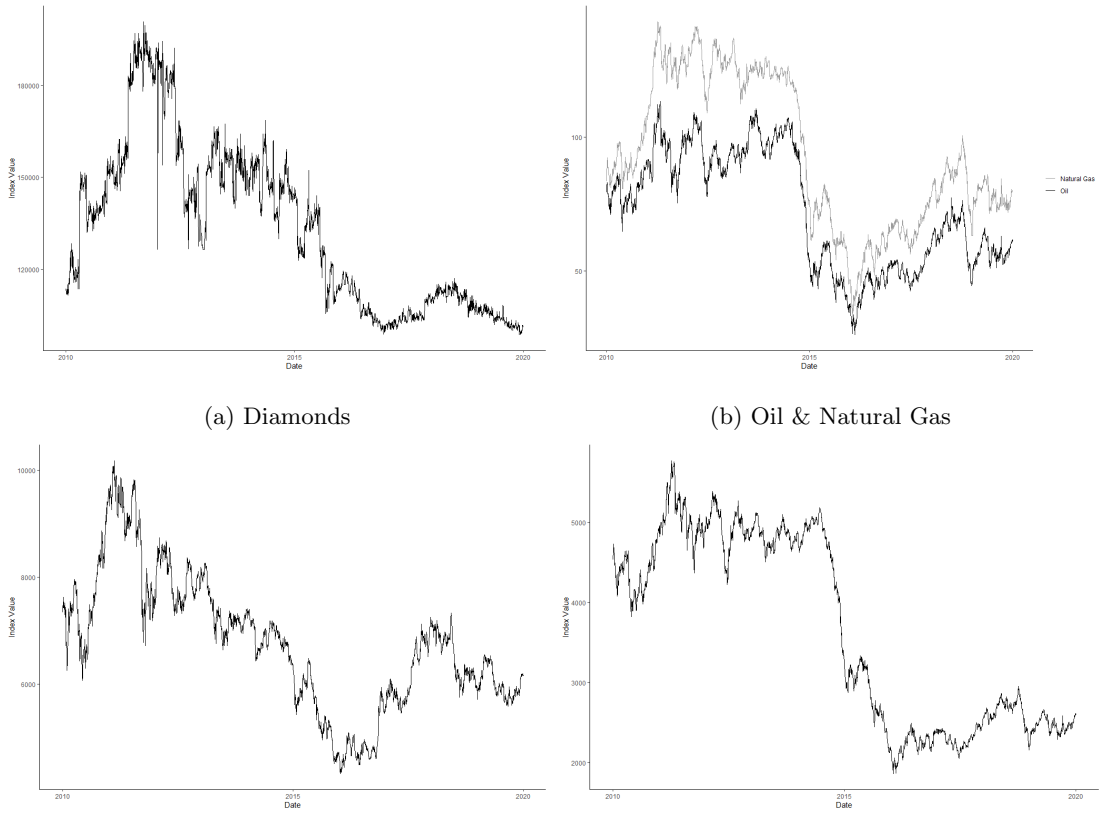
Replicating the figures from the Stock Data section (Figures 1 & 2), we now turn to the index value graphs plotted over time in Figure 4. All series follow to some extent the same trend, with higher levels earlier in the series and lower values as time progresses. Perhaps unsurprisingly, it is mainly the Oil & Natural Gas index and the GSCI that mimic each other, as crude oil is a more significant part of the GSCI compared to Diamonds or Copper.

Turning to the returns series (Figure 5), we can note that all series except Diamonds show a pattern similar to what is expected of a stationary time series. However, there appears to be some persistence in the periods of decreased volatility, especially for Oil & Natural Gas and the GSCI. The Diamonds series, as noted above, has some very extreme returns, but show no clear trend apart from the decreased volatility in the series from sometime after half of the sample period.

Data Manipulation

Commodity returns are calculated as

$$ln(\frac{IndexValue_t}{Indexvalue_{t-1}}).$$



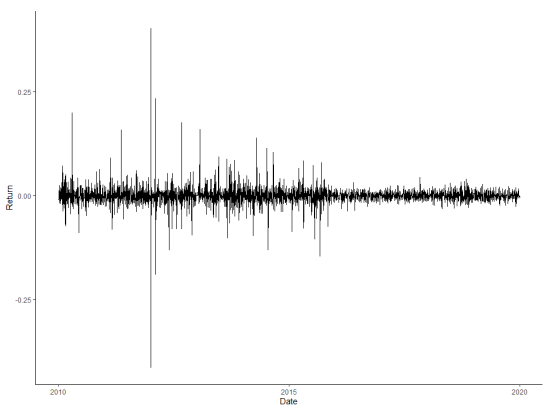
(a) Diamonds

(b) Oil & Natural Gas

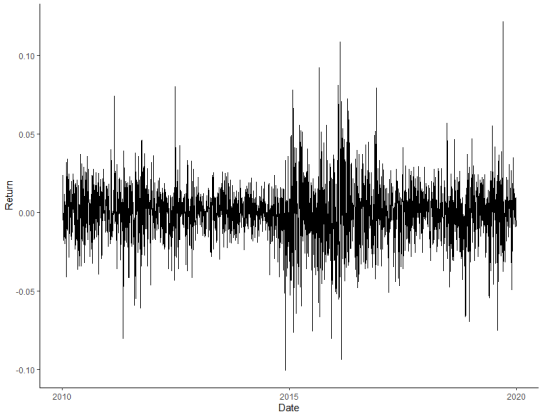
(c) Copper

(d) GSCI

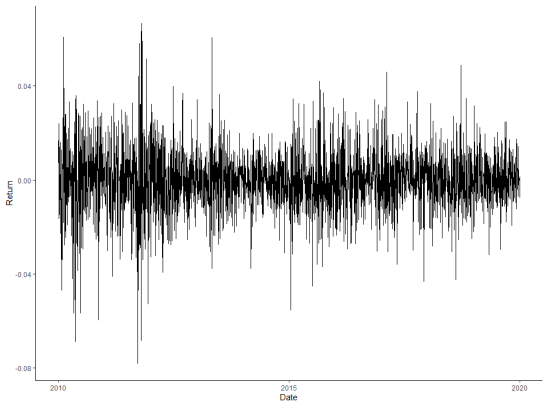
Figure 4: Commodity Index Value



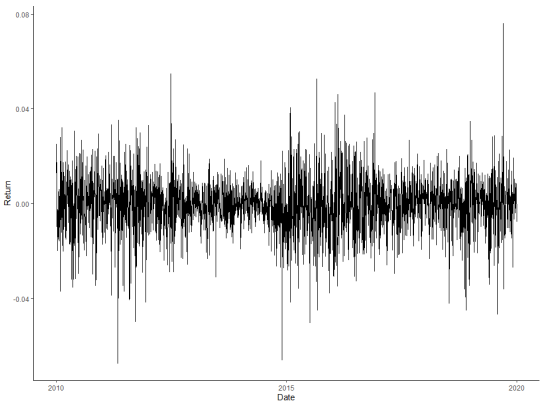
(a) Diamonds



(b) Oil & Natural Gas



(c) Copper



(d) GSCI

Figure 5: Commodity Returns

To match the stock returns data set, the commodity return sets span 2010-01-04 to 2019-12-30. As discussed above, the Diamonds index is a combination of several different price indices, and the Oil & Natural Gas index is comprised of the two weighted returns series, matching the level of dependency of the Nigerian economy on each export commodity.

4.3 Macro Data

The two macroeconomic variables used are GDP changes and change in exchange rate to the U.S. Dollar. The former is available on a quarterly basis, and the latter on a daily basis. A discussion on the choice of variables is available in Chapter 5. GDP level data is available quarterly between 2010-01-01 and 2019-12-31. However, since we are using quarterly changes in this study, change values are only available from the beginning of Q2 in 2010, when we can calculate the first change, from Q1 2010 to Q2 2010. For all countries except South Africa this occurs on the regular Q1/Q2 shift date, 31/3. For South Africa, GDP is reported on different dates, and is thus available on the first date for 15/2, and every three months after. Exchange data is available through 2010-01-01 to 2019-12-31 for all countries except Zambia, where the rate on 2019-12-31 is not available, and thus the last observation is dropped. Both the GDP and the exchange rate series are retrieved from Eikon. GDP is reported in local currency, to avoid currency effects on GDP so as to separate the effects of the two variables.

	No. Obs	Mean	Variance	Skewness	Kurtosis	Min	Max	Stationarity[a]
Botswana	2606	0.00	0.00	0.46***	4.52***	-0.03	0.04	|39.8|***
Nigeria	2606	0.00	0.00	18.87***	604.41***	-0.08	0.27	|36.0|***
Zambia	2605	0.00	0.00	0.21***	27.13***	-0.09	0.15	|35.8|***
South Africa	2606	0.00	0.00	0.17***	2.92***	-0.06	0.05	|36.9|***

Table 9: Statistics & Stationarity Tests Exchange Rate Changes

[a]Augmented Dickey-Fueller test, absolute value (*** if non-stationarity rejected). Kurtosis & Skewness, *** if statistically significant at 0.1% level, by Anscombe and Agostino tests respectively.

In Table 9 we see the main statistics for the exchange rate change series. Mean and variance are, as with the prior series sets, both zero for all countries. There is some slight positive skewness to all countries, with Nigeria experiencing a much stronger positive skewness. Nigeria also shows a much larger excess kurtosis, while the others vary a bit in size but all remain statistically significant. Nigeria also has a much larger maximum value compared to the other countries, whereas minimum values are alike. All four countries' exchange rate change series are stationary.

	No. Obs	Mean	Variance	Skewness	Kurtosis	Min	Max	Stationarity[a]
Botswana	2543	0.01	0.00	0.28***	-0.02[n.s.]	-0.04	0.07	|4.5|***
Nigeria	2543	0.01	0.01	-1.11***	-0.23 **	-0.17	0.09	|4.6|***
Zambia	2543	0.01	0.00	-0.62***	-0.53***	-0.09	0.11	|4.9|***
South Africa	2575	0.00	0.00	-0.58***	-0.31***	-0.01	0.01	|3.6|***

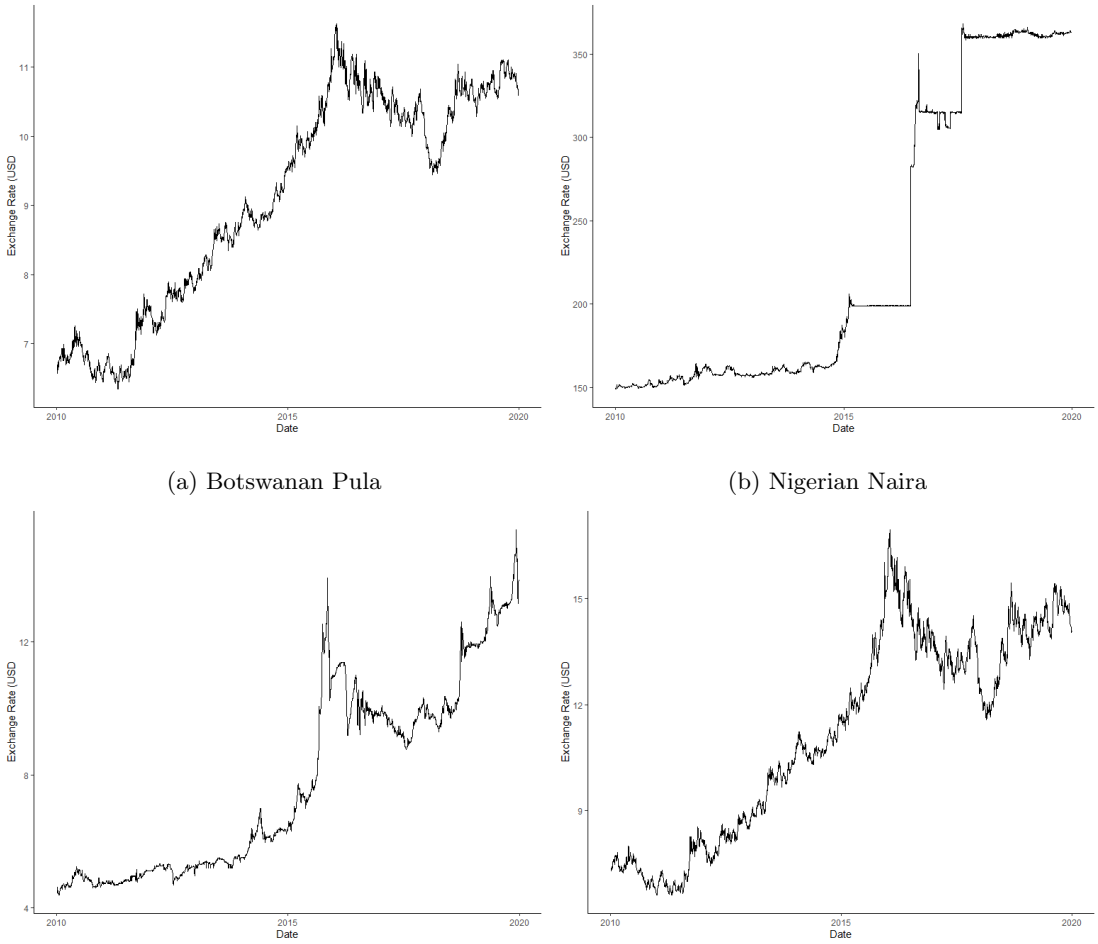
Table 10: Statistics & Stationarity Tests GDP Quarterly Changes

[a]Augmented Dickey-Fueller test, absolute value (*** if non-stationarity rejected). Kurtosis & Skewness, *** if statistically significant at 0.1% level (** at 1% level), by Anscombe and Agostino tests respectively.

The additional observations for South Africa in Table 10 are a direct result of what is discussed above, that the GDP data is reported from 2010-02-15 rather than from 2010-03-31 as is the case for the other countries. Mean values are not approaching zero in the same way as for the prior series, and the variance for Nigeria is also not zero. However, we must take into account that while we do have a similar number of observations in this data set, since changes remain the same throughout each quarter, we have much fewer unique values, and thus it is not very surprising that the mean and variance does not necessarily go to zero. There is some slight skewness, positive for Botswana and negative for the others. All series except Botswana also experience some excess kurtosis, but very small in magnitude. Nigeria has the lowest minimum value, but perhaps more notable is the difference of South Africa to the other countries. This reiterates South Africa being a further economically developed, and more economically stable, country than the others, in part highlighting the country's use as a benchmark in this thesis. All series are stationary with high statistical significance, albeit not with as high significance as most of the stock, commodity, and exchange rate series.

Each of the series in Figure 6 follow an upward trend, implying that the value of each local currency has decreased towards the dollar over time (one U.S. dollar buys more of the local currency, and vice versa, one unit of the local currency buys fewer dollars). The pattern is the most similar for the Botswanan Pula and the South African Rand, where the exchange rate has - apart from a dip - remained fairly stable for roughly the last quarter of the sample period. For Zambia, however, the exchange rate has continued in disfavour for Zambia after a brief period of stability. The Nigerian Naira is a different story, where it started off very stable, but has experienced enormous jumps since, with periods of stability in between.

Turning to Figure 7 we can easily see the connection between the exchange rate series in Figure 7 and this change series for Nigeria, with a period of rather stable changes, and then these extreme jumps that



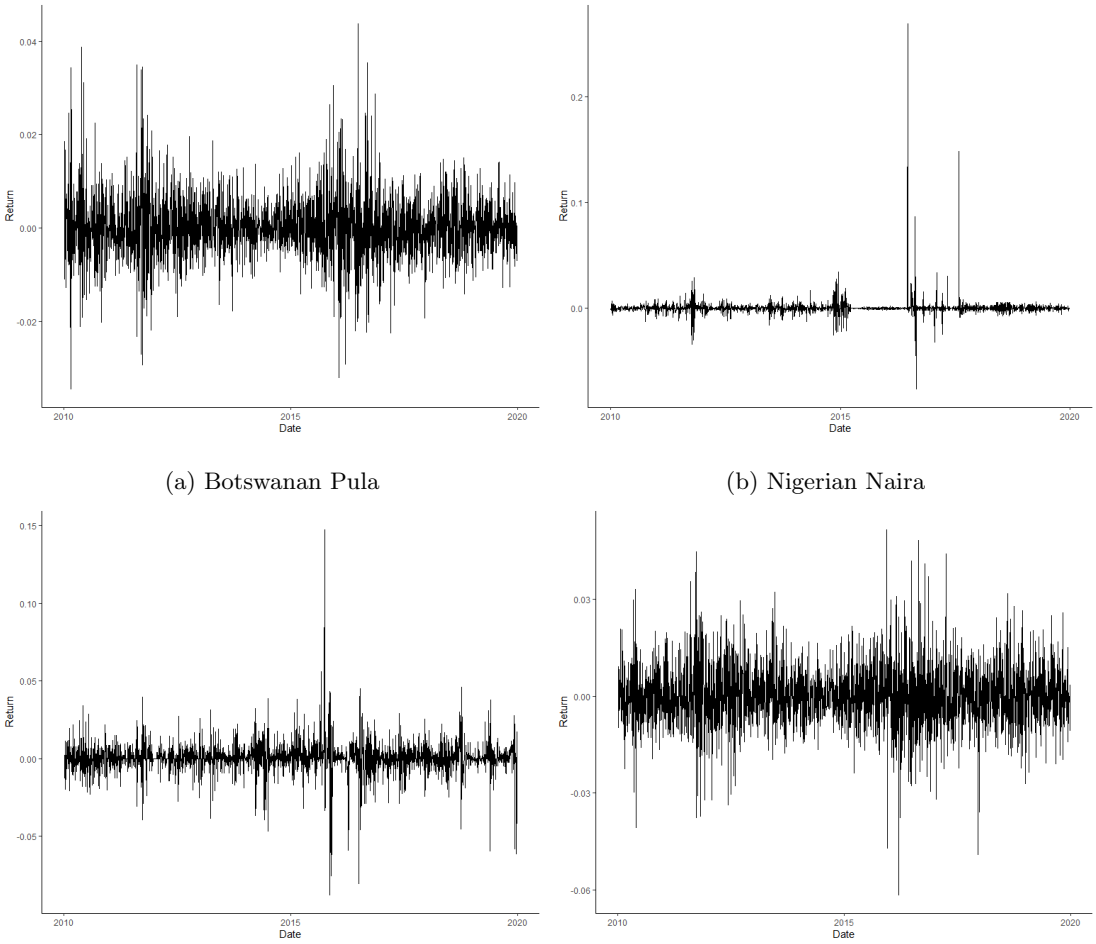
(a) Botswanan Pula

(b) Nigerian Naira

(c) Zambian Kwacha

(d) South African Rand

Figure 6: Exchange Rate (to USD)



(a) Botswanan Pula

(b) Nigerian Naira

(c) Zambian Kwacha

(d) South African Rand

Figure 7: Exchange Rate Changes (to USD)

we noted above. The other series, particularly Botswana and South Africa, follow a rather regular change series pattern, with Zambia experiencing periods of unusual volatility. All in all, there are no clear trends observable, which goes hand in hand with the stationarity we confirmed before.

Figure 8 shows the level of GDP in each country. The first thing to note is that for both Figure 8 & 9 we will see these flat periods for each observation, as the data is quarterly and thus does not change for three months at a time. With that said, in Figure 8 we can observe upward trends for all countries, indicating an increasing GDP between 2010 and 2020. The height of the changes differs between the countries, with Nigeria in particular showing a rather unusual pattern with a lot of heavy up- and down-movement. Again, we observe that South Africa shows a pattern which indicates higher stability than the other countries. In Figure 9 we observe instead the changes in GDP between quarters for each country. Noting that we do, indeed, have quite adequate volatility within these series, which is useful in determining its aptness as a variable in our regressions. To remind ourselves, we do require a certain degree of variance in a series in order for our OLS regressions to be able to make good estimates of the coefficients.

Data Manipulation

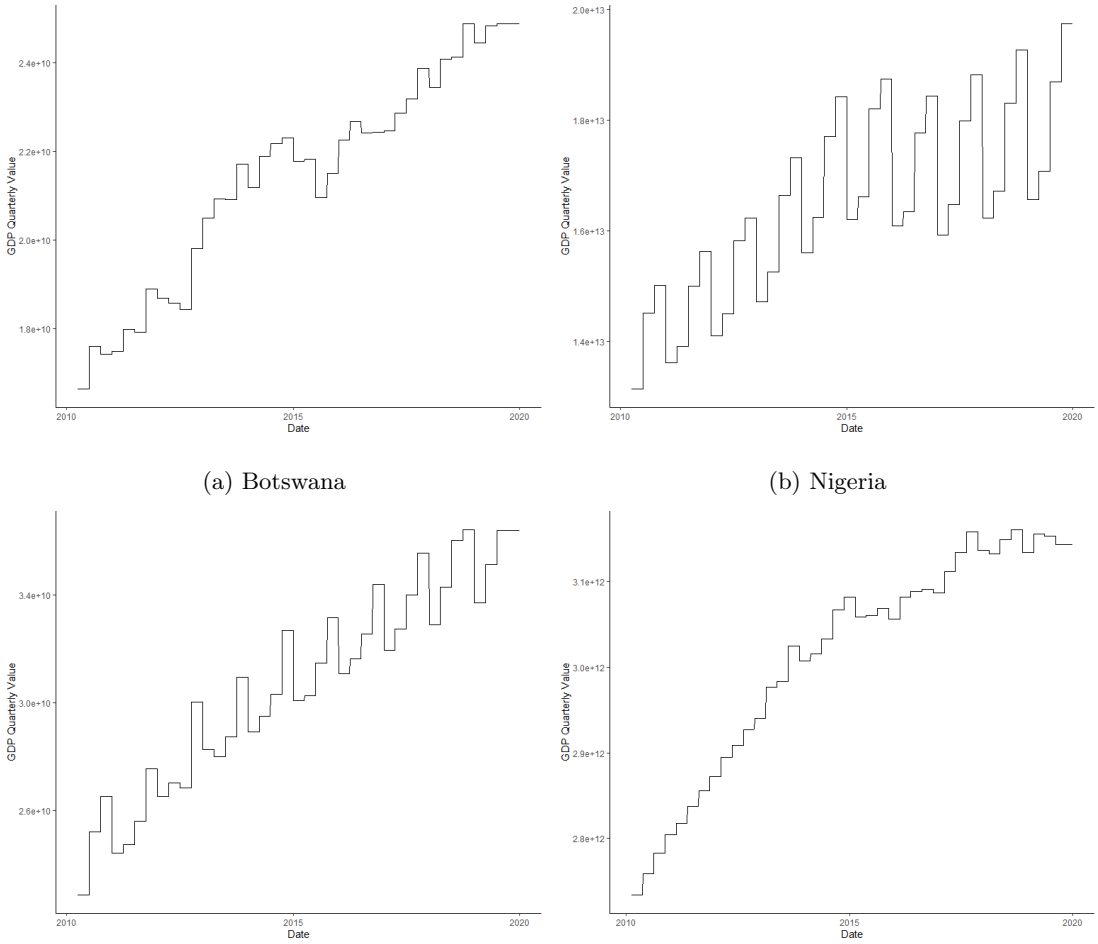
Since we are concerned with changes, observations between 2010-01-01 and the first lagged day with a new GDP report are deleted as the change is zero. When new GDP data is reported on e.g. 31/3, the new change is available from 1/4 as that is when the stock market has had the opportunity to incorporate the new information. I.e. in order to use it as a forecasting tool, we must wait one day. This means that the first observation is available for 2010-04-01 (South Africa 2010-02-16). For the next and all subsequent quarter cut-offs, e.g. 30/6-1/7 2010, the change from the former quarter is used for the first date (t=30/6 uses the Q1/Q2 change although the new GDP value has been reported that day) and t=1/7 uses the Q2/Q3 change. Again, this is in order to use the GDP change as a forecasting variable, since we are doing a forecasting model. Then, updated information that is only available at day t cannot be incorporated in the returns for day t, so there must be a day's lag in each quarter.

Changes in GDP are calculated as simple changes;

$$1 - \frac{GDP_{Q_t}}{GDP_{Q_{t-1}}},$$

whereas exchange rate changes are calculated as log changes;

$$ln(\frac{Exchangerate_t}{Exchangerate_{t-1}}).$$



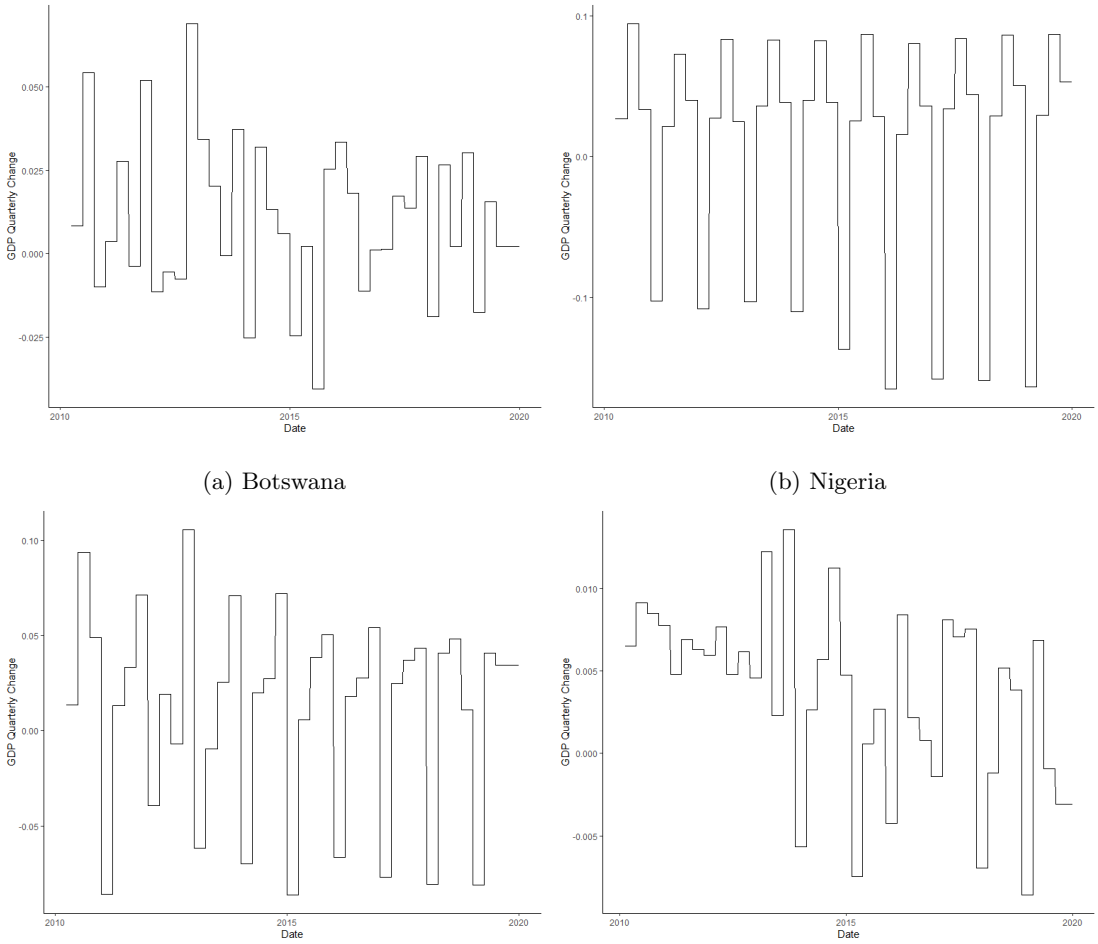
(a) Botswana

(b) Nigeria

(c) Zambia

(d) South Africa

Figure 8: GDP, Quarterly (local currency)



(a) Botswana

(b) Nigeria

(c) Zambia

(d) South Africa

Figure 9: GDP Quarterly Changes

4.4 The Different Data Sets

All nine regression models (Ch 5.2) are run over the three/four countries in each country set I, J respectively, and also the two different Botswanan indices - domestic and foreign, as explained above. Where $I = \{Botswana, Nigeria, Zambia\}$ and $J = \{Botswana, Nigeria, Zambia, South\ Africa\}$. Table 11 provides a summary for all data sets over which the regressions, are run and the number of observations in each, as this differs between sets. Firstly, the regressions are run over the full data set, with and without the macroeconomic variables. When including the GDP changes variable the data set is restricted, as we do not have data on the quarterly change for the first quarter. The number of observations differs between South Africa and the other countries, as the GDP data is available from 2010-02-15 for South Africa and 2010-03-31 for the rest. Additionally, as discussed above Zambia has one less observation in its FX data set as we lack the last observation, 2019-12-31.

Additionally, the full data set (all available dates) is divided into two by two subgroups, Comm(+)/(-) and GSCI(+)/(-). This is discussed further in the next chapter, 5.1 - Dividing the Data Set, but to briefly explain it; commodity returns at $t-1$ are observed and sorted into positive or negative returns. The rest of the variables are then sorted for that date (or the corresponding t) into two data sets. This is done both for the main-export commodities, and the GSCI. For the first six data sets here, Comm(+) to Comm(-); FX, the number of observations differ between countries, and is not available for South Africa. This is because we are using the country-specific commodity, which we do not use for South Africa as it has no clear such commodity. Naturally the number of observations will also differ, since these commodities are not perfectly correlated. Consequently, the number of days for which the commodity return is positive or negative will differ between countries. However, for the last six data sets, GSCI(+) to GSCI(-); FX, the same commodity returns series is used for the division, and so the only differences in number of observations are due to the same reasons as for the full data set.

	Botswana	**Nigeria**	**Zambia**	**South Africa**
Full Set	2606	2606	2606	2606
Full Set; GDP	2543	2543	2543	2575
Full Set; FX	2606	2606	2605	2606
Comm(+)	1189	1311	1270	-
Comm(-)	1294	1260	1253	-
Comm(+); GDP	1160	1278	1237	-
Comm(-); GDP	1260	1230	1223	-
Comm(+); FX	1189	1311	1270	-
Comm(-); FX	1294	1260	1252	-
GSCI(+)	1303	1303	1303	1303
GSCI(-)	1214	1214	1214	1214
GSCI(+); GDP	1273	1273	1273	1292
GSCI(-); GDP	1183	1183	1183	1196
GSCI(+); FX	1303	1303	1303	1303
GSCI(-); FX	1214	1214	1213	1214

Table 11: Summary of All Data Sets, Number of Observations

5 Methodology & Model

This chapter begins with an overview of the theoretical framework used to construct the models and choosing the variables, then followed by a presentation of the models and an explanation of the variables in section 5.2. In the first section we start by explaining the background of forecasting models, as that is the baseline of the models in this thesis. We then proceed to forecasts with commodities, and subsequently to incorporating macroeconomic variables in a forecasting model. In aggregate, this leads us to a set of models which will utilise past stock returns, past commodity returns, lagged changes in exchange rate, and current quarterly change in GDP as its variables. Before presenting the models, there is also a discussion on the division of the data set, which serves to investigate time-variation in results.

5.1 Theoretical Framework of Methodology

Forecasting

One key component of asset pricing is forecasting returns. Differing from other returns models, for example, the CAPM where a long-term expected return is calculated by using a long-term market return, forecasting models use past information to assess expected return today. Intuitively, the simplest model uses the past trading day's return to forecast today's return. Simply speaking, this follows the same logic as that the best guess of the weather tomorrow, barring access to any other information such as a meteorology forecast, is probably that it is going to be the same as today. In finance, as with the weather, however, this forecasting model is not perfect. Considering the returns graphs seen in the Data section above, combined with the confirmed stationarity of the series, we know that the relationship between the past day's return and today's is not going to be perfectly aligned.

The attempt behind forecasting models is then to try to find the variables which helps us making a better forecast of today's return. One of the more famous examples is, perhaps, that of the predictive power of the dividend-price ratio/dividend yield ((Campbell & Shiller, 1988), (Cochrane, 2008), (Fama & French, 1988), (Ang & Bekaert, 2007), and many others). Hjalmarsson (2010), apart from many of the studies which only consider the U.S. market, utilises a set of 40 countries, out of which some are emerging markets (although the only common country to this study is South Africa). Results vary over countries and categories (developed/emerging, etc). However, the dividend-price ratio is not in itself something this thesis covers, rather we take this as an argument of the relevance of developing studies on forecasting, and the need to differentiate between U.S. and other markets.

Forecasting research, however, is not limited to only the dividend-price ratio/dividend yield. Rapach et al (2005) study the forecasting ability of several different macro variables on equity returns in twelve industrialised countries. They find, for example, that for most countries, interest rates are to some extent valuable for forecasting stock returns. While interest rates are quite consistently significant, magnitudes are quite small, which is argued to be in line with equity returns forecasts generally only capturing a small part of movements. Or to say, that stock prices are notoriously difficult to predict (Rapach et al, 2005).

The intent in this study is not primarily to create the overall best forecasting model, but to analyse the role and impact of commodity returns in stock return forecasts of these countries.

Applying this to commodity returns

We have already, in Chapter 2, highlighted the relevance of commodities to economies in Sub-Saharan Africa ((Deaton, 1999), (Deaton & Miller, 1995)) as well as shown that there are multiple studies that find a connection between African and non-African stock markets and commodity returns ((Zaremba, 2015), (Musawa & Mwaanga, 2017), (Boako & Alagidede, 2016)). Thus in this section, the focus is not to argue in favour of including commodity returns as a variable of interest, but rather to highlight other studies which has used commodity returns in specifically forecasting models - to show that this thesis is not alone in doing so - with examples both for Sub-Saharan Africa and elsewhere.

For example, Black et al (2014) take a direct approach with asking the question whether commodity prices are useful for forecasting stock returns. This study, however, is not taking the approach of analysing certain commodities as particularly relevant to a country or its stock market, but rather the general (potential) relationship between commodities and stocks in a portfolio. They primarily focus on assessing commodities' forecasting power in the long-term, where they are connected to future economic performance rather than subject to brief shocks in supply or demand. In this, they use forecasting windows rather than single day returns, which differs from the approach taken in this thesis - again, the underlying motive for using commodity returns as well as the hypothesised reason behind a potential forecasting power also differs between this study and Black et al (2014). Still, it could certainly be argued that studying the long-term impact of export commodity price movements on stock returns in commodity-dependent countries is of high relevance, but this is an area which would need to be left as a suggestion for other studies.

Black et al (2014) applies the same GSCI Total Return index as in this thesis, and the S&P 500 for its stock market index. The model includes the stock price/commodity price ratio, dividend yields (see the section above), short-term interest rates, commodity returns, and stock returns, all lagged with one period. I.e. very similar to the approach in this thesis, with the exception that a stock price/commodity price ratio is included, as is the dividend yield - and a variable which in this thesis would be referred to as a macroeconomic control variable (but in Black et al (2014) rather refers to the use of interest rate as a forecasting variable in prior studies, as with the dividend yield) is interest rate instead of exchange rate changes or GDP changes.

Jordan et al (2016) for example show this outside of the U.S., looking at a large set of commodities and their forecasting power over stock returns in eight different Canadian sectors, and find some evidence for its usefulness in predictions. In another paper, Salisu et al (2019) evaluate a forecasting model of equity returns in the G7 countries using commodity returns as predictors, and in an extension also controlling

for macroeconomic variables, both lagged one day. This study finds significant coefficients on different commodity class returns as well as the macroeconomic indicators, for many of the countries - also outside of the U.S.. Focusing on oil returns, Narayan & Gupta (2015) utilise a 150 year data set (U.S.) and find evidence of its predictive power over stock returns, with improved predictive power in times of negative price shocks to oil.

As is mentioned in this chapter, there are frequent examples of research on correlation, cointegration, and variance measures for commodity and equity returns in Sub-Saharan Africa and other emerging markets. However, literature which applies forecasting models is more scarce. This is however not a major dissuasion for choosing this approach in this thesis. Clearly, as shown above, there are benefits to studying the forecasting power of commodities over stock returns in mature markets, and also for studying the relationship between commodities and equity in Sub-Saharan Africa, and thus combining these two sides, this thesis would argue that it is not controversial in its choice of method, even though research combining this more specific area using this method is not very prevalent.

Incorporating macroeconomic variables

The additional two variables used for the models are quarterly changes in domestic GDP, and daily changes in the exchange rate of the local currency to the U.S. Dollar. They serve primarily two purposes. Firstly, to control for changes in the domestic economy, i.e. comparing the coefficient on (forecasting ability of) commodity returns depending on whether we incorporate any, or both, of these macroeconomic variables in the regression model. Secondly, when we divide the data set into positive and negative commodity returns, to see whether the forecasting ability of either, or both, of these macroeconomic variables changes depending on how commodity prices move.

In deciding to incorporate macroeconomic variables in the model, the first choice was to use GDP. The reason behind this is that it is a stricter indicator of how the domestic economy is doing, unmarred by speculation (as exchange rate) or monetary policy efforts (interest rate and inflation). Of course neither of these are completely detached from one another, if the economy is going poorly, this will likely be reflected in the exchange rate and the monetary policy used to combat this economic slump might include changing the interest rate, and be noticed in the inflation rate. Likewise, if for other reasons than an unexpected GDP change the exchange rate changes drastically, or drastic monetary policy efforts impact the interest rate or inflation rate, this might impact the country's economic ability and thus its GDP. However, compared to other potential variables, changes in GDP more directly captures the economic condition of a country rather than market expectations or effects of policy.

To capture a broader spectrum of the use of macroeconomic indicators as forecasting variables, the choice was made to also include the exchange rate of the local currency to the U.S. dollar. This choice was made for several reasons. Firstly, as the base variables are daily, and thus follow the format of forecasting ability of their returns on $t-1$ for the stock return at t, it was deemed appropriate to include a macroeconomic variable which also experiences daily changes. GDP, for example, is not measured daily, and neither is inflation.

That leaves, primarily, two variables - exchange rate and interest rate. Out of these two, exchange rate has the benefit that apart from potentially being a forecasting variable, it is also directly relevant for the main intended user of the results of this study; the foreign investor. By including it, we are effectively controlling for changes in the exchange rate, since both stock returns and GDP changes are in local currency (except for the Botswanan stock market). Additionally, while exchange rate is often considered to be linked to the interest rate, it is also affected by other expectations. The exchange rate, it could then be argued, is a purer indicator of outside expectations of a country's economic state. This then serves as a stricter contrast to the GDP variable, and together they capture two very different sides of the potential forecasting ability of macroeconomic variables. Interest rate could have been added, and to differentiate further from the exchange rate variable perhaps the official repo rate rather than market rates, as an additional variable. That would mean that we cover both level of economic activity (GDP), market expectations (exchange rate), and monetary policy (repo rate). However, the results are quite extensive as is, and thus it was deemed that adding another variable was slightly out of scope, especially given that studying these variables is not the main purpose of this study.

Examples from the literature on the connection between certain macroeconomic variables and stock returns and/or the economy are abundant, also specifically for different countries in Sub-Saharan Africa. Musawa & Mwaanga (2017) include exchange rate and interest rate when trying to ascertain the relationship between the Copper price and the Zambian stock market. They find a negative effect of the interest rate on the stock price and a positive, but only weakly significant, effect of exchange rate on stock prices. Katusiime (2019) does not study the stock market in their paper on Uganda at all, but rather the relationship between commodity volatility and volatility in the financial sector, specifically the exchange rate to the U.S. Dollar, finding low levels of connection between the two, with increased correlation in their volatility during crisis periods. A paper which specifically argues for the relevance of using exchange rate in relation to commodities is Hegerty (2016), in which the author argues that since commodity exports from a country lead to an influx of foreign currency, the exchange rate should have a direct impact on the value received from the exported commodity.

A paper which, on the other hand, studies the forecasting power of macroeconomic variables on the stock market without including commodities is Buncic & Tishhauser (2017), who use T-bill rates, debt market spreads, and inflation - among other forecasting variables - to predict returns on the U.S. stock market. Another example is Rapach et al (2005), who evaluate the relationship between twelve different industrialised countries and macro variables such as the inflation rate, interest rates and industrial production. Salisu et al (2019), as mentioned in the previous section, also control for macroeconomic variables, including interest rates and inflation.

Other studies which incorporate macroeconomic variables and stock markets in emerging markets, including Sub-Saharan Africa are, for example the previously discussed Adjasi (2009) with his paper on the Ghanan stock market, which includes interest rates and the exchange rates as variables. Furthermore, Ho (2019) studies the relationship between the South African stock market and various macroeconomic variables, including inflation rate, interest rates, and GDP as an indicator for economic growth. Going beyond Sub-Saharan Africa, Fifield et al (2002) studies the relationship between macroeconomic variables and stock returns on a set of twelve, globally diverse, emerging markets (of which South Africa alone is common to this thesis). Macroeconomic variables in this study include inflation rate, exchange rate to U.S. Dollar, and GDP, among others. It also includes oil prices (WTI) but as a global economic variable rather than as a commodity of special relevance to these countries.

Additionally, in Chapter 2 arguments are made for the importance of commodity prices to the economy in Sub-Saharan Africa (Deaton (1999), (Deaton & Miller, 1995), (Hegerty, 2016), (Addison et al, 2015)). These arguments will not be repeated here, but instead the reader may be referred to Chapter 2. However, they do not only function as foundation for the purpose of studying the relationship between commodities and stock markets - as is their main purpose in that chapter - but also, as here, to argue for the relevance in including macroeconomic variables in this thesis' models. They also aid in providing a reasoning for including GDP changes, given that it is much less commonly used as a predictor than the exchange rate in the references literature, as they provide evidence of the connection between export commodity prices and the domestic economy.

Dividing the Data Set

While the regressions are run over thirteen different data sets (four out of nine regressions per data set, see the next section), the main division is of the full data set into the so-called positive and negative returns sets. The data is sorted on whether the country-specific, or general, commodity index has positive or negative returns in a given day $t-1$, and then the regressions are run over this restricted set. The intent behind this is to analyse, primarily, two things; firstly, if coefficients on commodity returns change

depending on whether they are positive or negative. And secondly, if coefficients on the other forecasting variables change depending on whether commodity returns on that corresponding date is positive or negative.

Hypothesize, for example, that for a country stock returns are not directly dependent on commodity returns and thus that variable has no statistically significant forecasting power. However, the impact of the daily FX change differs depending on whether that country's main export commodity experiences a positive or negative return. Not only does this imply that commodity returns are of importance to that country's stock market even if there is no significant coefficient on that variable, but it is also of direct use to an investor who today observes a negative return of a commodity, and with this information has some insight into how the change in exchange rate might affect tomorrow's stock price.

By dividing the data set, then, we enable a broader analysis and a more nuanced understanding of the impact of commodity returns on the stock market in these extremely commodity dependent countries. In order to compare between the different countries, and between the commodity dependent countries and South Africa, this is done also for the general index, GSCI.

This is not something that has, to the author's knowledge been done to any great extent. One example is Narayan & Gupta (2015), who sort oil returns into positive and negative returns and use this to forecast U.S. stock returns, and finding a difference between the two. However, not only is it expected that results will vary due to the differences between the U.S. and the countries in this sample, as well as the difference between the U.S.' economic relationship to oil and these countries' relationship to their main export commodities. This thesis also differs in that its intent is not primarily to create a forecasting model for stock returns, but is rather using this type of model to analyse each country's relationship to movements in commodity prices. That is to say, the relevance of studying the differences on the other forecasting variables between the two data sets. Something that Narayan & Gupta (2015) does not do.

Before proceeding to the model we briefly comment on why this study does not employ a volatility model, as it is frequently used in the reference literature. In short terms, such models - e.g. a GARCH - would not have allowed for incorporating the macroeconomic variables. Especially the GDP variable, as it only changes quarterly, and thus does not have any daily volatility. While the literature exploring the relationship between stocks and commodities using regressions is scarce, forecasting literature is ample and provides a good foundation for which to build the models in this thesis. Taking into account that analysing the coefficient on the commodity variable is only half of the results, the other is the changes in variable coefficients depending on data set, the lack of literature on estimating the commodity and stock

relationship through regressions is deemed less of an issue.

5.2 Regression Models & Variable Explanations

For all subsequent models we have the following; $i \in I$ where $I = \{Botswana, Nigeria, Zambia\}$, and its main commodity export(s): Diamonds, Oil/Natural Gas, and Copper respectively. $j \in J$ refers to a country out of $J = \{Botswana, Nigeria, Zambia, South\ Africa\}$. The regressions over the countries in J are done for a general commodity index, SP GSCI Total Return Index (henceforth GSCI/gen), which is the same for all regressions. The β's are the coefficients for each forecasting variable and will have individual loadings for each i, j. α represents the common intercept for each country i, j and regression model, and $\varepsilon_{i,t}$ / $\varepsilon_{j,t}$ are the estimation errors for each observation.

Both GDP and FX (exchange rate of local currency to U.S. dollar) are specified for each country in I,J. Q refers to the quarter corresponding to the current date t. That is to say, there is no lag of this variable. Due to the large time interval for which the value stays the same, the choice was made to use the current period. As is discussed in the Data section of this thesis, there is, however, a day's lag when the new GDP report is released (each quarter) to allow markets to incorporate this new information. The interpretation then follows as the impact of a change in GDP from last reporting period to the current reporting period (Q). Exchange data (FX) is available on a daily basis and is thus used as change at $t-1$, similarly as for commodities, with the assumption that changes in exchange rates today have forecasting power over the stock market tomorrow.

$$r_{j,t} = \alpha + \beta_1 (r)_{j,t-1} + \varepsilon_{j,t} \tag{1}$$

This first model is the simplest forecasting model, like the weather example discussed above, "the best guess barring any other information is that it is the same as today". We know that this is not the case due to the stationarity of the series; the returns are not constant or close to constant over time. However, it is very possible that there is some forecasting power in the past day's return, especially as we see in the Data section that several of the series have some lag effects. Since we can use the ACFs to determine this, and we have confirmed that coefficient will not be close to one as the series are stationary, running regression (1) is less about testing the actual forecasting ability of the past day's return alone, and more about enabling analysis between how coefficients might change depending on which forecasting variables are included.

Additionally, we cannot expect that commodity returns, alone or combined with a macroeconomic variable, are a perfect forecasting variable of returns. The question in this thesis is rather whether it has

an impact. Thus, we want to include a standard forecasting variable, where using the lagged return is supported e.g. by Rapach et al (2005).

Regression model (1) is run over all four countries in J, for each date t between 2010-01-04 and 2019-12-30 (T).

$$r_{i,t} = \alpha + \beta_1 (r)_{i,t-1} + \beta_2 (comm)_{i,t-1} + \varepsilon_{i,t} \tag{2}$$

Continuing we have regression models (2) through (5), which are run over the three countries $i \in I$, including the two separate indices for Botswana. Regression model (2) includes as additional variable only the commodity returns, lagged. Regression models (3) and (4) includes the quarterly change in GDP (GDP) and exchange rate (FX) variable additional to the commodity variable, respectively. And finally regression model (5) includes both GDP and FX as forecasting variables, additional to the commodity variable. The regression for models (2) and (4) is run over the full data set, T (model (4) stops at 2019-12-27 for Zambia), whereas regressions for models (3) and (5) go over 2010-04-01 through 2019-12-30 (model (5) also stops at 2019-12-27 for Zambia).

$$r_{i,t} = \alpha + \beta_1 (r)_{i,t-1} + \beta_2 (comm)_{i,t-1} + \beta_3 (GDP)_{i,Q} + \varepsilon_{i,t} \tag{3}$$

$$r_{i,t} = \alpha + \beta_1 (r)_{i,t-1} + \beta_2 (comm)_{i,t-1} + \beta_3 (FX)_{i,t-1} + \varepsilon_{i,t} \tag{4}$$

$$r_{i,t} = \alpha + \beta_1 (r)_{i,t-1} + \beta_2 (comm)_{i,t-1} + \beta_3 (GDP)_{i,Q} + \beta_4 (FX)_{i,t-1} + \varepsilon_{i,t} \tag{5}$$

Regression models (6), (7), (8), and (9) are used for the $j \in J$ countries, i.e. including South Africa, and again also for the two additional indices for Botswana. The only difference in the model specifications is that the individual commodity variable is switched to the general index GSCI. Apart from this, the same structure is applied, with the only difference being that for models (7) and (9) the time frame for South Africa differs, as the data set starts at 2010-02-16 instead of 2010-04-01.

$$r_{j,t} = \alpha + \beta_1 (r)_{j,t-1} + \beta_2 (gen)_{t-1} + \varepsilon_{j,t} \tag{6}$$

$$r_{j,t} = \alpha + \beta_1 (r)_{j,t-1} + \beta_2 (gen)_{t-1} + \beta_3 (GDP)_{j,Q} + \varepsilon_{j,t} \tag{7}$$

$$r_{j,t} = \alpha + \beta_1 (r)_{j,t-1} + \beta_2 (gen)_{t-1} + \beta_3 (FX)_{j,t-1} + \varepsilon_{j,t} \tag{8}$$

$$r_{j,t} = \alpha + \beta_1 (r)_{j,t-1} + \beta_2 (gen)_{t-1} + \beta_3 (GDP)_{j,Q} + \beta_4 (FX)_{j,t-1} + \varepsilon_{j,t} \tag{9}$$

6 Results

The Results chapter is divided into four main sections. First, we present and discuss regressions over the full data sets, using the country-specific commodities. Next, we divide the data set into the positive and negative commodity returns. The third section switches over to the general commodity index SP GSCI Total Return and is split into three subsections for the full data set, and the two divided data sets. The fourth and last section applies all nine regression models over all data sets, i.e. replicating all results from sections one through three, on the separate Foreign and Domestic stock indices from Botswana, in two subsections. The three first sections has one table per (sub)section, and the fourth section has two tables per subsection.

In each table, we will see the country on the right side, with the results for each regression in that section below, indicated by the model number. Each column represents a coefficient, where "-" indicates that this variable was not included in the regression. Regression coefficients are presented on top, with the corresponding p-value in cursive below. A majority of the regressions present heteroscedasticity in the data, and thus White-Robust Standard Errors are applied to control for this. Those p-values are indicated within the parenthesis next to the unadjusted p-value. Each coefficient for which the adjusted p-value (where applicable) is below 10% is marked with a (*).

Coefficients should be interpreted as to what percentage the stock return today is forecasted by the return/change of that variable. I.e. a coefficient of X implies that the stock return today follows the return/change from yesterday of a given variable by X% of that variable's return/change.

6.1 Country-specific Commodity: Full Data set

Results for this section are presented in Table 12. The only statistically significant results of this table is the coefficient on past returns for the Nigerian stock index. There, on the other hand, we find a forecasting power which is both strongly statistically significant (p-value approaching zero) and highly economically significant, with the past day's return predicting nearly a third of today's stock return. The coefficient changes slightly, by 0.002, when including the GDP change variable (models (3) and (5)), but the GDP change variable itself is decidedly not useful for forecasting, with an estimated coefficient of 0.000 and p-values approaching one. Perhaps more notably than that the coefficient value changes slightly when including the GDP change variable, is that it does not change between models (1) and (2), i.e. that including the commodity return variable does not have an impact on the coefficient value.

The key result from this first regression set is then that returns of the country-specific commodity is not an appropriate forecasting indicator for stock returns in a non-restricted data set.

Table 12: Regression Results

Full Data Set, Countries *I*. Country-specific Commodity.

	α	$\beta_{r_{t-1}}$	$\beta_{comm_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(1)	0.000	-0.053	-	-	-
	0.753 (0.751)	*0.007 (0.577)*	-	-	-
(2)	0.000	-0.053	-0.001	-	-
	0.754 (0.751)	*0.007 (0.576)*	*0.654 (0.491)*	-	-
(3)	-0.000	-0.070	-0.001	0.003	-
	0.701 (0.716)	*0.000 (0.466)*	*0.566 (0.381)*	*0.214 (0.202)*	-
(4)	0.000	-0.053	-0.001	-	-0.006
	0.740 (0.739)	*0.007 (0.576)*	*0.669 (0.509)*	-	*0.513 (0.458)*
(5)	-0.000	-0.070	-0.001	0.003	-0.006
	0.716 (0.732)	*0.000 (0.466)*	*0.570 (0.384)*	*0.217 (0.207)*	*0.528 (0.489)*
Nigeria					
(1)	0.000	0.303*	-	-	-
	0.719 (0.719)	*0.000 (0.000)*	-	-	-
(2)	0.000	0.304*	-0.013	-	-
	0.725 (0.725)	*0.000 (0.000)*	*0.178 (0.225)*	-	-
(3)	0.000	0.301*	-0.013	-0.000	-
	0.983 (0.983)	*0.000 (0.000)*	*0.241 (0.292)*	*0.973 (0.975)*	-
(4)	0.000	0.304*	-0.013	-	-0.000
	0.725 (0.723)	*0.000 (0.000)*	*0.178 (0.225)*	-	*0.987 (0.995)*
(5)	0.000	0.301*	-0.013	-0.000	-0.001
	0.982 (0.982)	*0.000 (0.000)*	*0.241 (0.292)*	*0.974 (0.975)*	*0.974 (0.991)*
Zambia					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(2)	0.000	-0.023	-0.013	-	-
	0.271 ()	*0.245 ()*	*0.231 ()*	-	-
(3)	0.000	-0.033	-0.011	-0.004	-
	0.177 ()	*0.101 ()*	*0.319 ()*	*0.157 ()*	-
(4)	0.000	-0.023	-0.013	-	-0.014
	0.288 ()	*0.250 ()*	*0.250 ()*	-	*0.356 ()*
(5)	0.000	-0.033	-0.011	-0.004	0.012
	0.188 ()	*0.103 ()*	*0.341 ()*	*0.156 ()*	*0.422 ()*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.2 Country-specific Commodity: Sorted on Commodity Price Movements

For this section, commodity returns have been sorted as positive or negative. For the results in Table 13, that implies that the dependent variable is returns on day t, where the corresponding commodity return on date $t-1$ is strictly positive (>0). Likewise, for the results in Table 14, the corresponding commodity returns on date $t-1$ are strictly negative. As discussed in Chapter 5, this allows for analysing whether the coefficients that we found in Table 12 changes depending on whether the most economically relevant commodity to this country experiences a positive or negative return in the forecasting day $(t-1)$.

Starting with Table 13, we now see that while the past day's stock return remains not significant for Botswana, the quarterly change in GDP is now a significant variable with a positive coefficient. While the coefficient is economically quite small, the evidence seen here clearly indicates that specifically when diamond prices go up, an investor can expect that, ceteris paribus, the Botswanan stock market will move slightly in accordance with whether GDP rose or decreased from the last quarter.

Turning to Nigeria, the coefficient on past stock return remains strongly statistically and economically significant. Returns today seem to follow the past day's return at an even slightly higher magnitude. Additionally, the exchange rate to the U.S. Dollar is not only strongly statistically significant, but also of a sizeable magnitude. That is to say, on days when Oil & Natural Gas increases in price, the next day's returns can be expected to be influenced by movements in the exchange rate.

For Zambia we still see no statistical significance in the variables. For both Botswana and Nigeria, however, these results indicate that investors on aggregate take macroeconomic variables into account specifically when the country's most exported commodity experiences a price increase.

Continuing with Table 14, where the data set only includes dates connected to a negative commodity return. For Botswana we still see that depending on commodity price movements, macroeconomic variables appear to be of importance to investors. However, as opposed to the result in Table 13 (with positive price movements), it is now the exchange rate variable which is significant. Additionally, the relationship is negative, implying that on days when Diamonds experience a price decrease, the average investor in the Botswanan market adjusts their expectations for the next date to be somewhat adversely connected to the change in the exchange rate.

For Nigeria, the past day's stock returns remain statistically and economically significant, at approximately the same levels as coefficient levels for the full data set for the first two regressions, models (2) & (3). Perhaps more interestingly, as with the results in Table 13, the exchange rate change is statistically significant and now of a rather large magnitude. The implication is that an investor, noting a negative

Table 13: Regression Results

Sorted on commodity returns; positive returns. Countries *I*. Country-specific Commodity.

	α	$\beta_{r_{t-1}}$	$\beta_{comm_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(2)	0.000	-0.066	-0.002	-	-
	0.740 (0.749)	*0.005 (0.601)*	*0.519 (0.299)*	-	-
(3)	-0.000	-0.088	0.002	0.005*	-
	0.380 (0.414)	*0.000 (0.490)*	*0.610 (0.393)*	*0.160 (0.079)*	-
(4)	-0.000	-0.067	0.002	-	0.011
	0.729 (0.739)	*0.005 (0.600)*	*0.538 (0.320)*	-	*0.356 (0.316)*
(5)	-0.000	-0.089	0.002	0.005*	0.011
	0.377 (0.739)	*0.000 (0.413)*	*0.616 (0.490)*	*0.168 (0.081)*	*0.383 (0.362)*
Nigeria					
(2)	-0.001	0.314*	0.011	-	-
	0.114 ()	*0.000 ()*	*0.547 ()*	-	-
(3)	-0.001	0.311*	0.013	0.001	-
	0.081 ()	*0.000 ()*	*0.509 ()*	*0.648 ()*	-
(4)	-0.000	0.316*	0.010	-	0.065*
	0.114 ()	*0.000 ()*	*0.614 ()*	-	*0.016 ()*
(5)	-0.001*	0.313*	0.011	0.001	0.065*
	0.082 (0.142)	*0.000 (0.000)*	*0.577 (0.479)*	*0.696 (0.776)*	*0.016 (0.002)*
Zambia					
(2)	0.000	0.042	-0.020	-	-
	0.337 ()	*0.132 ()*	*0.425 ()*	-	-
(3)	0.000	0.034	-0.008	-0.005	-
	0.515 ()	*0.225 ()*	*0.735 ()*	*0.236 ()*	-
(4)	0.000	0.042	-0.019	-	0.001
	0.345 ()	*0.129 ()*	*0.438 ()*	-	*0.565 ()*
(5)	0.000	0.034	-0.008	-0.005	0.012
	0.525 ()	*0.222 ()*	*0.751 ()*	*0.240 ()*	*0.590 ()*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

return for Oil & Natural Gas, should expect the next day's stock price to move, to the extent of about 16% of this day's exchange rate change, in the opposite direction.

Continuing on to Zambia, we now see some statistically significant results. While the economical magnitude is smaller than that for Nigeria, we still observe evidence for a sizeable forecasting power of the past day's return. That is to say, on days when the Copper price goes down, the subsequent trading day's stock price should move about a tenth in the opposite direction of today's stock return. Not only do we see a negative coefficient, indicating quite the opposite of the idea that the weather today will be the same as yesterday's. But, and perhaps more interestingly, as is evident in comparing Table 14 to Tables 12 & 13, the forecasting power of past stock return is only present when Copper prices are moving downward. Indicating that commodity price movements do have importance for forecasting stock returns, even if the coefficient on Copper returns itself is not significant.

Table 14: Regression Results

Sorted on commodity returns; negative returns. Countries *I*. Country-specific Commodity.

	α	$\beta_{r_{t-1}}$	$\beta_{comm_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(2)	0.000	-0.040	-0.004	-	-
	0.952 (0.948)	*0.282 (0.801)*	*0.369 (0.160)*	-	-
(3)	-0.000	-0.052	-0.004	0.002	-
	0.857 (0.848)	*0.167 (0.758)*	*0.375 (0.164)*	*0.578 (0.589)*	-
(4)	0.000	-0.040	-0.004	-	-0.022*
	0.917 (0.909)	*0.270 (0.804)*	*0.394 (0.177)*	-	*0.098 (0.047)*
(5)	-0.000	-0.054	-0.004	0.002	-0.022*
	0.914 (0.910)	*0.156 (0.751)*	*0.386 (0.172)*	*0.641 (0.656)*	*0.112 (0.065)*
Nigeria					
(2)	0.000	0.303*	-0.001	-	-
	0.264 (0.242)	*0.000 (0.000)*	*0.975 (0.977)*	-	-
(3)	0.000	0.301*	0.002	-0.001	-
	0.306 (0.285)	*0.000 (0.000)*	*0.909 (0.916)*	*0.645 (0.656)*	-
(4)	0.000	0.306*	-0.005	-	-0.161*
	0.260 (0.242)	*0.000 (0.000)*	*0.809 (0.825)*	-	*0.000 (0.001)*
(5)	0.000	0.305*	-0.002	-0.002	-0.164*
	0.300 (0.282)	*0.000 (0.000)*	*0.922 (0.928)*	*0.629 (0.640)*	*0.000 (0.001)*
Zambia					
(2)	-0.000	-0.092	-0.032	-	-
	0.601 (0.645)	*0.000 (0.020)*	*0.135 (0.317)*	-	-
(3)	0.000	-0.108*	-0.021	-0.005	-
	0.854 (0.870)	*0.000 (0.008)*	*0.319 (0.491)*	*0.215 (0.236)*	-
(4)	-0.000	-0.092*	-0.032	-	-0.012
	0.587 (0.634)	*0.001 (0.020)*	*0.240 (0.322)*	-	*0.530 (0.409)*
(5)	0.000	-0.108*	-0.021	-0.005	0.009
	0.865 (0.879)	*0.000 (0.008)*	*0.326 (0.496)*	*0.211 (0.232)*	*0.638 (0.523)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.3 General Commodity Index, incl. South Africa

For this section, the country-specific commodity variable is switched to a common variable - the SP GSCI Commodity Total Return Index. This allows for several different additional layers to the analysis; differences between using a country-specific commodity to a general index, differences between and within countries in exposure to commodities in general, and differences between the three heavily commodity-dependent countries used thus far to a geographically close but not commodity dependent country (South Africa).

The same three data set divisions are used. Firstly, in Table 15 regressions are run over the full data set for each country. In Table 16, the data set is restricted to dates for which the GSCI on $t-1$ is strictly positive. Lastly, in Table 17, the data set is similarly restricted to those dates t for which the GSCI on $t-1$ is strictly negative. Results are, as in sections 6.1. and 6.2 presented per country, and the tables should be read as in those sections.

6.3.1 Full Data Set

Table 15 presents the results of the full data set. We see essentially the same results as in 6.1, with Nigerian past stock returns being the only statistically significant variable, and the economical magnitude of that variable being roughly equal to that of the results in 6.1 (Table 12). Thus the evidence does not support that the GSCI, as the country-specific commodities, is an appropriate predictor of stock returns. Nor does it support that the combined prospect of commodity financialisation and increased global market integration for these countries would lead to a significant relationship between stock returns and general commodity returns.

Table 15: Regression Results

Full Data Set, Countries *J*. SP GSCI Total Return Index.

	α	$\beta_{r_{t-1}}$	$\beta_{gen_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(1)	0.000	-0.053	-	-	-
	0.753 (0.751)	*0.007 (0.577)*	-	-	-
(6)	0.000	-0.053	-0.008	-	-
	0.779 (0.778)	*0.007 (0.578)*	*0.073 (0.194)*	-	-
(7)	-0.000	-0.070	-0.010	0.003	-
	0.674 (0.691)	*0.000 (0.468)*	*0.044 (0.146)*	*0.021 (0.198)*	-
(8)	0.000	-0.052	-0.010	-	-0.010
	0.759 (0.758)	*0.007 (0.579)*	*0.044 (0.154)*	-	*0.258 (0.226)*
(9)	-0.000	-0.070	-0.011	0.003	-0.011
	0.697 (0.714)	*0.000 (0.468)*	*0.026 (0.117)*	*0.216 (0.204)*	*0.253 (0.237)*
Nigeria					
(1)	0.000	0.303*	-	-	-
	0.719 (0.719)	*0.000 (0.000)*	-	-	-
(6)	0.000	0.304*	-0.022	-	-
	0.741 (0.741)	*0.000 (0.000)*	*0.133 (0.167)*	-	-
(7)	0.000	0.303*	-0.023	-0.000	-
	0.996 (0.996)	*0.000 (0.000)*	*0.222 (0.260)*	*0.980 (0.981)*	-
(8)	0.000	0.303*	-0.023	-	0.000
	0.741 (0.739)	*0.000 (0.000)*	*0.133 (0.167)*	-	*0.983 (0.994)*
(9)	0.000	0.301*	-0.019	-0.000	-0.001
	0.995 (0.995)	*0.000 (0.000)*	*0.222 (0.260)*	*0.980 (0.981)*	*0.971 (0.990)*
Zambia					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(6)	0.000	-0.023	-0.003	-	-
	0.266 ()	*0.245 ()*	*0.810 ()*	-	-
(7)	0.000	-0.032	0.002	-0.004	-
	0.173 ()	*0.103 ()*	*0.885 ()*	*0.154 ()*	-
(8)	0.000	-0.023	0.003	-	0.015
	0.285 ()	*0.250 ()*	*0.784 ()*	-	*0.322 ()*
(9)	0.000	-0.032	0.002	-0.004	0.013
	0.184 ()	*0.106 ()*	*0.862 ()*	*0.153 ()*	*0.390 ()*
South Africa					
(1)	0.000	-0.010	-	-	-
	0.118(0.117)	*0.601(0.660)*	-	-	-
(6)	0.000	-0.020	-0.022	-	-
	0.109 (0.107)	*0.340 (0.417)*	*0.176 (0.214)*	-	-
(7)	0.000	-0.022	0.020	0.020	-
	0.283 (0.285)	*0.305 (0.383*	*0.226 (0.266)*	*0.559 (0.543)*	-
(8)	0.000	-0.017	0.026	-	0.015
	0.114 (0.112)	*0.422 (0.487)*	*0.133 (0.166)*	-	*0.454 (0.487*
(9)	0.000	-0.019	0.023	0.019	0.015
	0.287 (0.289)	*0.381 (0.448)*	*0.174 (0.209)*	*0.569 (0.553)*	*0.463 (0.496)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.3.2 Positive Commodity Returns

Turning to Table 16, and the data set where we have sorted on positive GSCI returns. Note that, unlike the results in 6.2 (Tables 13 & 14), the data set is now the same for all countries - apart from the slight differences with regards to the GDP and FX data as discussed in the Data section. Here we have the first result where the commodity variable has a statistically significant forecasting power for stock returns, in Botswana model (9). The effect is quite small, around 3% of the change in price of the GSCI in a day translates, adversely, to the next day's stock return, but only when controlling for both GDP changes and FX changes. It has, however, a p-value of 10.3% for model (7), when including only GDP changes. It should also be noted that while the coefficient on FX changes in model (9) is as well not by definition statistically significant, but when using Robust Standard Errors the p-value is 10.4%, so very close to our cutoff at 10%. Apart from this, for Botswana we see similar results for section 6.2 with regards to GDP, albeit slightly stronger coefficients. However, changes in FX were only statistically significant for the negative commodity returns data set when we used Diamonds as the commodity variable, and now we instead see a decently sized, negative but significant, forecasting power for FX changes in the positive commodity returns data set. Taking into account that FX changes are close to significant also in model (9), we suddenly have a forecasting model which tells us today's stock returns are forecasted by GSCI returns, GDP changes, and changes in exchange rate - but only in those days where the GSCI experiences positive returns.

For Nigeria we see, similarly to Table 13, that the economical magnitude of the past day's stock return increases, and that changes in exchange rate has a positive forecasting power over stock returns. Zambia remains without any significant results, and South Africa only has a small negative forecasting effect of the past day's return. Similarly to what occurred with Zambia for the results in Table 14, with negative Copper returns. While the forecasting power of the past stock returns is not in any way large, it is noteworthy that it occurs not for the complete data set, but only when the GSCI increases in value on a given day. And especially that it is occurring for South Africa, which is the only formally not commodity dependent country in this study.

Table 16: Regression Results

Sorted on commodity returns; positive returns. Countries J. SP GSCI Total Return Index.

	α	$\beta_{r_{t-1}}$	$\beta_{gen_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(1)	0.000	-0.053	-	-	-
	0.753 (0.751)	*0.007 (0.577)*	-	-	-
(6)	0.000	-0.0515	-0.028	-	-
	0.117 (0.179)	*0.067 (0.695)*	*0.050 (0.170)*	-	-
(7)	0.000	-0.061	-0.028	0.008*	-
	0.275 (0.295)	*0.033 (0.646)*	*0.023 (0.103)*	*0.066 (0.044)*	-
(8)	0.000	-0.052	-0.025	-	-0.020*
	0.124 (0.187)	*0.067 (0.694)*	*0.035 (0.140)*	-	*0.165 (0.057)*
(9)	0.000	-0.061	-0.029*	0.007*	-0.019
	0.280 (0.300)	*0.032 (0.646)*	*0.016 (0.085)*	*0.072 (0.049)*	*0.214 (0.104)*
Nigeria					
(1)	0.000	0.303*	-	-	-
	0.719 (0.719)	*0.000 (0.000)*	-	-	-
(6)	-0.000	0.320*	0.011	-	-
	0.471 ()	*0.000 ()*	*0.739 ()*	-	-
(7)	-0.000	0.318*	0.012	0.000	-
	0.423 ()	*0.000 ()*	*0.720 ()*	*0.997 ()*	-
(8)	-0.000	0.325*	0.006	-	0.077*
	0.493 ()	*0.000 ()*	*0.846 ()*	-	*0.005 ()*
(9)	-0.000	0.322*	0.007	-0.000	0.077*
	0.445 ()	*0.000 ()*	*0.826 ()*	*0.965 ()*	*0.005 ()*
Zambia					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(6)	-0.000	0.011	0.011	-	-
	0.697 (0.673)	*0.706 (0.873)*	*0.691 (0.628)*	-	-
(7)	-0.000	-0.007	0.010	-0.003	-
	0.727 (0.698)	*0.802 (0.918*	*0.712 (0.656)*	*0.539 (0.543)*	-
(8)	-0.000	0.011	0.011	-	0.015
	0.688 (0.666)	*0.702 (0.871*	*0.690 (0.626)*	-	*0.514 (0.429)*
(9)	-0.000	-0.007	0.010	-0.003	0.018
	0.717 (0.688)	*0.804 (0.918*	*0.710 (0.654)*	*0.542 (0.545)*	*0.418 (0.333)*
South Africa					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(6)	0.000	-0.080	-0.001	-	-
	0.230 (0.224)	*0.007 (0.023*	*0.977 (0.979)*	-	-
(7)	0.000	-0.080*	-0.005	-0.004	-
	0.244 (0.248)	*0.007 (0.024)*	*0.891 (0.900)*	*0.938 (0.937)*	-
(8)	0.000	-0.073*	0.004	-	0.038
	0.211 (0.203)	*0.015 (0.038)*	*0.890 (0.900)*	-	*0.175 (0.191)*
(9)	0.000	-0.073*	0.001	-0.005	0.038
	0.222 (0.223)	*0.015 (0.040)*	*0.978 (0.980)*	*0.919 (0.919)*	*0.174 (0.191)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.3.3 Negative Commodity Returns

In Table 17 we find the results for the regressions where we have sorted on negative GSCI returns. Interestingly, we find that all statistically significant results for Botswana in Table 16 has disappeared. It appears, then, that our model works for Botswana only when the GSCI experiences positive returns. Turning to Nigeria, however, not only does the past stock return and exchange rate change follow closely to the results in Table 13 (using Oil & Natural Gas), we now have that the GSCI variable is statistically significant for all models including for GDP change, FX change, or both. The effect is sizeable, while not as large as the other coefficients, implying that a day's stock return will follow - in adverse direction - approx. 6-7% of the change in the GSCI of the prior day. Again, however, only on days where the GSCI price went down.

For Zambia we now also see a completely new result, namely that the GDP change coefficient is statistically significant and implies a small negative relationship between stock returns and GDP change. We also have a statistically significant intercept for model (9), but at a quite small magnitude. Turning to South Africa, we also have some small, but significant, intercepts. However, more interestingly the GSCI variable is significant for all models, including when we do not include any of the macroeconomic variables. The effect is, as before, not massive, but we still see a forecasting power of about 7%, which is - in terms of forecasting stock returns - a quite decent size. As has been mentioned before, the interesting aspect is here is not only that the variable itself is statistically significant, but also that it only is so for this data set - i.e. on those days that the GSCI has a negative return. So, while South Africa is not per se commodity dependent as a nation, on days where commodity prices in general tend to go down, the stock market follows to some extent in its actions the next day. For interpretation here, note that the positive coefficient on these strictly negative GSCI returns implies that stock returns in South Africa go down by 7% of the value of the decrease in GSCI.

Table 17: Regression Results

Sorted on commodity returns; negative returns. Countries J. SP GSCI Total Return Index.

	α	$\beta_{r_{t-1}}$	$\beta_{gen_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Botswana					
(1)	0.000	-0.053	-	-	-
	0.753 (0.751)	*0.007 (0.577)*	-	-	-
(6)	-0.000	-0.059	-0.015	-	-
	0.251 (0.369)	*0.033 (0.646)*	*0.075 (0.270)*	-	-
(7)	-0.000	-0.091	-0.013	-0.002	-
	0.461 (0.549)	*0.001 (0.489)*	*0.128 (0.378)*	*0.608 (0.633)*	-
(8)	-0.000	-0.059	-0.015	-	0.001
	0.252 (0.370)	*0.033 (0.646*	*0.085 (0.326)*	-	*0.930 (0.942)*
(9)	-0.000	-0.091	-0.013	-0.002	0.000
	0.461 (0.548)	*0.001 (0.488)*	*0.135 (0.398)*	*0.609 (0.632)*	*0.988 (0.991)*
Nigeria					
(1)	0.000	0.303*	-	-	-
	0.719 (0.719)	*0.000 (0.000)*	-	-	-
(6)	-0.000	0.284*	-0.063	-	-
	0.243 (0.226)	*0.000 (0.000)*	*0.038 (0.049)*	-	-
(7)	-0.000	0.281*	-0.057*	0.001	-
	0.202 (0.188)	*0.000 (0.000)*	*0.065 (0.078)*	*0.857 (0.867)*	-
(8)	-0.000	0.291*	-0.068*	-	-0.156*
	0.259 (0.247)	*0.000 (0.000)*	*0.024 (0.034)*	-	*0.000 (0.001)*
(9)	-0.000	0.287*	-0.062*	0.001	-0.158*
	0.213 (0.205)	*0.000 (0.000)*	*0.041 (0.054)*	*0.840 (0.851)*	*0.000 (0.001)*
Zambia					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(6)	0.001	-0.050	0.035	-	-
	0.074 (0.101)	*0.063 (0.359*	*0.155 (0.274)*	-	-
(7)	0.001	-0.054	0.036	-0.008*	-
	0.032 (0.050)	*0.049 (0.345*	*0.139 (0.263)*	*0.064 (0.068)*	-
(8)	0.001	-0.050	0.036	-	0.011
	0.075 (0.101)	*0.065 (0.362)*	*0.148 (0.266)*	-	*0.586 (0.464)*
(9)	0.001*	-0.054	0.037	-0.008*	0.006
	0.032 (0.017)	*0.050 (0.447)*	*0.136 (0.109)*	*0.064 (0.064)*	*0.746 (0.742)*
South Africa					
(1)	0.000	-0.023	-	-	-
	0.268()	*0.246()*	-	-	-
(6)	0.001*	0.023	0.074*	-	-
	0.017 ()	*0.450 (*	*0.027 ()*	-	-
(7)	0.001	0.021	0.069*	0.070	-
	0.142 ()	*0.497 ()*	*0.043 ()*	*0.176 ()*	-
(8)	0.001*	0.022	0.073*	-	-0.003
	0.017 ()	*0.468 ()*	*0.033 ()*	-	*0.926 ()*
(9)	0.001	0.020	0.067*	0.070	-0.005
	0.142 ()	*0.524 ()*	*0.052 ()*	*0.175 ()*	*0.874 ()*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.4 Botswana; Foreign vs Domestic

In this section, we look at results when applying the regressions separately to the Foreign and Domestic sub-index of the Botswanan stock index. This is discussed in more detail in the Data section, but to briefly recap; companies included in the Foreign index are also listed outside of Botswana, and companies included in the Domestic index are only listed in Botswana. Tables are designed slightly differently for these results. There are two tables each for regressions over the Diamonds index and the GSCI respectively. One of these covers the full data set, and the other the split between positive and negative commodity returns. The only difference in structure within each table is that we first see the data set specified, then followed by each sub-index for which each different regression is on each row, specified by the regression model number.

6.4.1 Country-Specific Commodity

Already in Table 18 we note a difference from Table 12, where we looked at the full Botswanan stock market. Changes in GDP is statistically significant for both the Foreign and the Domestic sub-index, with a value of +/- 0.005, quite clearly explaining why the variable would not be significant for the full data set. That is to say, the Foreign sub-index of the Botswanan stock market sees its returns forecasted to move slightly in accordance with quarterly changes in GDP, and the Domestic sub-index sees its returns forecasted to move slightly in the opposite direction to GDP changes. No other variables are significant, and GDP change alone is not the main variable of interest in this study, but this result confirms the value of considering different characteristics of the companies listed on the stock exchange. If nothing else, then, this serves as an argument for the relevance of future research which controls for differences between listed companies in the countries studied.

In Table 19 we observe the results as split between positive and negative returns on Diamonds. Interestingly, the effect we saw in Table 18 for the coefficient on GDP changes appears to belong to the days with positive returns for the Foreign index, and the days with negative returns for the Domestic sub-index. The coefficients are also slightly stronger in magnitude, especially for the Domestic index. Thus we can say that also in terms of the relationship between stock markets and commodities, there is relevance to studying more deeply the importance of which companies the stock market consists of. Building on that, we now find that for the Foreign sub-index, on days with negative Diamonds returns, the coefficient on Diamonds is statistically significant for all different models.

Interestingly, the coefficient changes from positive to negative when we start controlling for macroeconomic variables. Still, the main takeaway here must be the change from using the full Botswanan index,

Table 18: Regression Results

Botswana, Foreign vs Domestic. Commodity: Diamonds

	α	$\beta_{r_{t-1}}$	$\beta_{comm_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Full Data Set					
Foreign					
(1)	0.000	-0.051	-	-	-
	0.836 (0.835)	*0.010 (0.598)*	-	-	-
(2)	0.000	-0.051	-0.002	-	-
	0.837 (0.836)	*0.009 (0.597)*	*0.572 (0.390)*	-	-
(3)	-0.000	-0.070	-0.002	0.005*	-
	0.493 (0.522)	*0.000 (0.474)*	*0.480 (0.287)*	*0.089 (0.083)*	-
(4)	0.000	-0.051	-0.002	-	-0.005
	0.827 (0.827)	*0.009 (0.597)*	*0.582 (0.400)*	-	*0.644 (0.601)*
(5)	-0.000	-0.070	-0.002	0.005*	-0.005
	0.501 (0.533)	*0.000 (0.475)*	*0.482 (0.289)*	*0.090 (0.085)*	*0.666 (0.638)*
Domestic					
(1)	0.000	0.063	-	-	-
	0.590 (0.579)	*0.001 (0.414)*	-	-	-
(2)	0.000	0.063	0.001	-	-
	0.590 (0.578)	*0.001 (0.414)*	*0.609 (0.406)*	-	-
(3)	0.000	0.062	0.002	-0.005*	-
	0.241 (0.160)	*0.002 (0.421)*	*0.590 (0.386)*	*0.116 (0.058)*	-
(4)	0.000	0.063	0.002	-	-0.009
	0.572 (0.565)	*0.001 (0.414)*	*0.588 (0.386)*	-	*0.332 (0.325)*
(5)	0.000	0.062	0.002	-0.005*	-0.010
	0.230 (0.159)	*0.002 (0.421)*	*0.584 (0.380)*	*0.113 (0.056)*	*0.318 (0.321)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

in where the Diamonds variable is not significant for any regression, regardless of data set or regression model. This can perhaps be explained by the fact that, although not significant, the coefficient values of the Domestic sub-index match up almost perfectly in economic magnitude, but with the opposite sign. However, the evidence remains as is, that for the Foreign sub-index on days with negative price movements for Diamonds, their return have forecasting power over stock returns. Here we then have indication that not only does the relationship between our different forecasting variables and the stock market change depending on price movements of the commodity (as has been shown throughout this chapter), but there are also parts of the stock market for which we can say that country-specific commodity prices has a direct forecasting power over stock returns. For interpretation, note that the negative sign on this coefficient for a variable that is - for this data set - strictly negative, it implies that returns are forecasted to increase with 0.7% of the value of the negative return Diamonds experienced.

Apart from the significant coefficient on Diamonds returns, coefficients on FX are also positive for the Foreign sub-index and negative Diamonds returns. While it falls short of the cutoff p-value for model (5), with a p-value of 10.8% we can still keep it mind in our analysis. This follows the results for the full Botswanan stock market, also in economical magnitude. A change from the full Botswanan stock market is seen for the Domestic sub-index, negative Diamonds returns, just below. There we find that the coefficients on GDP change are significant both for models (3) and (5). Indicating that when Diamonds experience a price decrease, the next day's stock returns will move slightly in the opposite direction of that quarter's GDP change. This was not found for the full index. Particularly interesting, but not something that is within the scope of this thesis to delve deep into, is the implication of it being the strictly Domestic companies that have this relationship with GDP change. Thus, when prices of Diamonds fall, a negative change in GDP from the last quarter will imply a small increase in stock returns the next day, and a positive change in GDP will imply a small decrease in stock returns. When one would, perhaps, be more inclined to assume that if the country's main export commodity experiences a price decrease, even if this does not affect the Domestic companies directly (as the largest Diamond producers are not strictly Domestic companies) it could be assumed to have a negative effect on the economy, and thus would make the stock market more sensitive to changes in GDP, i.e. a positive coefficient. However, the evidence presents otherwise, albeit with a small effect. However, given the small returns of a stock index in a given day, a change of approx. 0.1% that can be attributed to the effect of Diamonds price decreases and changes in GDP is still not something that cannot be neglected.

Table 19: Regression Results

Botswana, Foreign vs Domestic. Commodity: Diamonds

	α	$\beta_{r_{t-1}}$	$\beta_{comm_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Positive Commodity Returns					
Foreign					
(2)	0.000	-0.058	0.003	-	-
	0.761 (0.769)	*0.017 (0.646*	*0.543 (0.322)*	-	-
(3)	-0.000	-0.081	0.002	0.006*	-
	0.380 (0.416)	*0.001 (0.528)*	*0.634 (0.422)*	*0.142 (0.067)*	-
(4)	-0.000	-0.058	0.003	-	0.014
	0.751 (0.759)	*0.016 (0.646)*	*0.563 (0.345)*	-	*0.355 (0.322)*
(5)	-0.000	-0.081	0.002	0.006*	0.013
	0.378 (0.415)	*0.001 (0.528)*	*0.640 (0.433)*	*0.150 (0.068)*	*0.385 (0.372)*
Domestic					
(2)	0.000	-0.005	0.000	-	-
	0.770 ()	*0.390 (*	*0.935 ()*	-	-
(3)	0.000	-0.006	-0.000	-0.000	-
	0.501 ()	*0.315 ()*	*0.961 ()*	*0.837 ()*	-
(4)	0.000	-0.006	0.000	-	0.001
	0.774 ()	*0.382 ()*	*0.942 ()*	-	*0.765 ()*
(5)	0.000	-0.006	-0.000	-0.000	0.000
	0.502 ()	*0.310 ()*	*0.960 ()*	*0.832 ()*	*0.839 ()*
Negative Commodity Returns					
Foreign					
(2)	0.000	-0.048	0.006*	-	-
	0.828 (0.811)	*0.192 (0.780*	*0.224 (0.076)*	-	-
(3)	-0.000	-0.065	-0.007*	0.005	-
	0.523 (0.502)	*0.088 (0.716*	*0.218 (0.072)*	*0.275 (0.303)*	-
(4)	-0.000	-0.048	-0.006*	-	-0.022*
	0.858 (0.844)	*0.185 (0.777)*	*0.240 (0.083)*	-	*0.141 (0.074)*
(5)	-0.000	-0.068	-0.007*	0.004	-0.021
	0.565 (0.548)	*0.083 (0.711)*	*0.224 (0.075)*	*0.311 (0.347)*	*0.169 (0.108)*
Domestic					
(2)	0.000	0.085	0.007	-	-
	0.365 (0.390)	*0.007 (0.454)*	*0.351 (0.262)*	-	-
(3)	0.000	0.084	0.007	-0.009*	-
	0.149 (0.149)	*0.009 (0.459)*	*0.315 (0.230)*	*0.102 (0.047)*	-
(4)	0.000	0.085	0.007	-	-0.018
	0.352 (0.383)	*0.008 (0.456)*	*0.337 (0.259)*	-	*0.348 (0.311)*
(5)	0.000	0.083	0.007	-0.010*	-0.021
	0.137 (0.149)	*0.010 (0.462)*	*0.309 (0.228)*	*0.090 (0.044)*	*0.305 (0.285)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

6.4.2 General Commodity Index

To fully replicate the results from sections 6.1-6.3, we now apply regressions (6)-(9) with the GSCI as the commodity variable, ceteris paribus. In Table 20, with the full data set, we find very similar returns to that in Table 18, where we used Diamonds as the commodity variable. The only statistically significant variable is GDP changes, with a magnitude of +/- 0.05% for the Foreign/Domestic sub-index respectively. Again, the full index in regressions (6)-(9) did not have a significant coefficient on GDP changes (Table 16).

When splitting into positive and negative GSCI returns, we have much fewer significant variables than in Table 19, using the Diamonds returns. GDP changes is still significant for both the Foreign and Domestic sub-index, with opposing signs and slightly larger magnitudes than in the full data set. Differing from the results in Table 19, both of these are for positive GSCI return, whereas the Domestic sub-index had significant coefficients on GDP for negative return days only in the Diamonds-set. FX, alone, is also significant here for the Foreign sub-index and positive returns, whereas it was only for the negative returns set when using Diamonds as the variable.

Additionally, we see that for model (9), when using the Foreign sub-index and days with positive GSCI returns, the GSCI variable has a statistically significant and sizeable coefficient with a negative sign. That is to say, when controlling for GDP and FX, the Foreign sub-index of the Botswanan stock market is forecasted to move slightly in the opposite direction of the GSCI return (which is strictly negative, so the stock return increases).

Table 20: Regression Results

Botswana, Foreign vs Domestic. SP GSCI Total Return Index.

	α	$\beta_{r_{t-1}}$	$\beta_{gen_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Full Data Set					
Foreign					
(1)	0.000	-0.051	-	-	-
	0.836 (0.835)	*0.010 (0.598)*	-	-	-
(6)	0.000	-0.050	-0.011	-	-
	0.865 (0.864)	*0.010 (0.600)*	*0.054 (0.164)*	-	-
(7)	-0.000	-0.070	-0.012	0.005*	-
	0.469 (0.500)	*0.000 (0.478)*	*0.031 (0.121)*	*0.087 (0.081)*	-
(8)	0.000	-0.050	-0.012	-	-0.010
	0.848 (0.847)	*0.010 (0.600)*	*0.036 (0.137)*	-	*0.332 (0.301)*
(9)	-0.000	-0.070	-0.014	0.005*	-0.010
	0.485 (0.517)	*0.000 (0.477)*	*0.020 (0.103)*	*0.089 (0.084)*	*0.331 (0.318)*
Domestic					
(1)	0.000	0.063	-	-	-
	0.590 (0.579)	*0.001 (0.414)*	-	-	-
(6)	0.000	0.063	0.004	-	-
	0.581 (0.571)	*0.001 (0.414)*	*0.445 (0.237)*	-	-
(7)	0.000	0.062	0.004	-0.005*	-
	0.237 (0.159)	*0.002 (0.421)*	*0.451 (0.242)*	*0.117 (0.056)*	-
(8)	0.000	0.063	0.003	-	-0.008
	0.568 (0.562)	*0.001 (0.414)*	*0.582 (0.436)*	-	*0.427 (0.437)*
(9)	0.000	0.062	0.003	-0.005*	-0.009
	0.229 (0.159)	*0.002 (0.421)*	*0.593 (0.450)*	*0.115 (0.056)*	*0.401 (0.422)*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

Table 21: Regression Results

Botswana, Foreign vs Domestic. SP GSCI Total Return Index.

	α	$\beta_{r_{t-1}}$	$\beta_{gen_{t-1}}$	β_{GDP}	$\beta_{fx_{t-1}}$
Positive Commodity Returns					
Foreign					
(6)	0.000	-0.056	-0.025	-	-
	0.172 (0.236)	*0.046 (0.681)*	*0.063 (0.192)*	-	-
(7)	0.000	-0.068	-0.030	0.011*	-
	0.460 (0.474)	*0.016 (0.621*	*0.029 (0.117)*	*0.018 (0.011)*	-
(8)	0.000	-0.056	-0.027	-	-0.021*
	0.180 (0.246)	*0.045 (0.680)*	*0.046 (0.162)*	-	*0.217 (0.079)*
(9)	0.000	-0.068	-0.032*	0.011*	-0.019
	0.467 (0.480)	*0.016 (0.620)*	*0.022 (0.099)*	*0.020 (0.013)*	*0.287 (0.148)*
Domestic					
(6)	0.000	0.070	-0.005	-	-
	0.406 (0.486)	*0.013 (0.428)*	*0.751 (0.734)*	-	-
(7)	0.000	0.069	-0.006	-0.009*	-
	0.202 (0.257)	*0.016 (0.435*	*0.716 (0.697)*	*0.118 (0.060)*	-
(8)	0.000	0.070	-0.007	-	-0.018
	0.417 (0.491)	*0.013 (0.429)*	*0.675 (0.679)*	-	*0.364 (0.386)*
(9)	0.000	0.069	-0.008	-0.009*	-0.021
	0.206 (0.257)	*0.015 (0.435)*	*0.636 (0.643)*	*0.111 (0.058)*	*0.326 (0.367)*
Negative Commodity Returns					
Foreign					
(6)	-0.000	-0.046	-0.019	-	-
	0.262 (0.811)	*0.099 (0.780*	*0.068 (0.076)*	-	-
(7)	-0.000	-0.077	-0.016	-0.001	-
	0.446 (0.539)	*0.006 (0.545)*	*0.113 (0.352)*	*0.699 (0.714)*	-
(8)	-0.000	-0.046	-0.018	-	0.002
	0.263 (0.381)	*0.099 (0.714)*	*0.078 (0.307)*	-	*0.894 (0.912)*
(9)	-0.000	-0.077	-0.016	-0.001	0.000
	0.447 (0.538)	*0.006 (0.545)*	*0.123 (0.375)*	*0.699 (0.713)*	*0.970 (0.976)*
Domestic					
(6)	-0.000	-0.001	0.002	-	-
	0.520 ()	*0.982 ()*	*0.713 ()*	-	-
(7)	-0.000	-0.003	0.002	-0.001	-
	0.655 ()	*0.907 ()*	*0.711 ()*	*0.758 ()*	-
(8)	-0.000	-0.001	0.002	-	0.000
	0.521 ()	*0.980 ()*	*0.705 ()*	-	*0.929 ()*
(9)	-0.000	-0.003	0.002	-0.001	0.000
	0.656 ()	*0.906 ()*	*0.711 ()*	*0.758 ()*	*0.971 ()*

p-values inside () are corrected for heteroscedasticity using White-Robust Standard Errors in case of Breusch-Pagan test showing heteroscedasticity on a 10% p-value threshold.

** at least 10% significance*

7 Conclusion

In this thesis, an attempt has been made to shed more light on the nature of the relationship between stock markets commodity price movements in a select group of strongly commodity-dependent countries in Sub-Saharan Africa; Botswana, Nigeria, and Zambia, with South Africa as a benchmark. By utilising forecasting regressions of stock markets with potential predictors of past returns, past commodity returns, past exchange rate change, and current GDP change, the thesis seeks to find indicators of differences between and within countries. To test for a broader impact of commodity price movements on the stock market, time-varying differences are investigated through a division of each data set into days of positive or negative commodity returns. The Results consists of regressions run over the three commodity-dependent countries and their main export commodity(ies) over these three data sets, regressions run over all four countries and a general commodity index, the SP GSCI Total Return, over the same three sets, and finally regressions run for the two Botswanan sub-indices (Foreign-listed and strictly Domestic-listed) with all prior regressions and for both Diamonds and the GSCI.

This leaves an extensive set of results, presented in Tables 12 to 21, however many of these are not significant. For example, considering the "core" regressions, on the full data set against each country's main export commodity (i.e. the regressions in which we search for a forecasting ability of commodity returns on equity returns), the only statistically significant variables are those for Nigerian lagged stock returns. This thesis thus does not find any evidence for a time-consistent predictive power of commodity returns over stock returns for these countries, regardless of which other variables are included. With that said, when dividing the data set between days of positive and negative commodity returns, much changes and we can see examples for both Botswana and Nigeria where the forecasting power of the macroeconomic variables take out each other, more or less, between the different sets. All in all, direction of price changes in commodities affects the forecasting power of the included macroeconomic variables, albeit does not lead to statistical significance for any of the main-export commodity variables. Thus we can here provide evidence that commodity price movements are connected to these stock markets, albeit less directly than through a significant forecasting ability.

Results mimic for the regressions run over the GSCI variable, with no significance except Nigerian lagged returns and there is thus no real difference between the two commodity variables. However, on days with positive returns, Botswana sees a forecasting power of all variables except lagged returns, and on days with negative returns this same happens for Nigeria except it is the GDP change alone which is not significant. Thus, movements in commodity returns impact both the significance of the GSCI variable on returns, and of the macroeconomic variables. On days with negative GSCI returns, South Africa

has a consistently (through models) significant coefficient on lagged GSCI returns, as does Nigeria. The GSCI consists of a large share of Oil, so it is perhaps not surprising that Nigeria is affected. The lack of mimicking of this forecasting power in the main-export commodity regressions (where Nigeria applies an Oil & Natural Gas index) might be due to the choice of not using the Nigerian Bonny Light crude oil price, but instead the WTI. The reasoning was that this thesis considers the perspective of a foreign investor and thus someone who likely does not follow the Bonny Light price. However, it might be that the WTI price alone does not follow the Nigerian Bonny Light price sufficiently for the variable to be significant, or that there are other commodities in the GSCI which are important e.g. for import, and that this is where the effect comes from. South Africa, on the other hand, is a more globally integrated stock market (e.g. Boamah et al (2016)), and thus it is perhaps not very surprising that it shows co-movement with commodities, relating to the financialisation of commodities which is discussed in Chapter 2 of this thesis.

Finally, the last results relate to the split of the Botswanan stock market into companies also listed abroad, and strictly Domestic companies. Looking at the full set of dates, GDP changes is now significant but with different signs, and the tables show a large amount of different results over the different data sets and commodity variable used. In particular, on days with negative movements in Diamonds prices, the Foreign sub-index moves slightly in the opposite direction (increase in stock return) for all four regression models. Thus there is some evidence that, under certain conditions, main-export commodity returns are a significant forecasting variable for stock returns. Results also support that it would indeed be highly relevant to further study differences between company characteristics in their relationship to commodity price movements.

The main conclusion of this thesis would then be that one would be amiss to write off the impact of commodity returns on the stock market by looking at simply the forecasting power of the commodity variable itself. Results, more persistent for Botswana and Nigeria, but present for also Zambia and South Africa, show that which factors predict the stock market and to what degree vary with time, i.e. depending on commodity returns. Not only does this have implications for investors; who should be aware of the movements in commodity prices on a given day and take this into account when analysing other forecasting variables. But also for policy-makers who might use these results as a foundation for striving to deepen their understanding of the relationship between commodity prices and the stock market in different commodity-dependent countries. The results for South Africa, while an emerging and not a mature market and thus with some different characteristics, suggest that time-variation might exist also on a global level. This has been tested to some degree, but with a focus on crisis periods rather than

daily variations in return.

This thesis is not without limitations. For example, the last Results section show us that there are differences between different stock market sub-indices. Ideally constituent history would have been employed to categorise countries to further understand differences between types of firms. This data was not available for this thesis, and perhaps it would have also been somewhat out of scope to do this in a proper manner - it needs to remain as a suggestion for further research. Additionally, the time period of the data was cut a bit short to avoid the Global Financial Crisis and any potential impact. Much research, as presented in Chapter 2, looks at differences in the relationship commodity returns and stock returns and/or different behaviour of Sub-Saharan African markets in this period. The choice was made to exclude this to narrow the scope of the thesis, but it would certainly have been interesting to study the differences between crisis periods and regular times.

Another area which would presumably be of interest is that of persistent declines or increases in commodity prices, and the effect of this on the stock market. Hypothetically, we would assume that insofar as a commodity price decline implies problems for one of these countries, it would need to be significantly large or persistent as to properly affect investors' opinions on future economic ability of the country. Thus an extension could look at persistent price changes, and/or control for size of changes in commodity prices. Lastly, the choice was made to use two macroeconomic variables to limit the number of regressions to a manageable amount. More could easily be included, for example interest rates, which is a commonly used variable in the literature.

To summarise then, this thesis does find evidence of a time-varying relationship between commodity returns and stock market returns in its set of commodity-dependent, and not commodity-dependent, Sub-Saharan African countries. This implies that investors and policy-makers should look beyond the direct forecasting power of commodity returns to gain a fuller understanding of the impact of commodity price movements on their market. As this is a fairly new and small research area, this thesis has taken a more generalised approach, but there are many improvements and extensions which could be made in further research to deepen the understanding of this relationship.

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