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Business cycle synchronisation between BRICS and the G5 countries

A research report submitted by

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Declaration

I, Grerley Mutibura (364222) declare that this research report is my own unaided work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Masters in Business Administration at the University of the Witwatersrand, Johannesburg. This work has not been submitted for examination in this, or any other university.

Signed ……..

Signed at ……Wits Business School……...

On the……19th ….. day of ……May……..2017

Abstract

The BRICS and G5 groups of countries are currently the most influential economies in the world and in the near future the balance of financial and economic power is predicted to shift from the G5 to the BRICS countries. The study aims to determine the level of business cycle synchronisation between the BRICS and G5 bloc countries during this period of transition. That is to assess the relative responses of these two economies to various macroeconomic shocks.

The novel global vector autoregressive (GVAR) model was used to model the interaction of the economies under consideration and simulate the effect of the introduction five different shocks. The following shocks were imposed on the GVAR model; (1) a one standard error positive shock to BRICS' real GDP; (2) a one standard error positive shock to oil prices; (3) a one standard error positive shock to global inflation; (4) a one standard error negative shock to global equity prices; (5) a one standard error shock to the G5's nominal short-term interest rates.

It was observed that moderate to high levels of business cycle synchronisation exist between the BRICS and G5 countries. It was also found that the response patterns for both groups of countries are generally similar irrespective of the source of the shock. The G5 bloc economy was found to be generally more resilient to economic shocks, that is the intensity of any given shock was found to be higher for the BRICS bloc economy. The results suggest that macroeconomic policy makers can leverage this knowledge to predict business cycles in their jurisdictions by observing relevant synchronised economies and drafting appropriate polices to sustain growth in their economies.

The results can be taken with a fair degree of confidence as the GVAR model was found to be stable and containing no unit variables.

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TABLE OF CONTENTS

LIST OF TABLES vi

LIST OF FIGURES viii

CHAPTER 1. INTRODUCTION 1

1.1 PURPOSE OF THE STUDY 1
1.2 BACKGROUND 1
1.3 PROBLEM STATEMENT 4
1.3.1 MAIN PROBLEM 4
1.3.2 SUB-PROBLEMS 4
1.4 SIGNIFICANCE OF THE STUDY 5
1.5 DELIMITATIONS OF THE STUDY 5
1.6 DEFINITION OF TERMS 6
1.7 ASSUMPTIONS 7

CHAPTER 2. LITERATURE REVIEW 8

2.1 INTRODUCTION 8
2.2 WHY BRICS? 8
2.3 A DEEP DIVE INTO A BRICS COUNTRY: THE CASE OF SOUTH AFRICA 11
2.3.1 SOUTH AFRICA'S GDP SUPPLY BREAKDOWN OVERTIME 12
2.3.2 SOUTH AFRICA'S GDP DEMAND BREAKDOWN OVERTIME 14
2.3.3 MAIN TRADE PARTNERS 15
2.4 SHOCKS 16
2.5 THE GVAR MODEL 17
2.6 CONCLUSION 18

CHAPTER 3. RESEARCH METHODOLOGY 19

3.1 RESEARCH METHODOLOGY 19
3.2 RESEARCH DESIGN 21
3.3 POPULATION AND SAMPLE 23
3.3.1 POPULATION 23
3.3.2 DATA 23
3.4 DATA ANALYSIS AND INTERPRETATION 24
3.4.1 THE GVAR MODEL 24
3.5 LIMITATIONS OF THE STUDY 26

3.6 Research Ethical Issues 26

CHAPTER 4. DATA ANALYSIS & RESULTS 27

4.1 Introduction to Research process 27
4.2 Data processing 27
4.3 Overview of Modelling Techniques 28
4.4 Descriptive Statistics 29
4.4.1 Domestic Variables 29
4.4.2 Foreign-Specific Variables 30
4.4.3 Global variables 30
4.5 Unit Root Tests 31
4.5.1 Domestic variables 31
4.5.2 Foreign specific variables 33
4.5.3 Global variables 34
4.6 Model Selection 35
4.6.1 Lag orders and statistics of individual VARX models 35
4.6.2 Statistics for individual VECMX* models 36
4.6.3 Descriptive statistic of VECMX* residuals 37
4.7 Testing Weak Exogeniety 38
4.8 Contemporaneous effects of foreign variables on their domestic counterparts 38
4.9 Pair-Wise cross-sectional correlations: variables and residuals 39
4.10 Generalized Impulse response functions 41
4.10.1 Shock to BRICS real GDP 42
4.10.2 Shock to Oil Price 44
4.10.3 Shock to Global Inflation 47
4.10.4 Shock to Global equity prices 49
4.10.5 Shock to G5 nominal short-term interest rates 51

CHAPTER 5. DISCUSSION & CONCLUSION 53

5.1 Introduction 53
5.2 Brief Research Results 54
5.3 Implications of the Research 56
5.4 Implications for Future Work 56
5.5 Conclusion 57

REFERENCES 58

APPENDIX A 62

LIST OF TABLES

Table 1: Economic power today (proportion of world production) 10

Table 2: Financial power, 2015 (% of world) 11

Table 3: Descriptive statistics of domestic variables 29

Table 4: Descriptive statistics of foreign specific variables 30

Table 5: Descriptive statistics of global variables 31

Table 6: Unit root tests for the domestic variables at the 5% significance level ... 31

Table 7: Unit Root tests for the foreign variables at the 5% significance level 33

Table 8: Unit Root tests for the global variables at the 5% significance level 34

Table 9: Choice criteria for selecting order of VARX* models 35

Table 10: Corresponding residual correlations F-statistics 36

Table 11: VECMX* single-equation statistics 36

Table 12: BRICS VECMX* residuals 37

Table 13: G5 VECMX* residuals 37

Table 14: Order of weak exogeniety regression equations 38

Table 15: F-statistic for testing the weak exogeniety of country-specific foreign variables and global variables 38

Table 16:Contemporaneous effects of foreign variables on their domestic counterparts 39

Table 17: Average pair wise cross-section correlations of all variables and associated model's residual 40

Table 20: KEY..... 62

LIST OF FIGURES

Figure 1: GDP growth projections for the next decade measured in constant 2005 PPP $, Source: Canback- Global Income Distribution Database (C-GIDD) 3

Figure 2: GDP supply breakdown. Source: (EIU Canback, 2016), (World Bank, 2016) 13

Figure 3: GDP demand breakdown over time. Source: (World Bank, 2016); (EIU Canback, 2016) 14

Figure 4: Main trade partners. Source: StatsSA (2016), UN Comtrade (2016), EIU Canback (2016) 15

Figure 7: Generalized impulse response of a one standard error shock in BRICS real GDP 43

Figure 8: Generalized impulse response of a one standard error positive shock in oil price 45

Figure 9: Generalised impulse response of unit standard error negative shock to global inflation 48

Figure 10: Generalized impulse response functions for a unit standard error positive shock on global equity prices 50

Figure 11: Generalized impulse response of a positive unit standard error shock to G5 short term interest rates 52

CHAPTER 1

INTRODUCTION

1.1 Purpose of the study

The purpose of this research is to investigate how various shocks in macroeconomic variables of BRICS (which for the purposes of this study comprises of Brazil, India, China and South Africa) are transmitted to the G5 bloc (which for our purposes of this study comprises of France, Germany, Japan, The United Kingdom and the United States) and vice-versa. The research also aims to elucidate the major channels of shock transmission and the relative effect of each shock on the key macroeconomic variables of the regions under consideration i.e. the level of synchronisation in the business cycles of BRICS and the G5.

1.2 Background

According to Schumpeter (1939), economies and the businesses undergo periods of growth and shrinkage, and these business cycles are characterisctic of all global economies. These business cycles affect the patterns of interest rates, economic output, inflation and real equity prices which drive real GDP (Dees, Di Mauro, Pesaran, & Smith, 2007). Due to increased globalisation, global intergration of the world`s economies has significantly increased and as a result co-movements in real GDP are becoming stronger and more pronounced. This suggests that there is an opportunity to predict the trajectory of the business cycles of one economy by tracking the trajectory of a related economy or the core exogenous macroeconomic variables.

Some authors presented evidence suggesting that there was little synchronisation amongst economies during the period starting in 1990 to the turn of the century (Dees, Di Mauro, Pesaran, & Smith, 2007). On the other hand, some authors argue

that financial market intergration is on the rise and as a result, real international and financial interdependencies are becoming stronger (Kose, 2002; Kose, Otrok, & Whiteman, 2003). Another group of authors clearly showed that some common dynamics in terms of economic activity, exist for the G-7 countries; they were able to identify and quantify mutual flactuations in economic activity amongst these economies (Monfort, Renne, Ruffer, & Vitale, 2003). According to Dees, Di Mauro, Pesaran and Smith (2007), the effect of changes in oil prices are becoming increasingly important in comovements of business cycles in interlinked economies. Hence, understanding the exact effect of exogenous macroeconomic variables on macroeconomic performance is important now more than ever.In addition to that, shocks in the economy of one or more members of an interlinked group of countries will have ripple effects amongst all of them. This makes most economnies valnurable even though they may not directly experience a shock. Literature has shown that these shock effects are transimitted to the various economies through a number of mechanisms and channels such as interest rates, stock prices and exchange rates, production costs and consumer uncertainity (Anderton, di Mauro, & Moneta, 2004; Galesi & Lombardi, 2009).

It is worth noting that historically emerging economies have had relatively little financial and economic influence on the global stage. Hence shocks in their economies were of little significance to the global economy but recently the trend has been changing. Sharma and Mahendru (2013), reported that before 1980, cross border equity trading excluded developing economies. However, during the subsequent decades the potentially strong economic growth of emerging markets came into the spotlight, and as such developing economies began to enjoy greater inclusion in global financial activities such as cross boarder equity trading. Developing nations have continued to grow in relevance since 1990 and this is depicted by their growth in GDP that has constantly outperfomed the developed (Affluent) countries. This trend is expected to continue over the next ten years as shown in Figure 1.This makes this group of countries very important for the global economy.

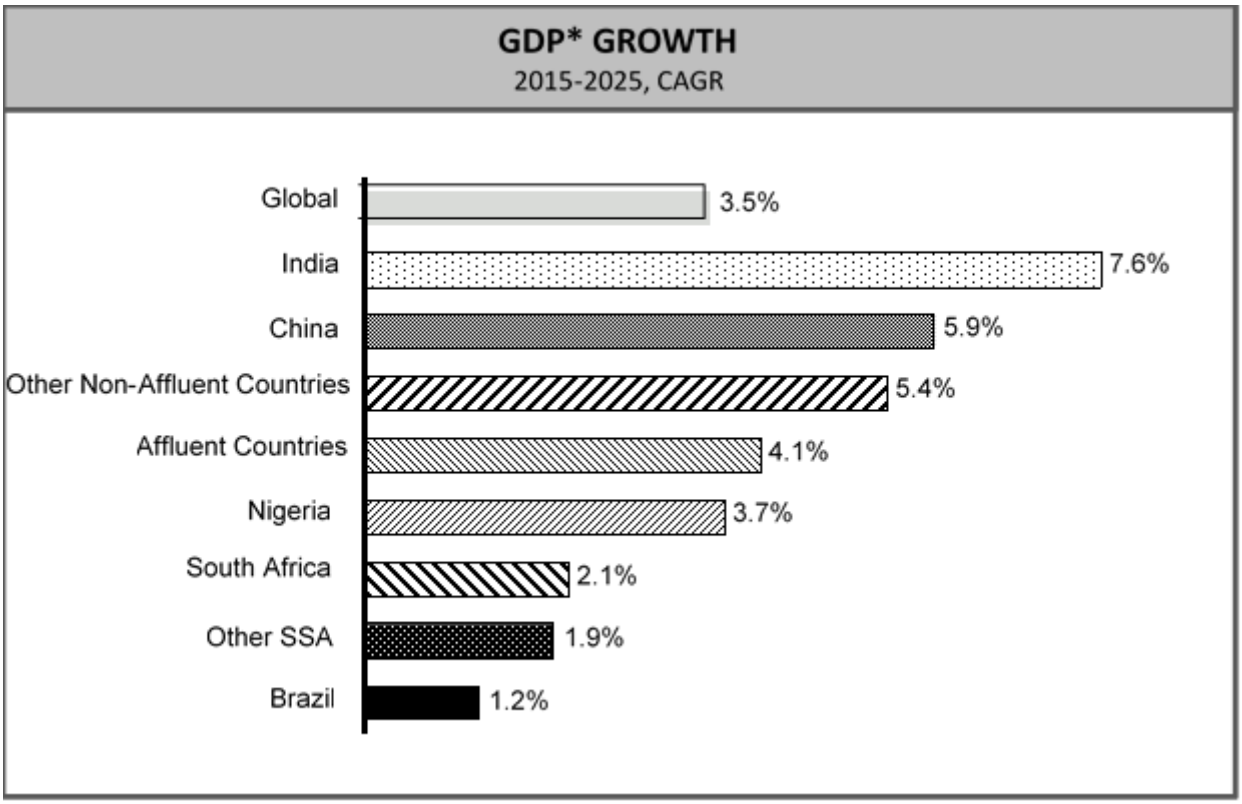


Figure 1: GDP growth projections for the next decade measured in constant 2005 PPP $[1], *Source: Canback- Global Income Distribution Database (C-GIDD)*

[1] **Affluent Countries:** Andorra, Australia, Austria, Bahrain, Belgium, Brunei, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Greenland, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, South Korea, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Macao, Malta, Monaco, Oman, Netherlands, New Zealand, Norway, Poland, Portugal, Qatar, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan, United Arab Emirates, United Kingdom, United States, Uruguay

[2] **SSA:** Angola, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo-Brazzaville, Congo-Kinshasa, Benin, Equatorial Guinea, Ethiopia, Eritrea, Djibouti, Gabon, Gambia, Ghana, Guinea, Cote d'Ivoire, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Guinea-Bissau, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Zimbabwe, South Sudan, Sudan, Swaziland, Togo, Uganda, Tanzania, Burkina Faso, Zambia

[3] **Other Non-Affluent Countries:** Afghanistan, Albania, Algeria, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Bhutan, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Cambodia, China, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Georgia, Guatemala, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Iraq, Jordan, Kazakhstan, North Korea, Kosovo, Kyrgyzstan, Laos, Lebanon, Libya, Macedonia, Malaysia, Mexico, Moldova, Mongolia, Montenegro, Morocco, Myanmar, Nepal, Nicaragua, Pakistan, Palestine, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Serbia, Sri Lanka, Suriname, Syria, Tajikistan, Thailand, Tunisia, Turkey, Turkmenistan, Ukraine, Uzbekistan, Venezuela, Viet Nam, Yemen

Brazil, Russia, India, China and South Africa (BRICS) form an association of the major emerging economies in world. This association allows a great degree of economic, financial and political collaboration amongst its members and thus there is a fair degree of interlinkage of these economies (Sharma & Mahendru, 2013).

Literature has shown that there is some degree of interlinkage in the stock exchanges of developing economies citing evidence from BRICS (Sharma & Mahendru, 2013). On the other hand, the transmission of economic shocks amongst the USA, the European Union and other developed economies has also been investigated suggesting the need to study this phenomenon in other geographies and contexts (Dees, Di Mauro, Pesaran, & Smith, 2007). No work was found in literature investigating the transmission of shocks between BRICS and the G5 which is the current economic and financial power house of the world. This presents an interesting topic as the dynamics of business cycles in the two regions are going to become more important as the balance of power shifts from the G5 to BRICS.

1.3 Problem statement

1.3.1 *Main problem*

The purpose of this study is to investigate how various economic shocks are transmitted between BRICS and G5 bloc economies and assess the level of similarity in their response to these shocks.

1.3.2 *Sub-problems*

The sub-problem is to investigate the responses in the core macroeconomic variables of both the BRICS and G5 blocs that are induced by shocks in select macroeconomic variables.

1.4 Significance of the study

The BRICS economies play a significant role in other emerging economies and the world. For example, China has been the largest global commodity consumer of the last decade and as such has been driving growth in commodity driven economies like South Africa. On the other hand, the G5 are the most powerful countries both financially and economically in the world and contribute significantly to both global production and consumption, hence any unforeseen circumstance will have effects transcending the boarders of these countries. This creates dependencies among countries with linkages being formed through trade and financial markets. such dependencies have grown in importance as the world continues to globalise and as economies intertwine more intimately (Mahdjour & Fischer, 2014). Hence an understanding of the dynamics of these linked economies is critical for macro-economic policy makers, and financial risk management personnel among others.

The insights that will be gained from this study will be valuable to:

- Macroeconomic policy makers as this will enable them to predict business cycles by studying the dynamics of related economies and thereby implementing appropriate policies to sustain strong macroeconomic performance
- Banks, as they can use the insights gained to develop more robust financial risk management models that may result in lower probability of financial losses
- Economics and finance academics, as the findings of this research will be a step towards a more holistic understanding of macroeconomic shock transmission and business cycle synchronisation

1.5 Delimitations of the study

- This study is delimited to testing the synchronisation of BRICS and G5 bloc economies only
- No effort is made to understand any other single or regional economy

- The study solicits insights from data provided by the IMF, IFS, World Bank, Bloomberg and Canback Global Income Distribution Database. No effort will be made to collect and use any data other than this
- The data is from quarter one 1979 to the fourth quarter of 2013. Data from any other period are out of the scope of this study. GVAR forecast are however calculated for 40 periods after the last quarter of this dataset

1.6 Definition of terms

Gross Domestic Product (GDP): is a macroeconomic variable that can be defined as the summation of all value added by both capital and labour in the process of production (Daly, 2002).

Economic Shock: can be defined as a sudden change in a given macroeconomic variable such as equity prices, real output or exchange rates which in turn has ripple effects on the GDP (Anderton, di Mauro, & Moneta, 2004).

Inflation: is a measure of the rate at which the purchasing power of a currency changes. It measures persistent and sizable rise in general price levels (Aruoba, 2016)

Real output: is the total sum of products and services produced by a given country over a specified period corrected for inflation (Berger & Sedunov, 2016)

Equity Prices: is the cost of purchasing a stock which is either publicly or privately traded. It can also be considered as the cost of purchasing an ownership interest represented by any other form of securities (Sloan & You, 2015).

Exchange rates: represents the number of units of given local currency that can be purchased from a single unit of a given foreign currency (Cenedese, Payne, Sarno, & Valente, 2016).

Global Vector Auto Regression analysis(GVAR): is a novel approach developed for the purposes of macroeconomic modelling. It makes use of a combination of time series, panel data, and factor analysis techniques. It provides a robust

quantitative approach to analyse the importance of various shocks and channels of transmission mechanisms (Smith & Galesi, 2014).

BRICS: is a group of five developing countries (Brazil, Russia, India, China and South Africa) that have been earmarked for high growth prospects. They are described as the most lucrative emerging markets and economies as they represent 40% of the world's population. It is predicted that by 2050 these countries will become global leaders in terms of economic growth, out and development (Zamana, et al., 2016).

G5: a group of the most advanced economies in the world which includes Germany, France, Japan, United Kingdom and the United States

1.7 Assumptions

The research conducted was based on the following assumptions:

- All BRICS economies can be considered to be part of a single economy which is representative of all member countries
- All G5 economies can be considered to be part of a single economy which is representative of all member countries
- IMF, IFS, Bloomberg and World Bank data are true and an exact representation of the economic activity of the respective countries
- A quantitative approach is sufficient in capturing all the insights necessary for the study. There is no need to supplement with qualitative data.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of the growing importance of BRICS in the global economy. It also highlights the role of the G5 as current leaders in global economics and finance and how the balance of power is shifting. Attention is paid to the extant literature on the effect of shocks on macroeconomic performance and mechanisms of shock transmission. Finally, an overview of the Global Autoregressive Modelling is provided to create context for the subsequent methodology chapter.

2.2 Why BRICS and G5?

The G5's dominance (led by America) of global finance, society and politics has just passed its climax (Armijo, 2007). The remainder of this century will see a multipolar international system being established with various powers emerging as leaders in different aspects of the international systems (Armijo, 2007; Zamana, et al., 2016). The biggest threat to the United States' hegemony is going to be from the largest emerging economies; that is Brazil, Russia, India and China rather than the Western European countries as one would expect (Mensi, Hammoudeh, Nguyen, & Kang, 2015).

According to Wilson & Roopa (2003), as of 2003 the combined gross national product (GNP) of these largest four emerging economies were equivalent to only fifteen percent of the combined gross national product of the world's six most advanced industrial nations. These industrialised nations are the United States, Italy, Germany, France, Japan and Britain respectively. These authors predict that it will take about four decades for the BRICs countries to match the top six

industrialised nations. Thus, the BRICs countries will become the main drivers of new demand growth and, ability and willingness to spend.

Due to increasing globalisation, the BRICS countries are becoming more involved in the global capitalist economy and such participation has been made easier by the fact that they all possess fairly modernized industrial and financial sectors (Armijo, 2007). For instance, the ratio of the market capitalisation of the stock exchange to the respective gross national product of country range from 35% to 72%. In terms of global integration Russia and China lead the way, with trade to GDP ratios 51% and 41% respectively as of 2015 (World Bank, 2016). To create some context, the United States had a trade to GDP ratio of 28% over the same period. On the other hand, Brazil and India have lower global integration indices of 27% and 31% respectively. Most BRICs countries have a perpetual trade surplus except for India (UN Comtrade, 2016). This suggests high levels of industrial productivity and self-sufficiency. However, it is worthwhile investigating the level of dependency of the BRICS countries on the more industrialized nations and how they respond to shocks thereof.

According to Wilson and Roopa (2003), these four economies provide outstanding opportunities to invest and as a result of the expected high growth in the middle class demand for electricity, cars and branded consumer goods among other things, will increase. This suggests that these economies will drive growth going forward and because they are large, they are less risky investment destinations relative to smaller emerging economies because they are more resilient to exogenous economic shocks.

Hence with time these four emerging powers will rise to compete directly with the G6 which are currently the world's top economy. As one author notes that after the Soviet Union fell, the United States assumed the position of the only super power (Jain, 2006). He goes on to say that the United States will not be able to maintain this position of superiority for a prolonged time and managers of US based companies should prepare to compete with BRICs. It is also worth noting that the predicited competetiveness of the BRICs bloc will not just be driven by the above average growth rates and return on investment rates (ROI) but rather by their

ernomous combined economic size (Armijo, 2007). To contextualise the size of these economies, Table 1 shows the evolution of economic power over the years .

Table 1: Economic power today (proportion of world production)

Country	GDP in current PPP					GDP in current USD				
	1980	1990	2000	2010	2016	1980	1990	2000	2010	2016
Japan	6.7%	7.8%	6.6%	4.9%	4.2%	8.9%	13.5%	14.2%	6.2%	6.3%
Germany	5.7%	5.4%	4.9%	3.7%	3.4%	7.7%	7.7%	5.9%	3.9%	4.6%
United Kingdom	3.3%	3.3%	3.1%	2.5%	2.4%	4.6%	4.8%	4.7%	2.7%	3.5%
United States	19.1%	19.8%	20.9%	17.0%	15.8%	23.3%	26.0%	30.9%	17.0%	24.5%
France	3.9%	3.7%	3.4%	2.7%	2.3%	5.7%	5.6%	4.1%	3.0%	3.3%
Italy	4.0%	3.7%	3.3%	2.4%	1.9%	3.9%	5.1%	3.4%	2.4%	2.5%
G6	**42.7%**	**43.8%**	**42.2%**	**33.2%**	**29.9%**	**54.1%**	**62.7%**	**63.1%**	**35.3%**	**44.6%**
China	2.0%	3.6%	7.3%	13.8%	17.6%	2.5%	1.7%	3.6%	6.8%	14.9%
India	2.5%	3.3%	4.2%	6.1%	7.5%	1.5%	1.4%	1.4%	1.9%	3.0%
Brazil	3.7%	3.3%	3.1%	3.1%	2.6%	1.6%	1.8%	2.0%	2.5%	2.3%
Russia	7.1%	6.1%	3.1%	3.4%	3.0%	5.6%	2.5%	0.8%	1.7%	1.5%
BRICs	**15.3%**	**16.3%**	**17.8%**	**26.4%**	**30.7%**	**11.1%**	**7.4%**	**7.7%**	**13.0%**	**21.7%**
G6+BRICs	**58.0%**	**60.2%**	**60.0%**	**59.6%**	**60.6%**	**65.2%**	**70.1%**	**70.9%**	**48.2%**	**66.3%**

Source: Armijo (2007), EIU Canback (2016)

According to Table 1, the locus of global economic power has been shifting over the past four decades. The contribution of the G6 countries to world production as measured by GDP in purchasing power parity, has been declining at a cumulative annual rate of 1% while the BRICS contribution has been increasing at a rate of 1.9% annually. As of 2016 The BRICS contribution to global production has surpassed the G6 countries. However, in terms of contribution to global production (in current US Dollars) it will take an additional 25 years for the BRICS countries to catch up with the G6 countries.

Armijo (2007), suggests that an alternative way to juxtapose BRICS and the G6 is by evaluating their respective financial power. This can be evaluated in a number of ways. For instance, post the second world war, most central banks stocked the US dollar as the reserve currency of choice but this has since declined to less than 55% of all reserve banks. This is due to the rise of other currencies as reserve currencies such as China's yuan which was granted reserve status by IMF in 2015 (Mayeda, 2015). Financial power can also be measured by the size of cash

reserves and other liquid assets. China holds larger reserves of this nature larger than any G6 country.

Table 2: Financial power, 2015 (% of world)

Country	Foreign Exchange Reserve	Inward FDI, stock	Outward FDI, stock
United States	1.1	16	19.2
Japan	17.3	1	3.6
United Kingdom	0.8	8	11.6
Germany	0.8	5	9.1
France	0.8	5.9	8
G5	**20.8**	**35.9**	**51.5**
China	23.8	2	0.4
India	3.4	0.4	0
Brazil	5.8	1.3	1.1
Russia	1.7	2	0.7
BRICS	**34.7**	**9.7**	**2.2**
G5+BRICS	**55.5**	**45.6**	**53.73**

Source: (UNCTAD, 2016)

The foreign exchange reserves of the BRICS countries far exceed those of the G5 countries suggesting some degree of financial power. However, the inward and outward stocks of foreign direct investments for the G5 countries still surpass those of the BRICS countries. This difference is expected to reduce in magnitude in the coming decades (Armijo, 2007). Hence an understanding of the subtleties in business cycles as this transition in the balance of power occurs will be critical

2.3 A deep dive into a BRICS country: The case of South Africa

It is worthwhile investigating the dynamics of a typical BRICS economy, the way it is structured and its interaction comparable economies. South Africa became the fifth member of the BRICS group of countries in late 2010 (Pinto, 2012). Relative to the other BRICS nations, South Africa is small in terms of both population and economy and this begs the question why Nigeria, which has a much larger population and comparable economy was not selected. Cheng, Gutierrez, Mahajan, Shachmurove, and Sharhokhi (2007), describe the BRICS economies as being

dominated by raw-material exports which favours South Africa's economy relative to Nigeria's; that is, its vast reserves of platinum group metals, diamonds and gold as well as outstsanding infrastructure, readily available credit lines, globally competitive banking systems and relatively stable micro and macro financial systems made more favourable.

South Africa has become the gateway and regional hub for BRICS investments into the largely untapped African market (Pinto, 2012). It is uniquely positioned to better exploit opportuinities in Africa than any of its BRICS counterparts because it shares the same historical profile and struggles such as poverty, inequality and unemployment with most other African countries .

2.3.1 *South Africa's GDP supply breakdown overtime*

Figure 2 shows that South Africa's GDP is dominated by finance and public administration which is expected to contribute over 40% as of 2016. This is more than that of peer countries such as Nigeria and Kenya. Manufacturing, construction and mining contribute another 40% to the GDP; this suggests a dependency on other economies for the sale of mining products, the purchase of capital goods for manufacturing and raw materials for construction. This also suggests a dependency on global macro-economic variables such as oil prices and the prices of other raw materials.

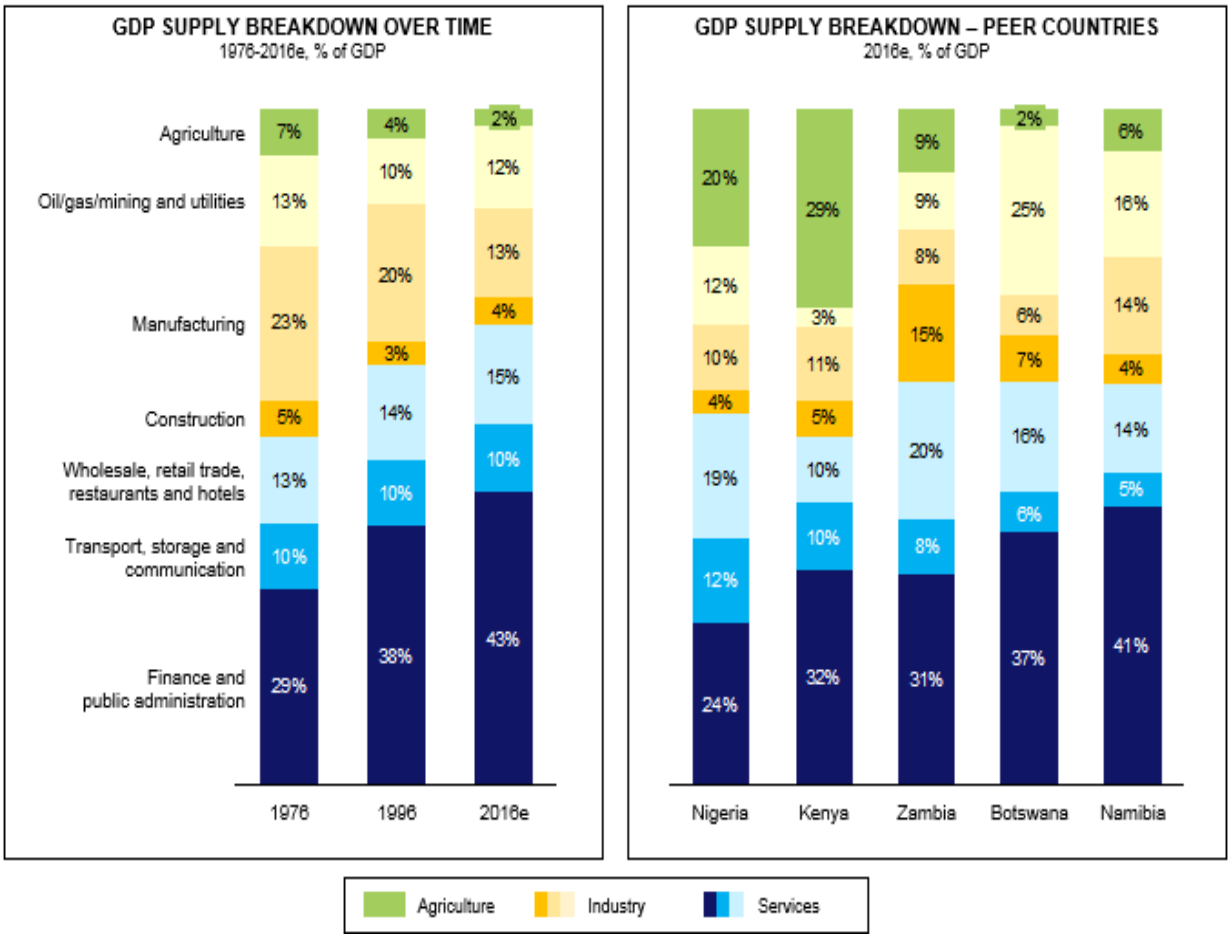


Figure 2: GDP supply breakdown. *Source:* **(EIU Canback, 2016)**, **(World Bank, 2016)**

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Figure 2 also shows that the service sector has been the largest contributor to South Africa's GDP over the last four decades hence factors that directly affect this sector, likewise impact the GDP. For instance, literature proposes multiple mechanisms by which predictable fluctuations in inflation rates hinder the effective allocation of resources in the financial sector (Boyd, Levine, & Smith, 2001). Demirguc-Kunt and Levine (1996), showed that there is a correlation between growth in GDP and market capitalisation of a given country. On the other hand, there is a correlation between stock prices and exchange rates (Cenedese, Payne, Sarno, & Valente, 2016) .

2.3.2 *South Africa's GDP demand breakdown overtime*

South Africa's demand side GDP is dominated by household consumption. Berben and Stokman (2016) found that a decline in price levels has a detrimenal effect on real consumption growth and household investment. They found that the consequence of inflation flactuation is more pronounced for investment than it is for household consumption and it has a delayed effect.

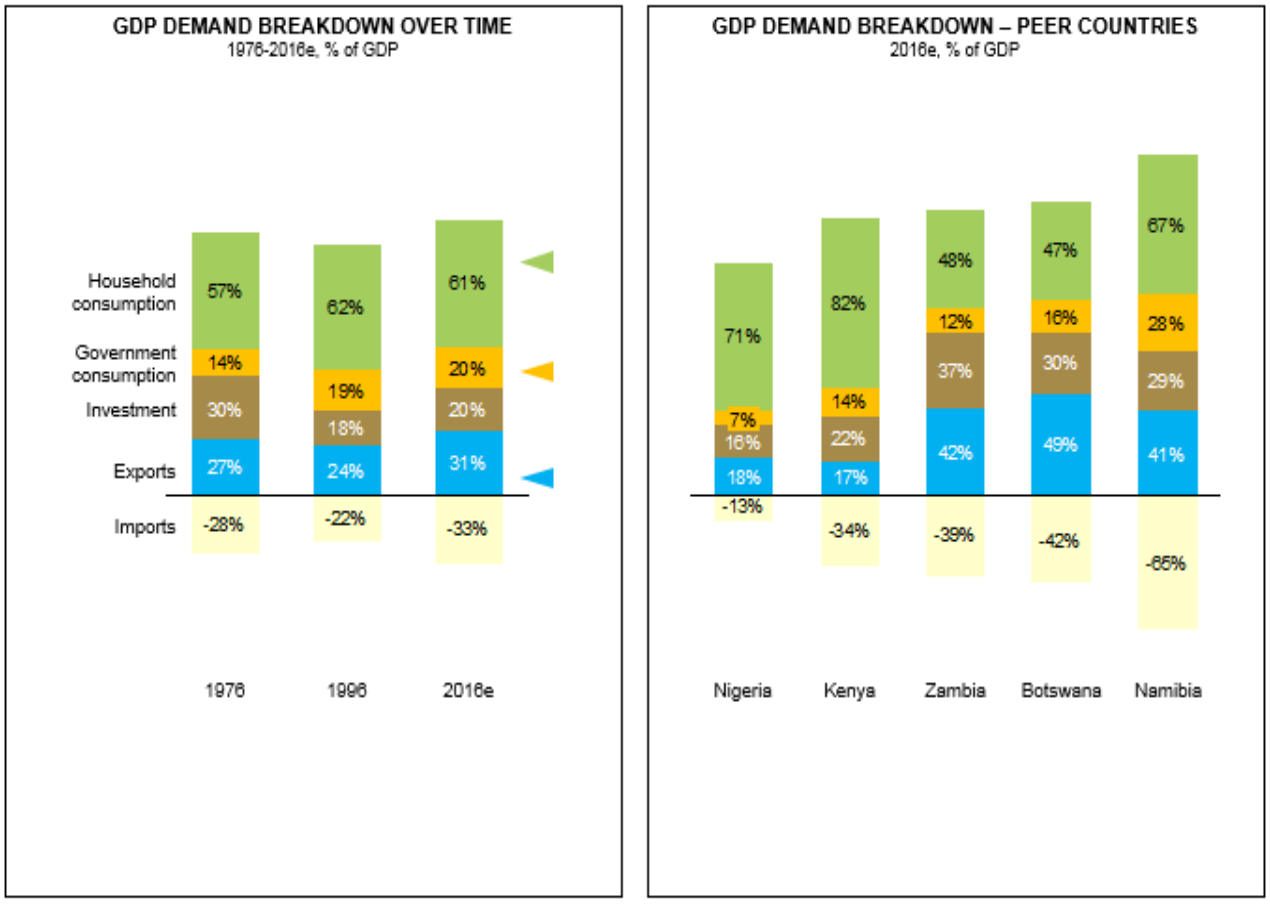


Figure 3: GDP demand breakdown over time. *Source:* **(World Bank, 2016)***;* **(EIU Canback, 2016)**

Looking at the balance of trade, South Africa is a net importer and this is in-line with its peer countries. Net imports suggest that a large stock of foreign exchange is necessary to facilitate these transactions, thus exchange rates have a direct impact on the gross domestic product.

2.3.3 *Main trade partners*

Figure 4 shows that South Africa's main export and import partner is China which accounts for about 18% of all imports and 8.3% of all exports. Other top trade partners are the members of BRICS and G6 respectively. This suggest that fluctuations in the business cycles of any of these economies can be expected to have an impact on South Africa's business cycles and vice-versa.

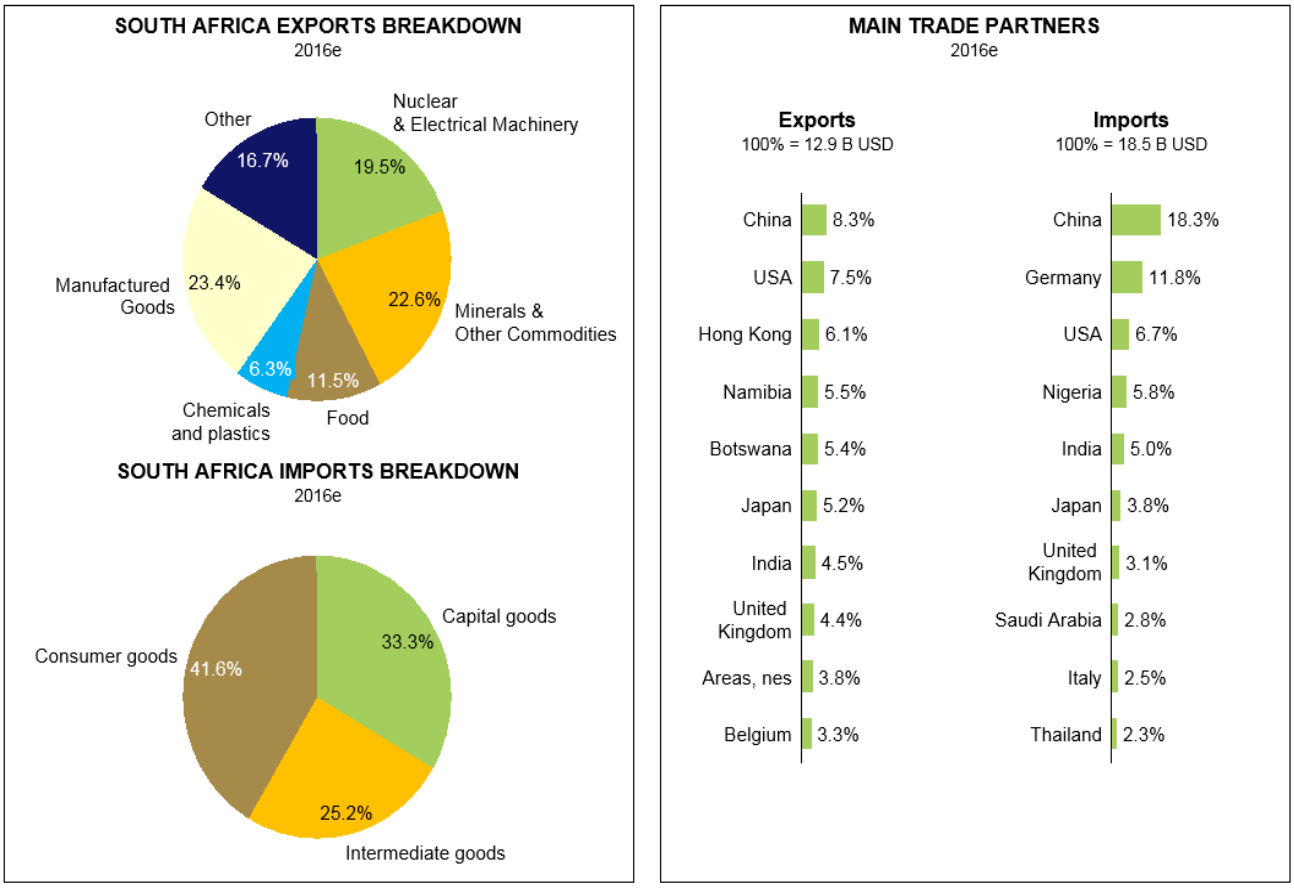


Figure 4: Main trade partners. *Source: StatsSA (2016), UN Comtrade (2016), EIU Canback (2016)*

For instance, macroeconomic factors that affect South Africa's trade partners' ability to import or export will influence its GDP. A sudden drop in demand for commodities in China will in turn reduce South Africa's commodity exports to China. A number of authors have investigated the spill-over effect of such shocks and the mechanisms through which there are transmitted to other economies (Sun, Heinz,

& Ho, 2013; Anderton, di Mauro, & Moneta, 2004; Cologni & Manera, 2008; Dees, Di Mauro, Pesaran, & Smith, 2007; Smith & Galesi, 2014; Boako & Alagidede, 2016; Mensi, Hammoudeh, Nguyen, & Kang, 2015; Mukhejee & Bhaduri, 2015). Galesi and Lombardi (2009), came to the conclusion that extensive economic integration that is prevalent in today's global economy is exposing most global economies to external shocks which are manifesting in the macroeconomics of these economies. As discussed above, the BRICS countries are the rising economic super powers and their economic and financial influence will continue to increase with time, hence gyrations in their macroeconomic indicators will have a direct impact on interlinked economies especially the G6 countries which are their top trade partners. Therefore, it is worthwhile investigating how shocks in BRICS countries' macroeconomic variables such as inflation, exchange rates, oil price, raw material prices and equity prices which have been shown to have some degree of influence on the aggregated economy of the top five industrialized nations globally and vice versa. No study was found in literature directly addressing this issue, which makes it a worthwhile endeavour. The question therefore is, what are shocks and how would one evaluate their effect on interlinked economies?

2.4 Shocks

Shocks are sudden changes in macroeconomic variables; they can be internal (endogenous) or external(exogenous) (Galesi & Lombardi, 2009). Endogenous shocks originate from within a given economy for example interest rates, inflation and equity prices. They have a direct impact on a given country's economy and can be modified using appropriate monetary policy. Exogenous shocks are not influenced by any one economy and their effects span across multiple economies. A good example is increases in oil prices; since it is traded in the interlinked global market, it is difficult for any given country to control its price. From a short-run perspective, macroeconomic performance is affected by oil price shocks through its influence on production costs, real income and uncertainty. According to Galesi and Lombardi (2009), oil price affects macroeconomic performance through several channels such as the terms trade effect in which real income is transferred from oil importing economies to oil exporters. Secondly, it will be through inflationary effects

as several components of the consumer price index are oil based. It could also be through productions cost hikes in oil, the fuel source for production processes and transportation. Financial markets are very sensitive to fluctuations in core macroeconomic variables hence changes in oil prices will affect equity prices, bond rating, exchange rates and the like. There is also a psychological impact on consumers who are likely to cut back on oil consumption if the there is a perceived uncertainty in supply.

Such effects on macroeconomic performance are experienced with changes in both endogenous and exogenous shocks however, the exact effect or channel of transmission are sometimes more difficult to identify. Nonetheless, it is important to quantify the effect of such shocks where possible.

2.5 The GVAR model

The GVAR approach was has been found to be the best way to model global macroeconomic interactions (Pesaran, Schuermann, & Weiner, 2004).This is a relatively novel modelling technique called the Global Vector Autoregressive Modelling approach. Literature, also suggests that it is the best way to address the questions raised by this research study (Dees, Di Mauro, Pesaran, & Smith, 2007; Galesi & Lombardi, 2009; Mensi, Hammoudeh, Nguyen, & Kang, 2015; Pesaran, Schuermann, & Weiner, 2004; Sun, Heinz, & Ho, 2013).The model was developed by Pesaran, Schuermann and Weiner (2004) and later extended by Dees, Di Mauro, Pesaran, and Smith (2007). This model makes use of a macroeconometrics framework which gives it the unique ability to analyse the interactions among a set of economies.

In essence this approach models the economies under scrutiny individually using a vector autoregressive models (VAR). It then combines these individual models into one global model involving all countries of interest by the use of foreign specific variables which are related to the trade patterns of each respective country (Pesaran, Schuermann, & Weiner, 2004).

The novelty of the global autoregressive model is the way the model is estimated. That is, it assumes the small open economy hypothesis for all countries or regions of interest and then uses this to estimate the individual models using the weak-exogeniety assumption for the global variables (Dees, Di Mauro, Pesaran, & Smith, 2007). The estimation process is in such a way that it integrates the properties of the data series which makes it possible for the relationships between domestic and foreign variables to be determined (Galesi & Lombardi, 2009; Smith & Galesi, 2014). Finally when all respective country specific VARX models have been estimated, the resulting estimates are linked through matrices which can then be stacked to form the full Global Vector Autoregressive model. Results can be analysed thereafter using Generalised Impluse Response functions (GIRFs) and Generalized Forecast Error Variance Decompositions (GFEVDs) (Galesi & Lombardi, 2009). The details of how this model will be applied to the context of this research will be fully described in the next chapter.

2.6 Conclusion

The literature states that the world's economies are becoming more and more integrated. This has resulted in the synchronization of business cycles. The effect of macroeconomic events (shocks) in one geography has now been found to have ripple effects in other geographies. Hence shocks in economies with strong macroeconomic influence can be expected to influence the macroeconomic performance of interrelated economies. The BRICS countries have been earmarked to be the next generation of economic and financial powerhouses hence they will play an increasingly more important role in global economic going forward. Thus, it is imperative to understand shock transmission and level of business cycle synchronization between the BRICS and G5 blocs as the balance of power shifts from the G5 to the BRICS bloc.

CHAPTER 3

RESEARCH METHODOLOGY

The research highlights shock transmission and the level of business cycle synchronisation between BRICS and the G5 economic blocs. For example, investigating how a sudden change in BRICS's short term interest rates affects other macroeconomic variables in both the BRICS and G5 economies. This chapter discusses the research methods that is used to achieve the goals of this research study. The first section describes the research paradigm and its suitability for this study. The next section describes the research design, which gives the methodological approach that is adopted. Section three describes the data that is used to construct the GVAR model. In section six, a discussion of how the data is analysed and interpreted is given. Finally, limitations of the study and issues of validity and reliability are discussed in the last section.

3.1 Research Methodology

The research paradigm that is followed in this study is quantitative. Quantitative research methodologies accentuate quantification in the way that data is collected and analysed (Bryman, 2012). The alternative paradigm is qualitative in nature and places greater focus on words rather than quantification in the collection and analysis of data (Bryman, 2012). A third paradigm exists and it combines aspects of both qualitative and quantitative research methods and it is called mixed methods research (Leedy & Ormrod, 2005; Bryman, 2012).

Quantitative research was selected because it has several merits that make it particularly attractive for the purposes of this study. According to Bryman (2012), quantitative research involves an approach that is predominantly deductive when relating theories to research. Likewise, this study aims to deduce causal links between various shocks and the resultant responses in the BRICS and G5 bloc

economies. On the other hand, qualitative methods mainly use an inductive approach with importance placed on the generation of theories.This makes them inappropriate for the current study which focuses on quantifying the effect of various shocks on selected economies rather than the generation of theories.

Quantitative research methodology are practices and norms that have been adopted from the natural scientific model of research and of positivism (Bryman, 2012). Leedy and Ormrod (2005), define positivism as a descriptive category which describes a philosophical position that can be determined in research. The objectives of this research resonate well with this line of thinking; that is, a philosophical position which postulates that a high level of business cycle synchronization exists Between the BRICS and G5 bloc economies. On the other hand, qualitative research paradigms have rejected practices from posivitism and natural sciences research but rather focus on the way individuals view their social world (Bryman, 2012). As a result, this makes this approach fundamentally inappropriate for the purposes of this study.

Some of the shortcommings of quantitative research are that it fails to clearly distinguish between people, social institutions and the natural world (Bryman, 2012). This is flawed in that it disregards the differences in the social and natural worlds respectively. Secondly, the process of measuring gives a false sense of accuracy and precision; for example, if there is an error in the way in which the data is collected and complied the resulting insights are also flawed (Leedy & Ormrod, 2005; Bryman, 2012). However, this will not be a problem for this study because actual observed data as recorded by the most reputable global sources of economic data e.g. the World Bank, Bloomberg and the IMFwill be used. The quantitative approach proposed for this investigation uses historical data to derive insights about the way global ecomies interact. The challenge with this approach is that there is no garauntee that historic trends will hold in the future, hence any gneralizations have to be made with the utmost caution. To reduce the effects of this, data will be drawn from a long time horizon starting from 1979.

On the other hand, qualitative research does address some of the issues associated with quantitative reseacrh but also has some weaknesses. This research approach

is very subjective and it is difficult to replicate (Leedy & Ormrod, 2005). Due to the nature of qualitative research the scope of the findings are limited, which makes it difficult for generalisations to made. Then again, it also has issues around transparency because one can never know exactly how or what the researcher did to reach his conclusions (Bryman, 2012).

This particular study aims to make generalisations about the nature of interactions among BRICS economies but this would be difficult with qualitative research because of the above mentioned weaknesses. Another reason is that qualitative research seeks contextual understanding of social phenomena while quantitative seeks to use hard and reliable data to make generalisations.

It is clear from the above discussion that the suitability of the qualitative research paradigm for this study is questionable while the quantitative approach seems more appropriate. For this reason, this study uses the quantitative research paradigm.

3.2 Research Design

Quantitative research design can take several forms; these include structured interviewing, self-completion questionnaires and the use of data archives.

Structured interviews are one way in which a research survey can be delivered to chosen participants. In this approach an interviewer is tasked with the role of administering the questionnaire (closed ended questions would be asked) directly to the respondent (Bryman, 2012). According to Leedy and Ormrod (2005), some advantages of this approach are that the way questions are asked and answers recorded can be standardised with reduced errors due to limited interviewer variability and the possibility of missing data. However, the main setbacks include time and monetary cost associated with data collection from the large number of respondents necessary for this study. Due to the resource limitations (i.e. time and money) associated with the MBA research report, structured interviewing will not be used.

The other option is the self-completion questionnaire. In this approach the respondents complete the questionnaire unaided by an interviewer at their own chosen time. The self-completion questionnaire can be administered using numerous survey administration tools like Qualtrics.

The self-completion questionnaire has advantages which include that it is relatively inexpensive and quick to distribute, especially for samples which are geographically dispersed. This research design reduces biases introduced by the interviewer`s social cues during the interview; for example, questions on whether a finance minister thinks his economy is resilient in the face of economic shocks may not get a truthful response because the respondents fear of being judged as poorly performing. This makes it ideal for this study as it enables respondents to be as honest as possible. Another advantage is that interviewer variability is factored out of the equation hence eliminating errors associated with changes in the way interviewers administer the questions. It is also very convenient for the respondents as they are free to complete the questionnaire when and where they please and at a pace that is most suitable for them. This creates a relaxed environment which means that the best possible responses are obtained.

The down side of self-completion questionnaires however, is that in the case of a respondent having difficulty with understanding or answering the question there is no one to help. Another disadvantage is that there is no way to probe the respondent to get deeper understanding of their responses. In addition to the above. The greatest disadvantage of this approach is low response rates in the order typically less than 40% (Bryman, 2012; Gcaza, 2013).

However, this research will make use of historical data captured for the various macroeconomic variables in the respective countries. The biggest advantages of this type of research design include very little costs incurred in the collection of the data and such data can be collected in a relatively short timeframe. Biases are eliminated as the data is observed economic phenomena and not respondent opinions. The problem of low response rates is also eliminated as data can be readily found in World Bank archives and other similar data repositories. Another advantage is that it eliminates the complexities associated with collecting data from

respondents who are geographically dispersed. This research design also instils a great deal of confidence in the conclusions that are drawn because of the high integrity of data that is used. On the other hand, the disadvantage of this research design is that such data is limited in showing the qualitative aspects of the observed trends and historical trends may not be the best proxies for future trends. However, if the data is collected for a sufficiently long period future behaviour can be approximated with some degree of confidence.

In the context of this study, the advantages of using historical data outweigh the disadvantages and some ways to counteract some of these disadvantages have been found which makes it a good choice.

3.3 Population and Sample

3.3.1 *Population*

As the study investigates the dynamics of both the emerging economies and the developed economies in response to external economic shocks. The total population of from which a sample could be drawn sum of all developed and emerging economies of the world. However, the BRICS countries have been found to be the bellwethers of economic trends in the emerging markets, while the G5 are likewise for the developed economies (Sharma & Mahendru, 2013). Therefore, BRICS (China, Brazil, India and South Africa) and G5 (Germany, France, Japan, United Kingdom and United States) are the only countries that are considered in this study as they constitute the sample space of interest.

3.3.2 Data

The data that used to fulfil the objectives of this study is drawn from multiple reputable sources. The dataset contains data from the first quarter of 1979 through to the first quarter of 2013.The input variables for the GVAR model are broken down into endogenous and exogenous macroeconomic variables. Exogenous variables are considered as having a direct effect only to the economy of the country of

interest, whilst effects experienced by linked economies are secondary. This means that some identifiable transmission mechanism is responsible for transferring the shock in this variable to other economies linked to the source of the shock. Endogenous variables include consumer price indices (Inflation), Equity price indices, exchange rates, short-term interest rates and long-term interest rates. On the other hand, exogenous variables are not limited to specific countries or economies but rather affect all global economies. These include oil prices and other commodities such as agricultural raw materials and metal prices. It is noteworthy that the effect of these variables varies in nature and intensity from one country to the next depending on the structure of the economy. For example, a large oil producing economy is less affected by shocks in metal prices than it is by shocks in oil prices. The cleaned dataset can be found in Appendix A.

3.4 Data Analysis and Interpretation

The first stage after the collection of the data involved assessing the accuracy of the collected data and then running the frequency distributions on all variables. It is however, not be necessary to conduct a missing data analysis as steps were taken in the data collection stage to ensure no data is missing.

3.4.1 *The GVAR Model*

According to Smith and Galesi (2014), the global vector autoregressive model combines individual vector error correcting models for all the countries under consideration. This approach relates country specific domestic variables and the corresponding foreign variables in a consistent manner which simplifies subsequent analysis. The GVAR approach is a solid and comprehensive way to model the global economy or any other group of interlinked economies and more importantly it depends completely on observable variables. Such observable variables can be macroeconomic aggregates as in this case or financial variables (Pesaran, Schuermann, & Weiner, 2004).

This modelling approach is advantageous in that it provides a transparent way in which to evaluate interlinkages amongsts economies either at national or international level (Smith & Galesi, 2014). It also allows long-run relationships which are in line with extant economic theory as well as short run relationships which are in line with the data to be modelled (Pesaran, Schuermann, & Weiner, 2004; Galesi & Lombardi, 2009). Most importantly, the GVAR model is a universal and robust framework for analysing the relative importance of different shocks and shock transmission channels in a quantitative manner (Smith & Galesi, 2014). These properties make the GVAR approach very appropriate for the purposes of this study.

The global vector autoregressive model that is built for this study covers nine countries that are augmented into two regions, the G5 and BRICS blocs for analysis respectively.The augmentation makes use of appropriate weighting to generate regional variables for the individual countries. In this model the two respective regions are each represented by a unique auto regressive model. These four $VARX_{(pi,qi)}$ (where ì represents the respective BRICS contries) models isl then augmented using weekly exogenous variables. The model relates domestics variables of one region to the foreign specific variables and global variables as shown in equation 1 below:

$$\phi_i(L,P_i)x_{it} = a_{i0} + a_{it}t + \Lambda_i(L,q_i)x_{it}^{*} + \psi_i(L,q_i)d_t + u_{it} \qquad (1)$$

For $i = 1,2,3,4$ and $t = 1,2,\ldots\ldots,T$, x_{it} represents the set of domestic variables (real GDP, inflation, real equity prices, nominal dhort and long term interest rate). $\phi_i(L,P_i)$ is the matrix lag polynomial of the associated coefficients; a_{i0} is a vector of fixed intercepts and a_{it} is a vector of coefficients of the deterministic time trend; x_{it}^{*} is the set of foreign specific variables and $\Lambda_i(L,q_i)$ is the matrix lag polynomial of the associated coeficients, d_t is the set of exogenous variables (oil price, raw material price and metal prices) and $\psi_i(L,q_i)$ is the matrix lag polynomial of related coefieicents, finally u_{it} is a vector of idiosyncratic, serially uncorelated country specific shocks. The GVAR model estimation and analysis is done using MATLAB levergaing the GVAR tool box developed by Smith and Galesi (2014).

3.5 Limitations of the Study

This research study aims to assess the levels of business cycle synchronisation between the BRICS and G5 bloc economies. It also investigates how various shocks are transmitted in this group of interlinked economies. The focus is on the list of selected countries only any other country or group of countries are considered to be out of the scope of this study. This opens the opportunity for future studies on the level of synchronization between the entire group of emerging economies and that of the developed economies to be conducted, as the GVAR modelling approach has the capability to handle such a large number of countries, high data volumes and complexity. The study focuses on the G5 instead of the more conventional G7 because the aim was to have to have relatively similar numbers of countries in economic blocs under consideration. Another opportunity for future study would be considering business cycle synchronisation between the G7 and BRICS.

3.6 Research Ethical Issues

No ethical issues are foreseen as the design of this research eliminates the need for interviewing participants to solicit opinions or requesting permission and data from organisations. This is because all the data that will be utilised for purposes of this study are freely available online or through the university's paid subscriptions to the various data portals

CHAPTER 4

DATA ANALYSIS & RESULTS

4.1 Introduction to Research process

This chapter describes the data that was used and how it was analysed to achieve goals of the research study. The modelling techniques used in the investigation as well as the efficacy of the models developed is discussed in this chapter. The first section discusses the cleaning and processing of the macroeconomic data that was used in this investigation. An overview of modelling techniques and the descriptive statistics of the data that was used are then presented. This is followed by a summary of results for the unit root tests that were performed. Section seven discusses the weak exogeniety tests that were performed and the associated results. Section eight discussed the tests performed for structural breaks and section nine describes the pair-wise cross-sectional correlations between the variables and the respective residuals. Section ten tests the robustness of the GVAR results obtained. Finally, the generalised impulse response functions is presented for the tests undertaken for the various shock transmission mechanisms investigated.

4.2 Data processing

This section describes how the raw macroeconomic data were analysed to get the analytical variables that were model-ready. Quarterly GDP data was sort from the International Financial Statistics (IFS) database (IMF, 2016). An index was created with the year 2005 taken as the base year, that is the index for 2005 was set as the base year. Missing data was sourced from other sources such as Bloomberg. Similarly, the consumer price index data was collected from the IMF`s International Financial Statistics online database. An index based on 2005 values was also created. Missing data points were obtained by extrapolation of growth rates in the period of interest from Bloomberg data (Smith & Galesi, 2014). The Bloomberg portal was used to attain the equity prices over

the period of interest. MSCI country indices for each quarter in the local currency for each of the countries of interest were also obtained . The Bloomberg data is only used to supplement missing data. Bilateral exchange rates against the US dollar were obtained for each country and for every quarter in the period of interest. The methodology for attaining the quarterly exchange is as described by Smith and Galesi (2014). Both long and short term interest rates data were obtained from the International financial statistics only database and the methodology is also consistent with that of Smith and Galesi (2014).

For the global variables, comodity prices (agricultural raw materials and metal prices), World Bank monthly prices were used to compute the quarterly averages. Backward extrapolation was used to attain missing data. To construct the quartely series for the oil prices, averages were calcualted from the daily prices as reported by the U.S. Energy Information Administration (2016).

4.3 Overview of Modelling Techniques

Extant literature has shown that the properties of business cycles are the related fluctuations in interest rates, output, inflation and real equity prices (Anderton, di Mauro, & Moneta, 2004; Dees, Di Mauro, Pesaran, & Smith, 2007; Galesi & Lombardi, 2009). The nature and similarity of these fluctuations have become more defined due to globalisation and greater financial and economic integration (Dees, Di Mauro, Pesaran, & Smith, 2007). As such, a lot of effort has been dedicated to developing techniques to model these inter-relations. Some techniques that have been developed include bivariate correlation analysis, multivariate and multi country analyses, dynamic factor analysis among others (Galesi & Lombardi, 2009). The challenge however, arises from the fact that there are many channels through which international business cycles are transmitted. They can be transmitted through observable factors like changes in oil or metal prices and they can also be transmitted unobservable factors like the rate of global technology and innovation diffusion. This makes it difficult to capture the effect of diverse business cycle co-movements in the global economy. The global autoregressive model developed by Pesaran, Schuermann and Weiner (2004), is the solution to this problem as it provides a

global framework with the ability to test the relative importance of various sources of co-movements.

4.4 Descriptive Statistics

The investigation used various macroeconomic variables from nine countries representing the two regions of interest. Macroeconomic variables from Brazil, China, India and South Africa were augmented to create the BRICS region. On the other hand, the macroeconomic variables from France, Germany, Japan, the UK and the USA were also augmented to represent the G5 as a single region. The descriptive statistics were calculated for all three types of variables that were input in the GVAR model, these are domestic variables, foreign-specific variables and global variable respectively. For each of the variables, the mean, median, max, min, standard deviation, skewness, kurtosis and the Jarque-Bera statistic were calculated. The p-value associated with the Jarque-Bera statistic was also calculated.

4.4.1 *Domestic Variables*

Most variables display varying degrees of positive skewness apart from real GDP and real equity prices for G5 region and all real exchange rates which are slightly negatively skewed. The spread of the values around the mean and minimal, with the highest standard deviations observed for real GDP and real equity prices respectively.

Table 3: Descriptive statistics of domestic variables

Variable	Region	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera	P-value
REAL GDP	BRICS	4.35	4.32	5.75	3.08	0.78	0.15	1.88	7.22	0.03
	G5	4.45	4.43	4.86	4.00	0.27	-0.06	1.62	10.54	0.01
INFLATION	BRICS	0.05	0.02	0.32	-0.01	0.06	1.72	6.27	132.47	0.00
	G5	0.01	0.01	0.03	0.00	0.01	0.89	3.23	18.72	0.00
REAL EQUITY PRICES	BRICS	1.32	1.33	2.29	0.38	0.44	0.16	2.71	0.94	0.63
	G5	1.56	1.59	2.63	0.31	0.65	-0.25	1.81	9.05	0.01
REAL EXCHANGE RATE	BRICS	-2.97	-2.93	-2.52	-3.51	0.23	-0.63	3.08	9.35	0.01
	G5	-3.70	-3.72	-3.13	-4.27	0.31	-0.08	2.12	4.23	0.12
	BRICS	0.05	0.03	0.32	0.01	0.06	1.86	6.97	174.09	0.00

NOMINAL S RATE	G5	0.02	0.01	0.04	0.00	0.01	0.47	2.12	9.23	0.01
NOMINAL L RATE	BRICS	0.02	0.02	0.04	0.01	0.01	0.34	1.60	13.37	0.00
	G5	0.02	0.02	0.04	0.01	0.01	0.38	2.16	7.13	0.03

4.4.2 *Foreign-Specific Variables*

Table 4 shows that all foreign-specific variables are positively skewed except for real GDP and real equity prices in BRICS region and exchange rates in both the BRICS and G5 regions. The Jarque-Bera statistic and the respective p-values all variables except the G5`s real equity prices suggest that the distributions are not normal.

Table 4: Descriptive statistics of foreign specific variables

Variable	Region	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera	P-value
REAL GDP	BRICS	4.45	4.43	4.86	4.00	0.27	-0.06	1.62	10.54	0.01
	G5	4.35	4.32	5.75	3.08	0.78	0.15	1.88	7.22	0.03
INFLATION	BRICS	0.01	0.01	0.03	0.00	0.01	0.89	3.23	18.72	0.00
	G5	0.05	0.02	0.32	-0.01	0.06	1.72	6.27	132.47	0.00
REAL EQUITY PRICES	BRICS	1.56	1.59	2.63	0.31	0.65	-0.25	1.81	9.05	0.01
	G5	1.32	1.33	2.29	0.38	0.44	0.16	2.71	0.94	0.63
REAL EXCHANGE RATE	BRICS	-3.70	-3.72	-3.13	-4.27	0.31	-0.08	2.12	4.23	0.12
	G5	-2.97	-2.93	-2.52	-3.51	0.23	-0.63	3.08	9.35	0.01
NOMINAL S RATE	BRICS	0.02	0.01	0.04	0.00	0.01	0.47	2.12	9.23	0.01
	G5	0.05	0.03	0.32	0.01	0.06	1.86	6.97	174.09	0.00
NOMINAL L RATE	BRICS	0.02	0.02	0.04	0.01	0.01	0.38	2.16	7.13	0.03
	G5	0.02	0.02	0.04	0.01	0.01	0.34	1.60	13.37	0.00

4.4.3 *Global variables*

Table 5 shows that there is a fair amount of spread in oil and raw materials due to the volatile nature of these commodity prices. These two variables also show a strong degree of positive skewness and deviation from normality as shown by the Jarque-Bera statistic.

Table 5: Descriptive statistics of global variables

Variable	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera	P-value
OIL PRICE	3.42	3.32	4.81	2.41	0.63	0.67	2.43	11.96	0.00
RAW MATERIAL PRICE	4.55	4.59	5.10	4.06	0.23	-0.34	2.60	3.48	0.18
METAL PRICE	4.37	4.20	5.52	3.81	0.47	1.05	2.76	25.58	0.00

4.5 Unit Root Tests

Two types of unit root tests are performed for each respective variable; that is, the augmented Dickey-Fuller test which will be referred to as ADF going forward and the weighted-symmetric augmented Dickey-Fuller test which be referred to as WS. The tests were carried out for global, foreign specific and domestic variables that were used in the global vector autoregressive model. Each respective variable was tested for unit roots at current levels, first order and second order differences respectively. Regressions including both the trend and intercept and another with just the trend were calculated when the tests were performed.

4.5.1 *Domestic variables*

At the 5% significance level, there is evidence to suggest that there are no unit roots in most domestic variables time series data. Variables without a trend are more likely to contain unit roots as Table 6 shows that the respective statistics are less negative than those of variables with a trend. The hypothesis suggesting the presence of unit roots is even more strongly rejected as the order of differences increases. That is second order differenced variables generally have more negative statistics than first order differenced variables meaning the null hypothesis can be more strongly rejected. The weighted-systematic augmented Dickey-Fuller test shows results relative to the simple augmented Dickey-Fuller test which concurs with Dees, Di Mauro, Pesaran and Smith (2007).

Table 6: Unit root tests for the domestic variables at the 5% significance level

Domestic Variables	Statistic	Critical Value	BRICS	G5

y (with trend)	ADF	-3.45	-2.11814	-2.47404
y (with trend)	WS	-3.24	-2.015	-2.60745
y (no trend)	ADF	-2.89	1.094951	-0.56126
y (no trend)	WS	-2.55	0.909728	1.253302
Dy	ADF	-2.89	-3.60761	-5.19569
Dy	WS	-2.55	-3.80656	-5.38881
DDy	ADF	-2.89	-10.7515	-7.79653
DDy	WS	-2.55	-10.4767	-7.92321
Dp (with trend)	ADF	-3.45	-2.95233	-2.73835
Dp (with trend)	WS	-3.24	-2.9012	-2.27262
Dp (no trend)	ADF	-2.89	-2.35543	-2.36564
Dp (no trend)	WS	-2.55	-2.58428	-0.50614
DDp	ADF	-2.89	-8.79147	-8.71057
DDp	WS	-2.55	-8.94795	-8.88857
DDDp	ADF	-2.89	-9.83646	-9.77342
DDDp	WS	-2.55	-10.0687	-10.0099
eq (with trend)	ADF	-3.45	-4.15857	-2.46813
eq (with trend)	WS	-3.24	-4.03031	-2.66126
eq (no trend)	ADF	-2.89	-1.67119	-1.17805
eq (no trend)	WS	-2.55	-1.85557	-0.51659
Deq	ADF	-2.89	-6.89689	-7.36766
Deq	WS	-2.55	-6.70187	-7.51071
DDeq	ADF	-2.89	-9.22184	-8.86983
DDeq	WS	-2.55	-9.31909	-9.09984
ep (with trend)	ADF	-3.45	-1.73215	-2.02013
ep (with trend)	WS	-3.24	-1.08579	-2.21951
ep (no trend)	ADF	-2.89	-0.02691	-0.72459
ep (no trend)	WS	-2.55	-0.45007	0.632343
Dep	ADF	-2.89	-7.11423	-7.51657
Dep	WS	-2.55	-7.21616	-7.58327
DDep	ADF	-2.89	-9.69339	-9.76359
DDep	WS	-2.55	-9.93545	-10.024
r (with trend)	ADF	-3.45	-2.8563	-3.43757
r (with trend)	WS	-3.24	-2.60186	-3.73861
r (no trend)	ADF	-2.89	-2.1243	-1.51426
r (no trend)	WS	-2.55	-2.34712	-0.85778
Dr	ADF	-2.89	-11.124	-5.57471
Dr	WS	-2.55	-11.2959	-5.64994
DDr	ADF	-2.89	-11.1536	-8.68843
DDr	WS	-2.55	-11.4192	-8.87059
lr (with trend)	ADF	-3.45	-3.65903	-3.92069
lr (with trend)	WS	-3.24	-2.3576	-3.59271
lr (no trend)	ADF	-2.89	-0.54423	-1.03665
lr (no trend)	WS	-2.55	-0.96636	-1.03811
Dlr	ADF	-2.89	-6.03892	-5.75664

Dlr	WS	-2.55	-5.93408	-5.5195
DDlr	ADF	-2.89	-8.09021	-8.67071
DDlr	WS	-2.55	-8.25883	-8.83387

Note: 'y' represents real GDP, 'Dp' represents nominal inflation rates, 'eq' represents real equity prices, 'ep' represents foreign exchange, 'r' represents nominal interest rates, 'lr' represents long-term interest rates, 'D' represents first order difference and 'DD' represents second order difference.

4.5.2 *Foreign specific variables*

Table 7 shows that similar results are obtained for the foreign variables as was observed for the domestic variables. That is the hypothesis that unit roots are present in the data can be rejected at the 5% significance level.

Table 7: Unit Root tests for the foreign variables at the 5% significance level

Foreign Variables	Statistic	Critical Value	BRICS	G5
ys (with trend)	ADF	-3.45	-2.47404	-2.11814
ys (with trend)	WS	-3.24	-2.60745	-2.015
ys (no trend)	ADF	-2.89	-0.56126	1.094951
ys (no trend)	WS	-2.55	1.253302	0.909728
Dys	ADF	-2.89	-5.19569	-3.60761
Dys	WS	-2.55	-5.38881	-3.80656
DDys	ADF	-2.89	-7.79653	-10.7515
DDys	WS	-2.55	-7.92321	-10.4767
Dps (with trend)	ADF	-3.45	-2.73835	-2.95233
Dps (with trend)	WS	-3.24	-2.27262	-2.9012
Dps (no trend)	ADF	-2.89	-2.36564	-2.35543
Dps (no trend)	WS	-2.55	-0.50614	-2.58428
DDps	ADF	-2.89	-8.71057	-8.79147
DDps	WS	-2.55	-8.88857	-8.94795
DDDps	ADF	-2.89	-9.77342	-9.83646
DDDps	WS	-2.55	-10.0099	-10.0687
eqs (with trend)	ADF	-3.45	-2.46813	-4.15857
eqs (with trend)	WS	-3.24	-2.66126	-4.03031
eqs (no trend)	ADF	-2.89	-1.17805	-1.67119
eqs (no trend)	WS	-2.55	-0.51659	-1.85557
Deqs	ADF	-2.89	-7.36766	-6.89689
Deqs	WS	-2.55	-7.51071	-6.70187
DDeqs	ADF	-2.89	-8.86983	-9.22184
DDeqs	WS	-2.55	-9.09984	-9.31909
eps (with trend)	ADF	-3.45	-2.02013	-1.73215
eps (with trend)	WS	-3.24	-2.21951	-1.08579
eps (no trend)	ADF	-2.89	-0.72459	-0.02691
eps (no trend)	WS	-2.55	0.632343	-0.45007
Deps	ADF	-2.89	-7.51657	-7.11423
Deps	WS	-2.55	-7.58327	-7.21616

DDeps	ADF	-2.89	-9.76359	-9.69339
DDeps	WS	-2.55	-10.024	-9.93545
rs (with trend)	ADF	-3.45	-3.43757	-2.8563
rs (with trend)	WS	-3.24	-3.73861	-2.60186
rs (no trend)	ADF	-2.89	-1.51426	-2.1243
rs (no trend)	WS	-2.55	-0.85778	-2.34712
Drs	ADF	-2.89	-5.57471	-11.124
Drs	WS	-2.55	-5.64994	-11.2959
DDrs	ADF	-2.89	-8.68843	-11.1536
DDrs	WS	-2.55	-8.87059	-11.4192
lrs (with trend)	ADF	-3.45	-3.92069	-3.65903
lrs (with trend)	WS	-3.24	-3.59271	-2.3576
lrs (no trend)	ADF	-2.89	-1.03665	-0.54423
lrs (no trend)	WS	-2.55	-1.03811	-0.96636
Dlrs	ADF	-2.89	-5.75664	-6.03892
Dlrs	WS	-2.55	-5.5195	-5.93408
DDlrs	ADF	-2.89	-8.67071	-8.09021
DDlrs	WS	-2.55	-8.83387	-8.25883

4.5.3 *Global variables*

Tables 8 shows that all test statistics are negative suggesting that at this level of significance, the hypothesis that unit roots are present can be rejected.

Table 8: Unit Root tests for the global variables at the 5% significance level

Global Variables	Test	Critical Value	Statistic
poil (with trend)	ADF	-3.45	-1.53
poil (with trend)	WS	-3.24	-1.14
poil (no trend)	ADF	-2.89	-0.19
poil (no trend)	WS	-2.55	-0.64
Dpoil	ADF	-2.89	-6.77
Dpoil	WS	-2.55	-6.94
DDpoil	ADF	-2.89	-9.56
Dpoil	WS	-2.55	-9.72
pmat (with trend)	ADF	-3.45	-2.43
pmat (with trend)	WS	-3.24	-2.68
pmat (no trend)	ADF	-2.89	-1.28
pmat (no trend)	WS	-2.55	-0.97
Dpmat	ADF	-2.89	-5.67
Dpmat	WS	-2.55	-5.86
DDpmat	ADF	-2.89	-9.37
Dpmat	WS	-2.55	-9.60
pmetal (with trend)	ADF	-3.45	-2.27
pmetal (with trend)	WS	-3.24	-2.18
pmetal (no trend)	ADF	-2.89	-0.95
pmetal (no trend)	WS	-2.55	-1.24
Dpmetal	ADF	-2.89	-5.16

Dpmetal	WS	-2.55	-5.34
DDpmetal	ADF	-2.89	-8.60
Dpmetal	WS	-2.55	-8.81

Note: pmetal represents metal price, pmat represent raw material prices and poil represents oil prices.

4.6 Model Selection

4.6.1 *Lag orders and statistics of individual VARX models*

An information criteria based lag order selection was performed. Here, three information criteria statistics were computed for each individual VARX* model. The statistics calculated were the log-likelihood (logLik), the Akaike (AIC) and Schwartz Bayesian (SBC) criteria respectively. The residual serial correlations were tested using the F-statistic for each VARX* model. The corresponding 95% critical-values and the degrees of freedom were also computed. These calculations were performed for all possible lag-orders.

Table 9: Choice criteria for selecting order of VARX* models

Region	P	q	AIC	SBC	logLik
BRICS	1	1	2254.0	2045.4	2398.0
BRICS	2	1	2259.3	1998.5	2439.3
G5	1	1	3026.6	2817.9	3170.6
G5	2	1	3025.9	2765.1	3205.9

Table 9 shows that lag orders of p= 2 and q=1 result in a better BRICS model, while p=1 and q=1 results in better G5 as they have smaller AIC difference relative to other models.

Table 10: Corresponding residual correlations F-statistics

Region	P	Q		Fcrit_0.05	Variables					
					Real GDP	Inflation	Equity Prices	Exchange rates	Short-term interest rate	Long-term interest rate
BRICS	1	1	F(4,106)	2.46	2.52	0.81	2.36	3.69	0.15	2.27
BRICS	2	1	F(4,100)	2.46	3.22	1.90	1.81	4.41	1.33	2.34
G5	1	1	F(4,106)	2.46	1.72	1.83	0.64	1.13	2.67	0.85
G5	2	1	F(4,100)	2.46	1.22	0.41	1.21	1.38	3.55	1.13

4.6.2 *Statistics for individual VECMX* models*

Table 11: VECMX* single-equation statistics

Country	Variable	R_square	Rbar_square	AIC	SBC
BRICS	Y	0.45	0.37	452.91	426.83
BRICS	Dp	0.47	0.39	322.45	296.37
BRICS	Eq	0.41	0.33	86.64	60.56
BRICS	Ep	0.31	0.21	259.38	233.29
BRICS	R	0.36	0.27	292.40	266.32
BRICS	Lr	0.58	0.52	740.61	714.53
G5	Y	0.64	0.61	540.11	522.72
G5	Dp	0.57	0.53	595.41	578.03
G5	Eq	0.50	0.46	192.31	174.93
G5	Ep	0.43	0.38	305.22	287.83
G5	R	0.26	0.20	630.75	613.37
G5	Lr	0.48	0.43	769.60	752.21

Note: 'y' represents real GDP, 'Dp' represents nominal inflation rates, 'eq' represents real equity prices, 'ep' represents foreign exchange, 'r' represents nominal interest rates, 'lr' represents long-term interest rates.

The R-squared and adjusted R-squared values for the individual VECMX* models are relatively low suggesting that the model fit is not perfect. However, these models are going

to be taken as acceptable as the information criteria method of model selection suggested that they were the best out of all the models that were tested.

4.6.3 *Descriptive statistic of VECMX* residuals*

Table 12: BRICS VECMX* residuals

Variable	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera	P-value
Y	5.8E-17	0.000	0.024	-0.019	0.007	0.074	3.334	0.951	0.622
Dp	1.17E-16	0.001	0.054	-0.092	0.019	-1.444	10.198	349.430	0.000
Eq	-2.1E-16	0.000	0.415	-0.296	0.111	0.413	4.472	17.131	0.000
Ep	-3.1E-16	-0.004	0.213	-0.063	0.031	2.601	18.853	1608.454	0.000
R	7.37E-17	0.001	0.062	-0.136	0.024	-2.063	14.308	838.699	0.000
Lr	8.08E-18	-6.8E-05	0.003	-0.002	0.001	0.270	3.388	2.738	0.254

The residuals of the BRICS VECMX* models do not follow normal distributions as shown by the Jarque-Bera statistic and its respective p-value. The models for real GDP (Y) and long-term interest rates are the only exceptions. The residuals all fall within a very narrow band as depicted by the relatively small standard deviations.

Table 13: G5 VECMX* residuals

Variable	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera	Probability
Y	-3.5E-17	0.000	0.010	-0.010	0.004	-0.133	2.866	0.452	0.798
Dp	7.81E-17	-1.8E-05	0.007	-0.007	0.003	0.034	2.879	0.060	0.970
Eq	1.24E-15	0.006	0.140	-0.195	0.053	-0.516	4.396	18.015	0.000122
Ep	-5.1E-16	0.001	0.062	-0.063	0.023	-0.285	3.092	1.960	0.375352
R	-2.1E-17	0.000	0.007	-0.007	0.002	-0.516	5.167	34.218	3.71E-08
Lr	1.34E-17	-7.9E-06	0.003	-0.002	0.001	0.131	5.155	28.241	7.37E-07

For the G5 group of countries, there is evidence at the 95% confidence level that residuals for the real GDP (Y), Inflation (Dp) and foreign exchange(ep) are normally distributed. While, the real equity prices and real interest rates are not. Deviation of these residuals from the mean is marginal.

4.7 Testing Weak Exogeniety

One of the fundamental assumption in the estimation technique of the GVAR is that the country specific macroeconomic variables such as exchange rates, real GDP and inflation are weakly exogenous relative to long-run parameters of the conditional model. The weak exogeniety tests were performed as described in Dees, Di Mauro, Pesaran, and Smith (2007).

Table 14: Order of weak exogeniety regression equations

Region	p*	q*
BRICS	1	1
G5	1	2

Table 15: F-statistic for testing the weak exogeniety of country-specific foreign variables and global variables

Country	F test	Fcrit_0.05	ys	Dps	eqs	eps	rs	lrs	poil	pmat	pmetal
BRICS	F(3,114)	2.68	0.98	4.16	0.34		1.43	0.75	2.09	0.16	0.81
G5	F(3,104)	2.69	3.22	0.64	0.60		0.31	0.24	0.40	1.06	3.04

Table 15, shows that for the two augmented regions that are under consideration the weak exogeniety hypotheses hold for all country specific and global models. The only exception is the metal prices model for the G5 region which is rejected at this confidence level.

4.8 Contemporaneous effects of foreign variables on their domestic counterparts

To better understand the relationship between domestic and foreign variables contemporaneous effects of foreign variables on domestic variables were determined. Whites heteroskedasticity-consistent variance estimator was used to compute robust t-

ratios. According to Dees, Di Mauro, Pesaran and Smith (2007), the estimates from the contemporaneous effects calculation can be viewed.

Table 16:Contemporaneous effects of foreign variables on their domestic counterparts

Region		y	Dp	eq	r	Lr
BRICS	Coefficient	0.13	-0.32	1.13	1.34	0.50
BRICS	t-ratio_White*	0.83	-0.46	7.81	1.18	4.98
G5	Coefficient	0.09	0.02	0.25	0.02	0.33
G5	t-ratio_White*	1.97	2.14	4.87	2.33	3.83

Note: t-ratio_White is Whites heteroskedastic- robust t-ratios*

Table 16 shows that the real output of the BRICs region is more strongly affected by changes in foreign output than the G5 group of countries which show slightly greater resilience. The BRICS region is significantly negatively affected by changes in foreign interest rates, this may be due to the highly-developed financing arrangements amongst member countries and the establishment of institutions such as the BRICS development bank. Inflation in the G5 countries is only slightly positively affected by changes in foreign inflation. On the other hand, there is very high contemporaneous elasticity in equity prices which is greater than unity (1) for the BRICS group of countries which suggests that they exaggerate their response to fluctuations in foreign stock prices. Stock prices in the G5 region also show similar trends but without the over-reactions to fluctuations in foreign stock prices. Brics short-term interest will overreact to changes in foreign short-term interest rate as shown by the contemporaneous elasticity which is greater than 1. The degree of overreaction is greater than that observed for equity prices. Long-term interest rates for both region are less than 0.5 suggesting that they are not strongly affected by changes in foreign long-term interest rates

4.9 Pair-Wise cross-sectional correlations: variables and residuals

Several assumptions are imposed to the modelling of global shocks using the GVAR technique. One such assumption is that unique shocks associated with the respective country models should be weakly-correlated in a cross sectional way. According to

Pesaran, Schuermann and Weiner (2004), when the shocks of individual country models are correlated in this way, the weak exogeneity assumption is roughly met.

Pair-wise cross-sectional correlations were calculated for the purposes of testing effectiveness of country specific foreign variables in minimising cross sectional correlations to other variables in the GVAR model. On average, it is expected that cross sectional correlations are high for endogenous variables. The levels of correlation generally drop when first order differences of the variables are taken (Pesaran, Schuermann, & Weiner, 2004; Dees, Di Mauro, Pesaran, & Smith, 2007).

Table 17: Average pair wise cross-section correlations of all variables and associated model's residual

Variable	Region	Levels	First Difference level	VECMX* Residuals
Y	BRICS	0.99	0.29	-0.04
Y	G5	0.99	0.29	-0.04
Dp	BRICS	0.33	0.13	-0.02
Dp	G5	0.33	0.13	-0.02
Eq	BRICS	0.88	0.56	-0.49
Eq	G5	0.88	0.56	-0.49
Ep	BRICS	0.71	0.39	0.24
Ep	G5	0.71	0.39	0.24
R	BRICS	0.54	0.14	-0.03
R	G5	0.54	0.14	-0.03
Lr	BRICS	0.94	0.52	-0.36
Lr	G5	0.94	0.52	-0.36

Real output and long-term interest rates have very strong cross sectional correlations of 99% and 94% respectively. Cross sectional correlations for equity prices, short-term interest rates and exchange rates are lower than those for real output and long-term interest rate (88%, 54% and 71% respectively). Inflation has the lowest cross sectional correlation levels of 33%. As expected, the first order differenced correlation levels are much lower than their undifferenced counterparts ranging from 13% to 56%.

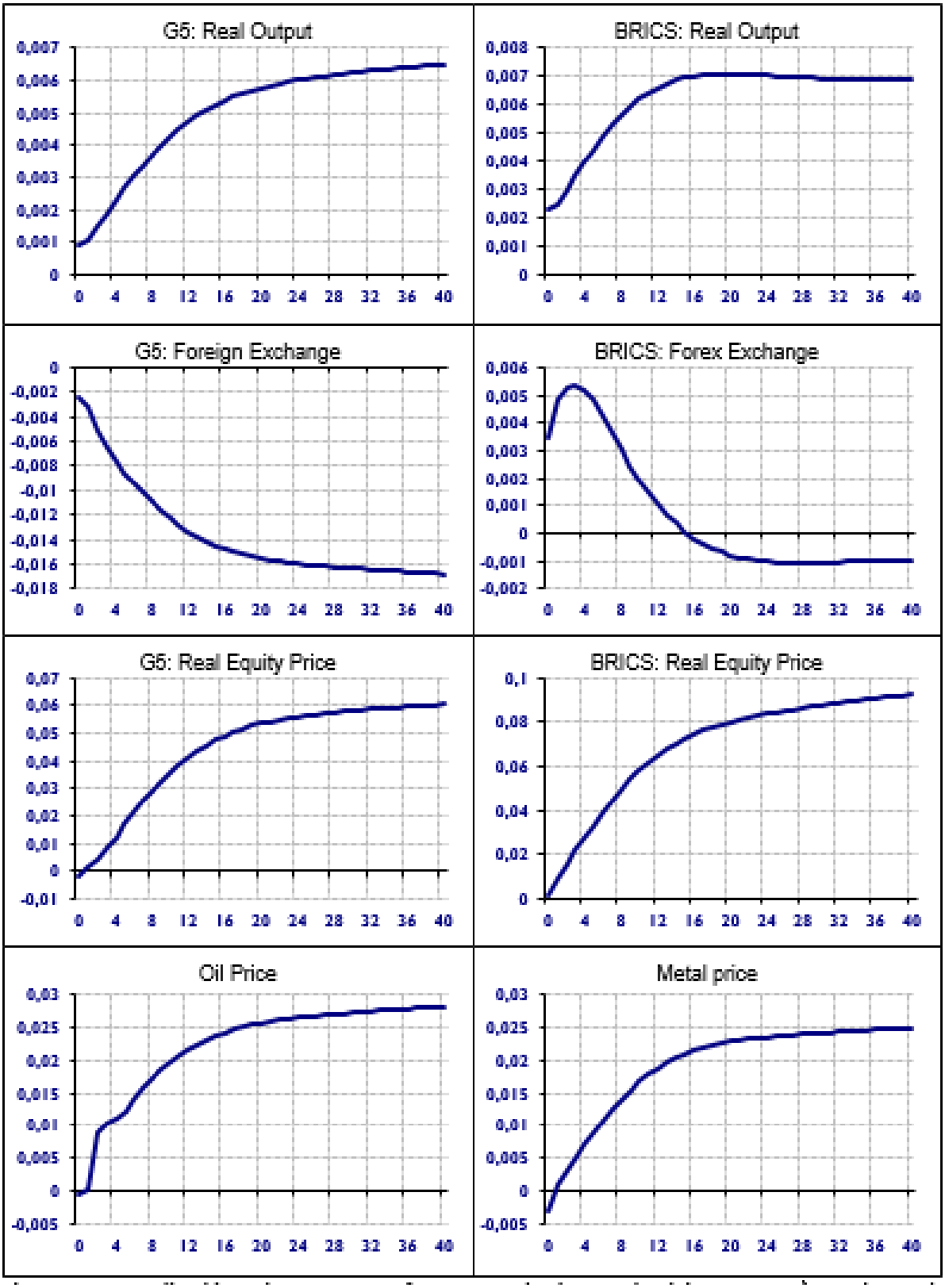
4.10 Generalized Impulse response functions

The study aims to determine the way shocks are transmitted in the BRICS and G5 economies when they are considered as single economies for these regional blocs. To achieve this, the time-profiles of the results of various shocks on the BRICS and G5 economies were tested. Six different external shocks were tested; (1) a one standard error positive shock to BRICS' real GDP; (2) a one standard error positive shock to oil prices; (3) a one standard error positive shock to global inflation; (4) a one standard error negative shock to global equity prices; (5) a one standard error shock to the G5's nominal short-term interest rates.

Generalized impulse response functions (GIRFs) are the best way to analyse the effect of the shocks under investigation (Peseran & Shin, 1998). The approach was adapted from Dees, Di Mauro, Pesaran and Smith (2007) and implemented using the GVAR tool box in MATLAB (Smith & Galesi, 2014). This approach provides useful information of fluctuations in the variables under consideration hence it is very insightful with regards to the subtleties of the spread of shocks in the BRICS and G5 economic regions. However, it is limited in that it does not highlight what causes these fluctuations.

For the discussion that will follow with regards to shock transmission and the illustrative general impulse response functions, the focus will be mainly on the three to four years post the shock. Literature has shown that such time horizons are acceptable and associated results are relatively credible (Peseran & Shin, 1998; Pesaran, Schuermann, & Weiner, 2004; Dees, Di Mauro, Pesaran, & Smith, 2007). The figures that follow also show that the GIRFs stabilize quickly and according Dees, Di Mauro, Pesaran and Smith (2007) this is an indication of overall model stability. The x-axis represents the number of quarters from the period in which the shock occurred. While, the y-axis represents the fractional change in the given variable under consideration. It is also noteworthy that global shocks represent the weighted average of the give variable under consideration for all the countries that are of interest.

4.10.1 *Shock to BRICS real GDP*



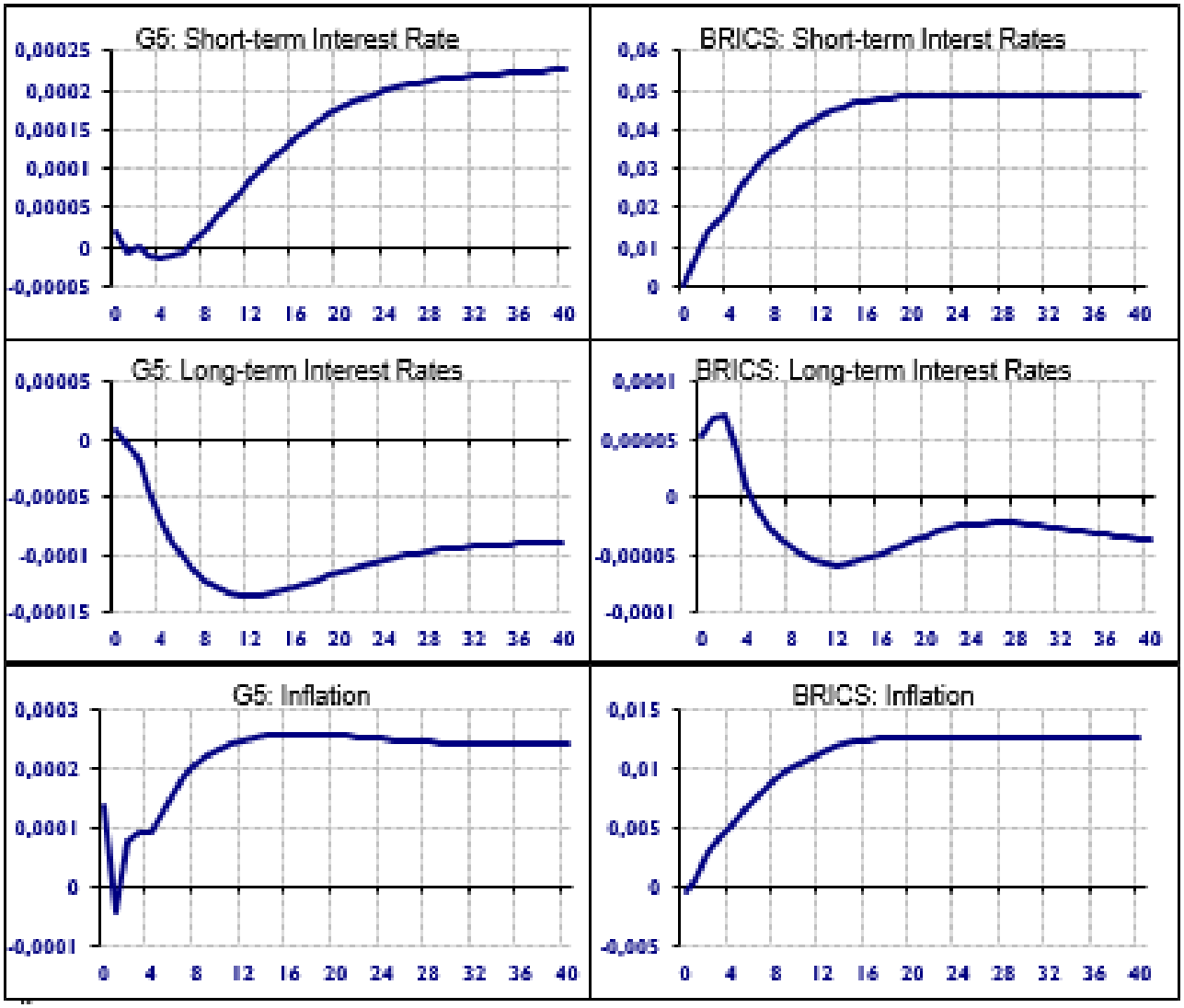
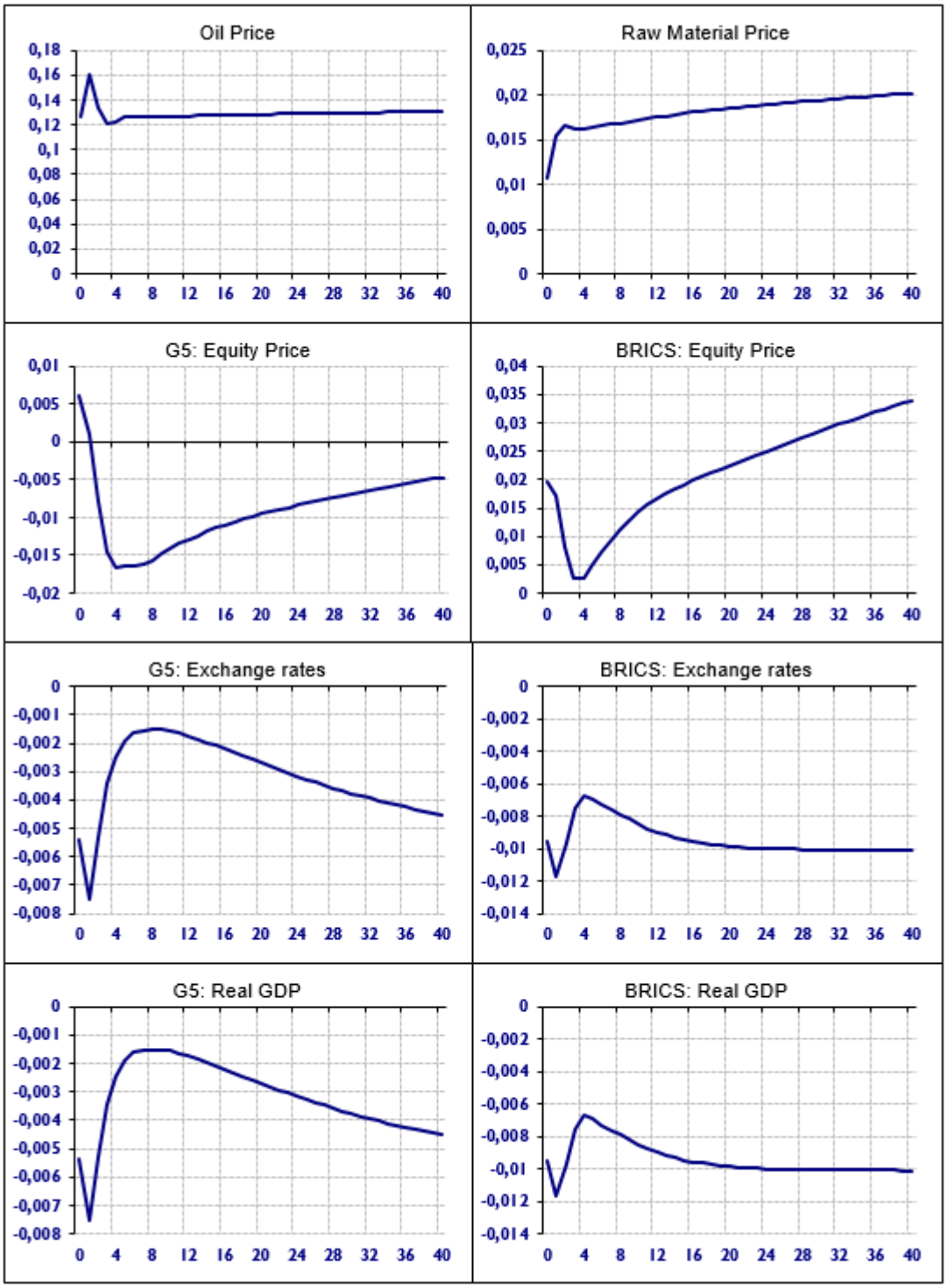


Figure 5: Generalized impulse response of a one standard error shock in BRICS real GDP

The generalised impulses response functions presented above show a unit standard error shock in the real GDP of the combined BRICS bloc. The result is a comparable increase in the GDP of the G5 bloc. Foreign exchange in the BRICS bloc increases marginally and then steadily declines after the first four quarters. On the other hand, the shock induced a drop o1.6% in the foreign exchange of the G5 bloc. The shock also causes increases in real equity prices of between 5% and 8%. Short-term interest rates for the G5 bloc experience a delayed response to the shock with noticeable upsurges only taking effect 5 to 6 quarters of the shock. However, the effect of the shock on the short-term interest rates of the BRICS bloc are immediate and more pronounced than those of the G5 bloc i.e. 5% and 0.02% respectively. Inflation in the G5 bloc drops sharply in the first two quarters and

then rises about 0.02%. The effect of the shock on the inflation of the BRICS bloc (increase of 1.25%) is again immediate and more pronounced than that of the G5.

4.10.2 *Shock to Oil Price*



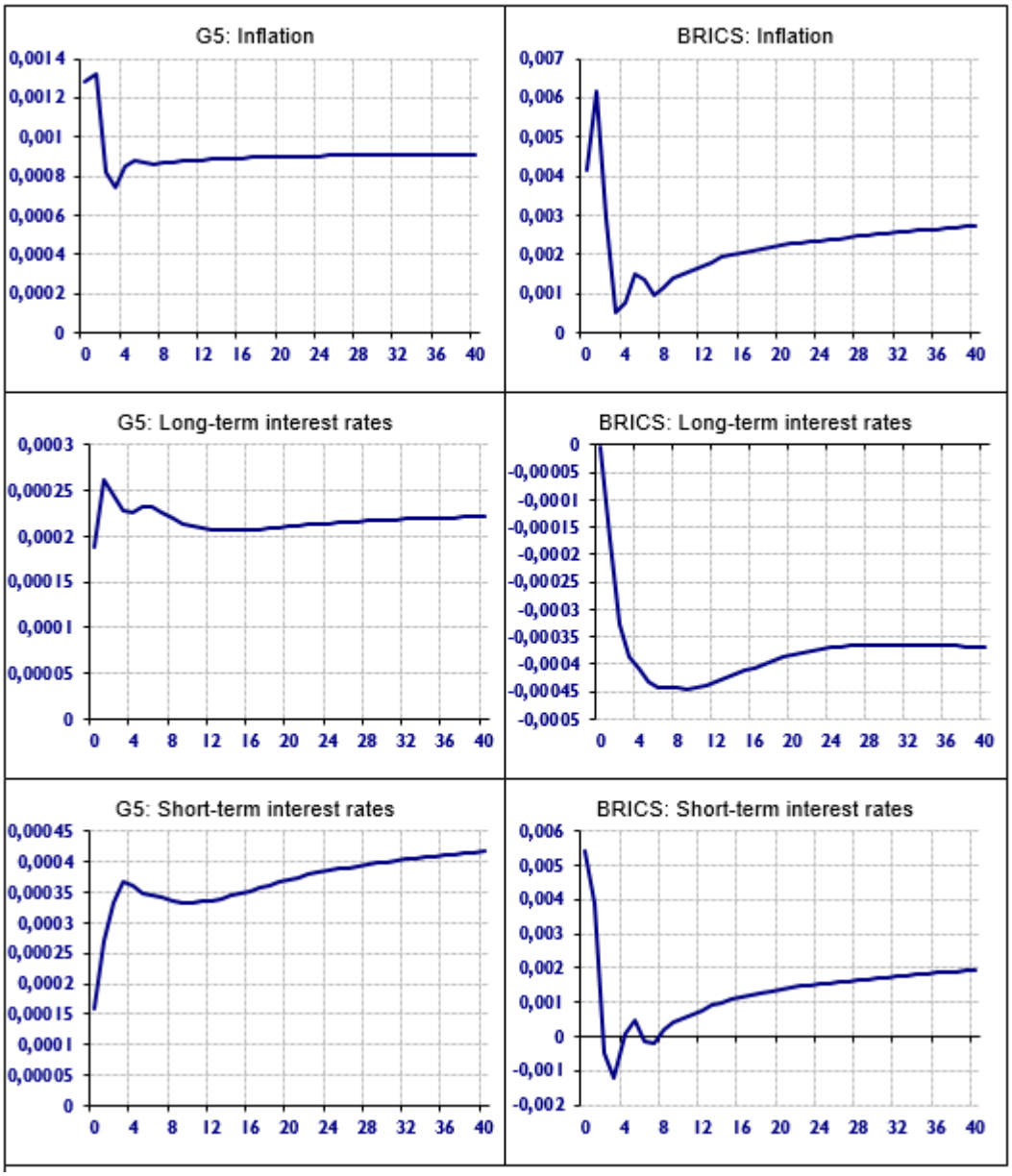
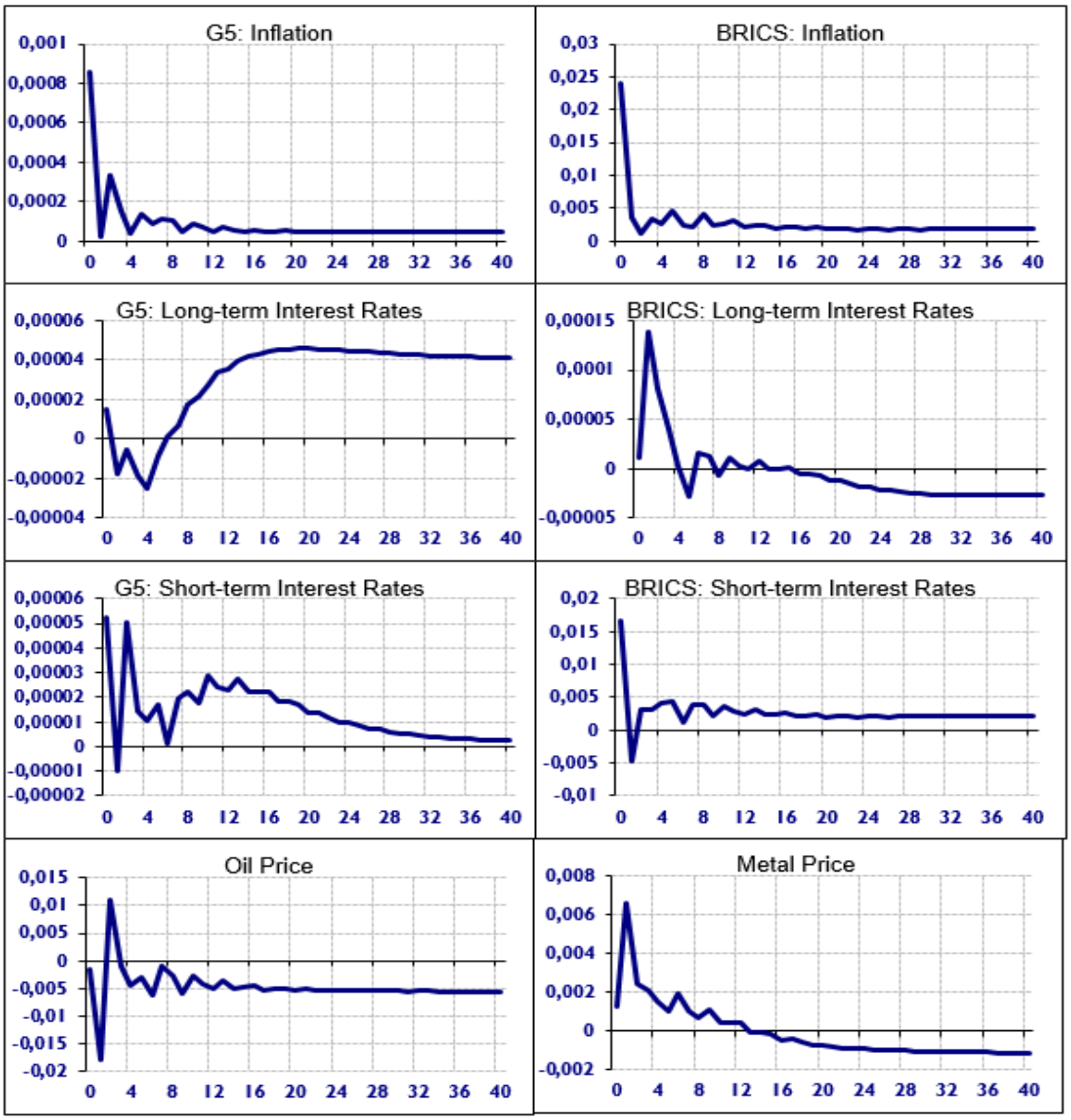


Figure 6: Generalized impulse response of a one standard error positive shock in oil price

Figures 8 A&B above depict the effect of a unit standard error positive shock on various macroeconomic variables of the G5 and BRICS blocs respectively. This shock is equivalent to 16% rise in oil prices. As can be expected an increase in oil prices has negative effects on the real equity on both the G5 and BRICS blocs. Equity prices in the G5 bloc drop by 0.5% per quarter for the first and then steadily rise thereafter. Equity prices for the BRICS likewise drop but at a lower rate of 0.35% per quarter in the first year and then rise quicker than that of the G5 bloc thereafter. The shock has a more pronounced negative effect on the BRICS real output because the constituent economies are more

resource and production based while the G5 constituent economies are more services driven. Inflation drops by 0.08% and 0.5% for the G5 and BRICS bloc respectively. The stronger effect of the oil price shock on the BRICS inflation is expected as these economies have a greater dependency on oil. Both short and long -term interest rates increase for the G5 bloc while they decrease for the BRICS bloc as result of the shock in oil prices. This may be due to policy intervention by the BRICS bloc to help boost real out which eventually drops due to this shock. On the other hand, the increase interest rates in the G5 bloc is an indication that bond markets have the propensity to respond less to growth prospects than they do to inflation expectations.

4.10.3 *Shock to Global Inflation*



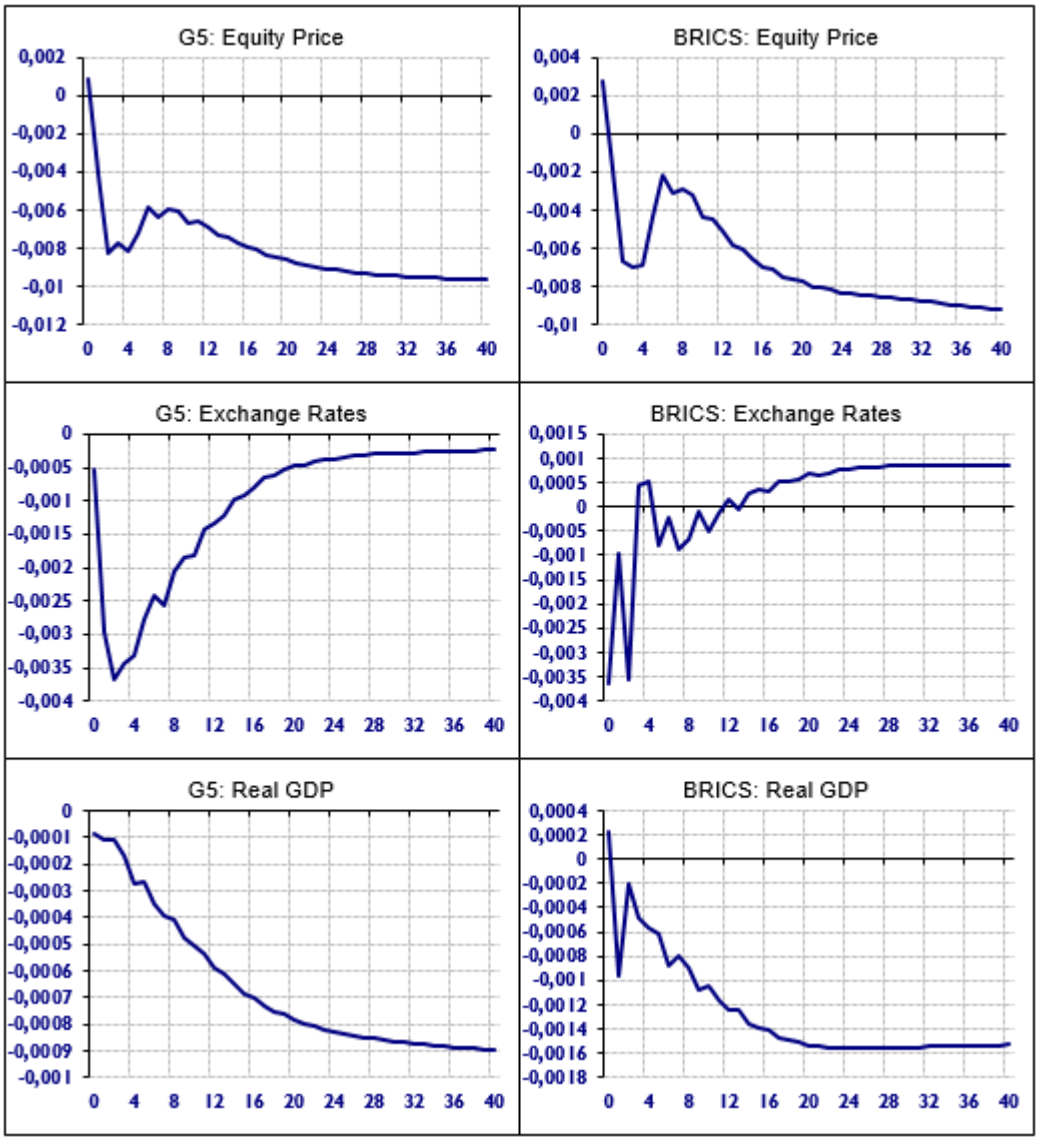
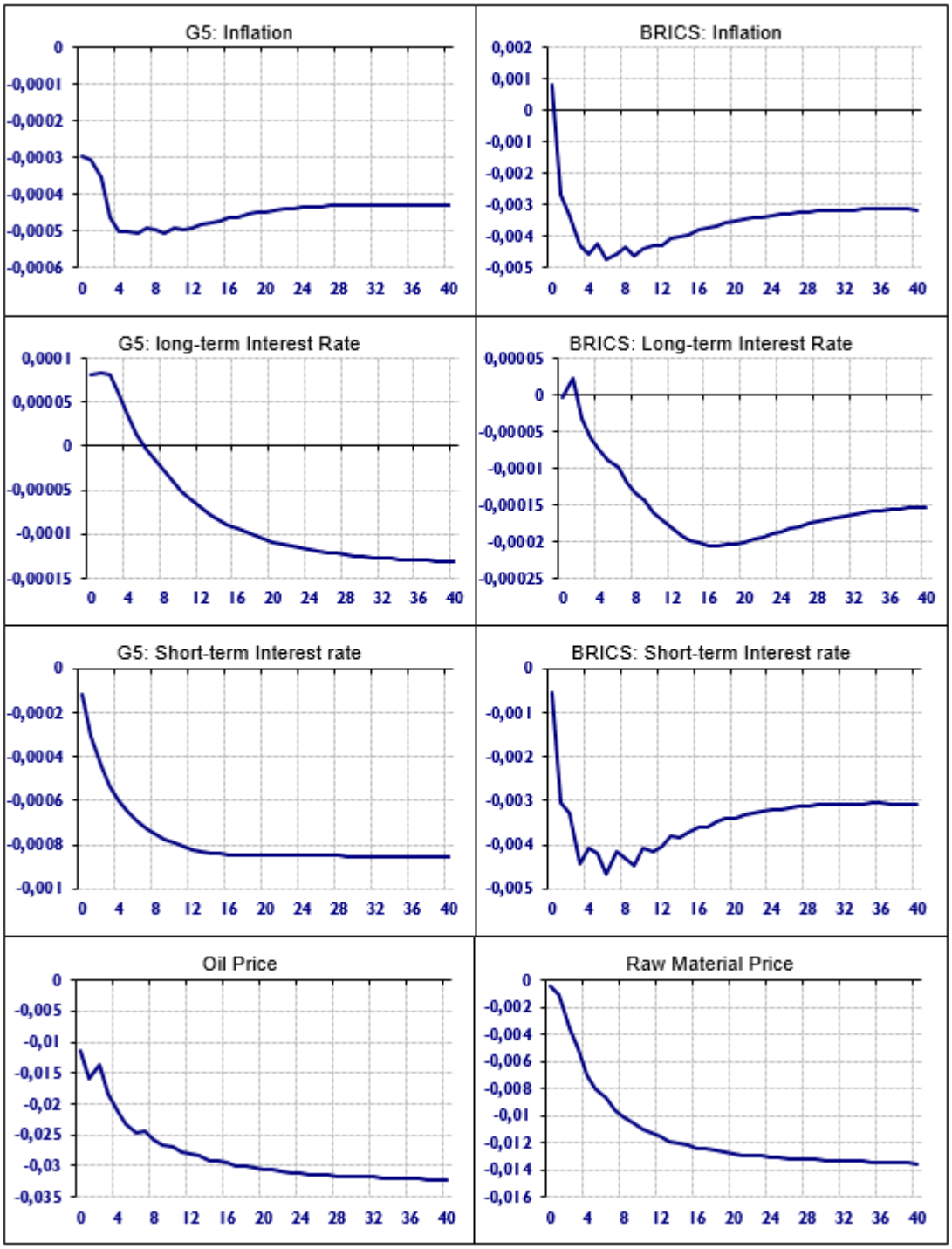


Figure 7: Generalised impulse response of unit standard error negative shock to global inflation

A unit standardized negative error in global inflation induces 0.04% drop in G5 inflation and about 1.25% in BRICS inflation per quarter respectively. Long term interest rates in the G5 bloc drop in the first year after the shock and then rise sharply in the second year. Steady decline is observed for both short and long term interest rates for the BRICS bloc. Real output for both regions on average steadily declines because of the negative shock in global inflation. Exchange rates drop by about 0.35% in the first year and then steadily rise thereafter in both regions.

4.10.4 *Shock to Global equity prices*



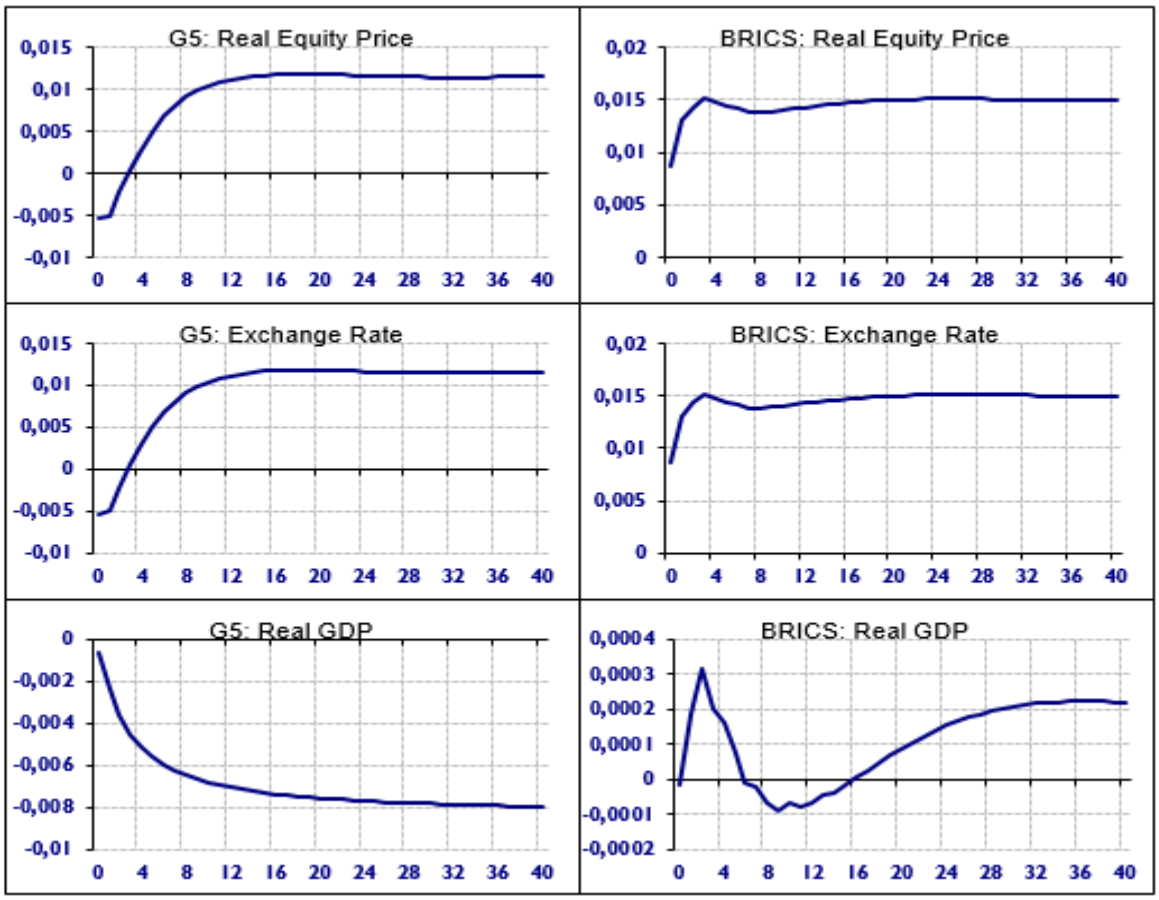
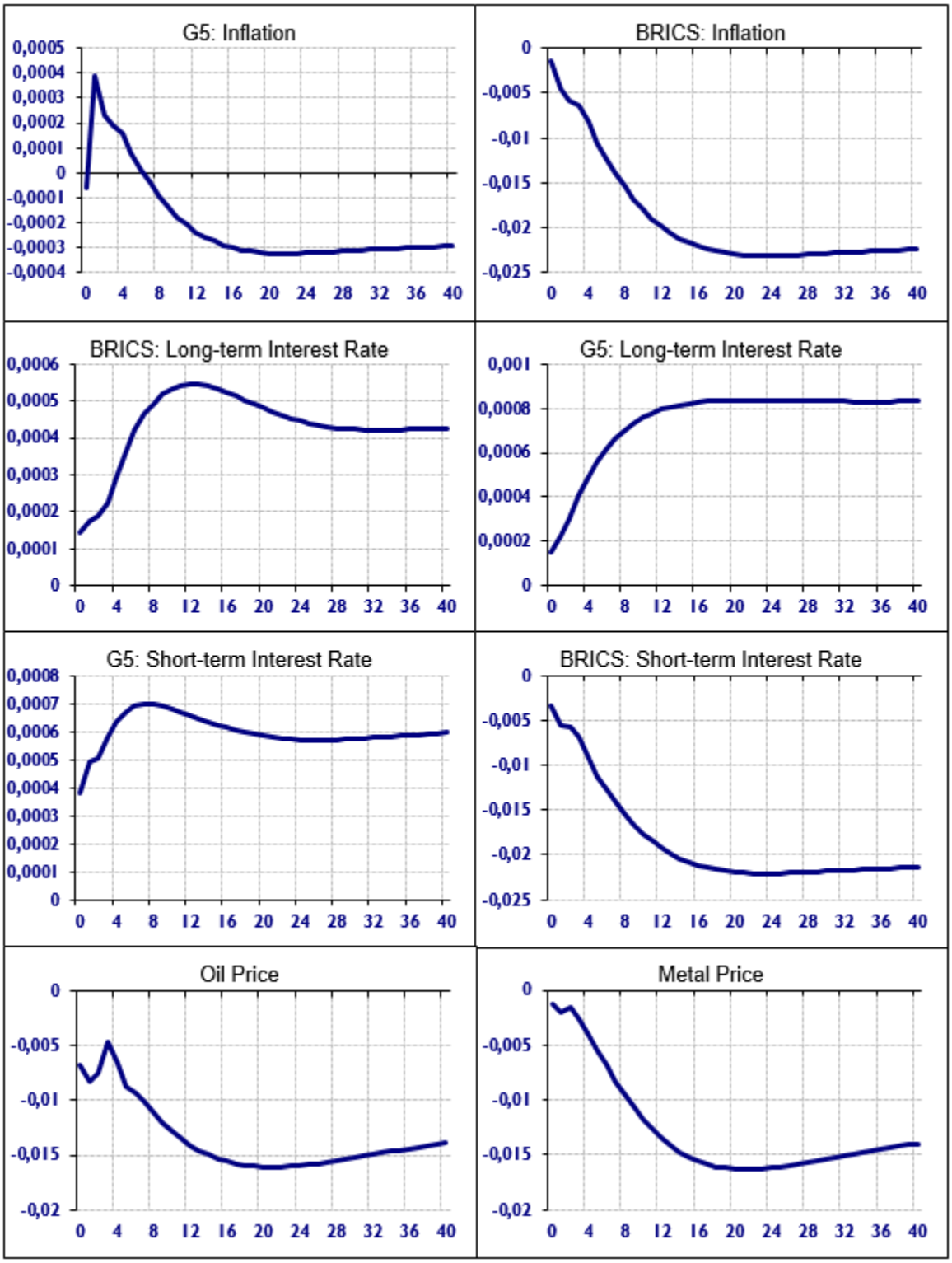


Figure 8: Generalized impulse response functions for a unit standard error positive shock on global equity prices

A positive unit standard error shock in global equity prices induces an increase in equity prices and exchange rates in both regions of between 1% to 1.5%. It also causes 0.02% drop in G5 inflation and 0.5% drop in BRICS inflation respectively. The G5 real GDP declines steadily and then plateaus in state if decline, while BRICS GDP increases by 0.03% over the first two quarters, declines over the next two years and then steadily increase over the rest of the period under consideration. Similarly, oil prices and raw material prices drop due to the positive shock in global equity prices. It is however noteworthy that the general effect of this shock on interest rates and inflation are generally small.

4.10.5 *Shock to G5 nominal short-term interest rates*



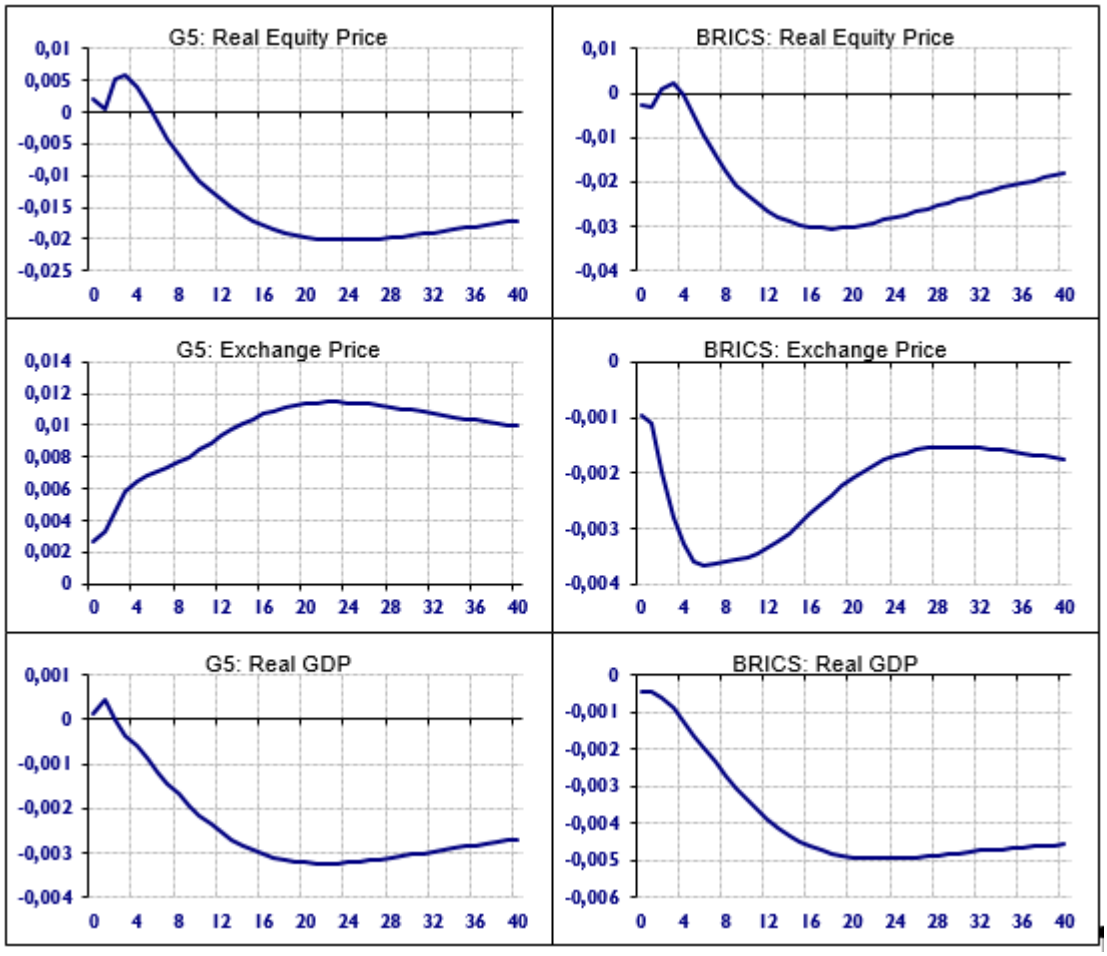


Figure 9: Generalized impulse response of a positive unit standard error shock to G5 short term interest rates

A positive shock in the G5 short term interest rates has negative effects on the inflation of both regions as well as on the oil prices and metal prices. However, inflation in the G5 bloc initially rises by 0.05% in the first two quarters then proceeds to decline in the subsequent quarters. Similarly, this negative effect is induced in the output of both regions. Real equity prices are also negatively affected by a positive shock in G5 short term interest rate, this is line with the inverse type relationship that exists between these two variables (Dees, Di Mauro, Pesaran, & Smith, 2007). BRICS exchange rates initially drop and then pick up in the second year. On the other hand, G5 exchange rates steadily rise from the time the shock occurs.

CHAPTER 5

DISCUSSION & CONCLUSION

5.1 Introduction

The study aimed to investigate the way in which macroeconomic shocks are transmitted between the current global economic powerhouse (the G5 bloc) and its soon to be successor (the BRICS bloc). The research study anticipated significant synchronisation of the two economic blocs and proposed several shock transmission mechanisms to be the key channels through which shocks are transmitted. The major driver for this work was to contribute to the body of knowledge in the field of macroeconomic modelling by investigating shock transmission between two economic blocs of global significance which has not been done before. Secondly, the study will help macroeconomic policy makers in developing frameworks to predict the evolution of business cycles in one regions by analysing the other.

The input data for this study was collected from various reputable macroeconomic data sources and manipulated using several econometric techniques in order to determine how shocks are transmitted between the two regions. The results reinforce the notion that equity prices, inflation, long and short term interest rates, oil and metal prices, exchange rates and real output are key channels through which shocks are transmitted from one economic region to the next. Some evidence has also been found to suggest that there is some level of synchronisation between the BRICS and G5 blocs' economies.

The following sections present a summary and discussion of the results, practical and theoretical implications of the results. The limitations of the research and opportunities for future research are discussed subsequently. The last section presents the closing remarks.

5.2 Brief Research Results

The research study proposes that there is some degree of synchronisation in the business cycles of the BRICS and G5 blocs. This suggests that any given shock that occurs induces a similar type of response in both economies under consideration. The global vector auto regression (GVAR) model was used to track the co-movements in these economies. As shown in the previous chapter, the developed model meets the weak exogeniety criterion. At the 5% significance level, evidence has also been found to suggest that there are no unit roots in most domestic, foreign-specific and global variables. This improves the confidence we have in the model's results. The R-squared and adjusted R-squared values for the individual VECMX* models are relatively low suggesting that the model fit is not perfect. However, the generalized impulse response functions (GIRFs) generated from the overall GVAR model stabilize relatively quickly and according to Dees, Di Mauro, Pesaran and Smith (2007) this is an indication of overall model stability. Hence the model is going to be taken as acceptable for the purposes of this study.

The model was used to test the effect of five different shocks on the BRICS and G5 economies respectively. The aim was to identify similarities in response to these shocks. Firstly, a unit standard error positive shock to the BRICS real output was tested. It was found that the general response to the shock across all transmission channels are similar, for instance this shock induces a 1% and 2.5% increase in real equity prices in the first year. However, differences in the intensity of the response are observed. It is also noteworthy that in some channels an initial overreaction to the shock occurs in one of the regions but synchronisation eventually occurs. For example, forex exchange in BRICS surge rapidly soon after the shock but then drops and follows the pattern of the G5 foreign exchange after a year. A similar phenomenon is also observed for the long-term interest rates whereby they surge in the first three quarters in response to the shock but starting declining thereafter to match the trend in G5 interest rates.

Secondly, a unit standard error positive shock in oil prices was imposed on the BRICS and G5 bloc economies respectively. Again, significant similarities in the response to the shock were observed with obvious differences in the intensity of the response. Real equity prices, inflation, exchange rates and Real GDP for both regions show perfect synchronisation for example exchange rates drop by about 0.2% in the first two quarters then rise by 0.5%-

0.6% in the next two quarters followed by a steady decline in both regions. Interest rates on the other hand show a disparity in synchronisation, that is both long and short term interest rates for the G5 surge in the first two quarters then continue to rise steadily and the opposite effect is observed in BRICS. The general observed responses to this shock are in line with Gunsel-Dogrul and Soytas (2010) findings. They propose that an increase in oil prices is a signal of reduced availability of basic input of production which pushes production costs up. The result is a decline in growth and productivity which in turn increase price levels and unemployment.

Thirdly, a unit standard error negative shock to global inflation was imposed to the GVAR model to assess the response of various shock transmission channels in BRICs and the G5 bloc respectively. This shock induces a decline in real output and inflation, response patterns for both regions are very similar. The response patterns for real equity prices and short term interest rates are also nearly perfectly synchronised i.e. real equity prices drop by about 0.9% in the three quarters then pick in the next three quarters by 0.2%-0.4% followed by a continuous decline in the coming periods. This provides some evidence in support of the notion that a fair degree of synchronisation exists between the BRICS and G5 business cycles.

The fourth test investigated the effect of a unit standard error positive shock to global equity prices on the BRICS and G5 economies respectively. A sudden drop in inflation was observed for both BRICS and the G5, however BRICS experienced a more severe drop but general response pattern is similar for the two regions. Long-term interest rates for both regions display a delayed response to the shock in global equity prices of about two quarters and then drop steadily thereafter. Short-term interest rates drop by 0.05% and 0.5% in the first year for the G5 and BRICS respectively. Although the general response pattern is similar the intensity of the shock is stronger on BRICS suggesting that the G5 short-term interest rates are more resilient. This shock also induces comparable drops in oil prices and raw material prices.

Finally, the effect of a unit standard error positive shock to the short-term interest rates of the G5 on the economies BRICS and the G5 was tested. Real output, oil prices, metal prices and real equity prices show significant levels of synchronisation. The greatest mismatch is observed in short-term interest rates where the shock induces an increase in

the G5 bloc and a decline in the BRICS bloc. Overall, significant synchronisation between the BRICS and G5 business cycles has been observed. Some anomalous trends have also been observed whereby a given shock induces different responses in the same transmission channel. This has been seen to happened most frequently in both long and short-term interest rates.

5.3 Implications of the Research

The findings of the research have two main theoretical implications. Firstly, new insights have been developed with regards to the transmission of shocks in the global economy. For example many authors have investigated shock transmission in the Euro Area (Anderton, di Mauro, & Moneta, 2004; Dees, Di Mauro, Pesaran, & Smith, 2007), transmission of shocks G-7 countries (Cologni & Manera, 2008), external shocks and inflations links (Galesi & Lombardi, 2009), and global financial crisis spill-over from the United states to the BRICS countries (Mensi, Hammoudeh, Nguyen, & Kang, 2015). This research investigation adds to this body of knowledge by presenting evidence of some degree of business cycle synchronisation between the BRICS and G5 economic blocs. This is in line with, and builds on the work done by Dees, Di Mauro, Pesaran and Smith, (2007) who found that some level of business cycle synchronisation exist between the US and Euro bloc economies. The second implication is that the effect of a given shock differs depending on the chanel through which it is transmitted.

The research implies that fiscal policy makers and monetary policy authorities in these two regions can draw insights from the behavior of the other region's business cycles and factor the relationships predicted by the GVAR model to develop policies that reduce the probability of periods of poor economic performance occuring.

5.4 Implications for Future Work

The study sought to understand the dynamics of shock transmission and the level of business cycle synchronization in the BRICS and G5 economic blocs. These two blocs were augmented into single economies representative of the member economies; hence no effort was made to understand the dynamics of shock transmission at the level of the

individual constituent economies. This provides an opportunity for future work to be performed with the aim of assessing the level of synchronization of the individual countries (economies) that make up the G5 and the BRICS blocs.

5.5 Conclusion

In closing, the findings of this study shed more light on the phenomenon of shock transmission in global economies. It also adds some insight on the level of synchronization that exists between the business cycles of the G5 bloc and BRICS. However, more work must be done to further understand shock transmission at country level in these two regions.

The study suggests that significant amounts of business cycle synchronization exist between the G5 bloc and BRICS economies. This presents an opportunity for fiscal policy makers and monetary authorities to leverage this knowledge in roughly predicting the behavior of their economy by studying the other.

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APPENDIX A

The datasets that have been compiled for the purposes of fulfilling the requirements of this study are presented below.

Table 18: KEY

Abbreviation	Description
RGDP	Real GDP
CPI	Consumer price index
nomEQ	Nominal equity price index
FXdol	Exchange rate of country *i* at time *t* expressed in US dollars
Rshort	Nominal short-term interest rate per annum, in per cent (typically a three month rate)
Rlong	Nominal long-term interest rate per annum, in per cent (typically a ten year rate)
POILdolL	Nominal price of oil in US dollars
PRAWMATdol	Nominal price of agricultural raw material in US dollars
PMETALdol	Nominal price of metal in US dollars

South Africa Dataset

APPENDIX A

Date	RGDP	CPI	nomEQ	FXdol	Rshort	Rlong	POILdol	PRAWMATdol	PMETALdol
1979Q1	66.4918	9.003	131.52	0.844876	6.88667	9.17333	21.38	58.091	61.191
1979Q2	66.9214	9.23641	131.1233	0.834551	5.50667	9.26667	30.98626	63.368	66.698
1979Q3	67.4209	9.80327	143.5667	0.826533	4.68333	9.33	35.74185	71.727	66.557
1979Q4	68.8044	10.0367	177.4767	0.81709	3.95667	9.27	40.31522	68.040	74.124
1980Q1	70.218	10.2034	203.0667	0.803731	4.21667	9.25333	38.92582	74.539	84.040
1980Q2	71.5529	10.5368	207.34	0.779906	4.47667	9.49333	38.21978	67.190	72.555
1980Q3	72.7779	11.0037	264.9567	0.749083	4.51667	10.11	34.81522	72.958	72.082
1980Q4	72.9414	11.5372	267.2433	0.740953	5.35667	11.4867	39.62011	72.542	66.401
1981Q1	73.8474	11.8373	223.9233	0.760105	7.19	12.6533	39.13056	67.010	62.526
1981Q2	75.4601	12.104	225.8367	0.827143	8.55	12.9233	35.20978	65.465	59.323
1981Q3	76.5584	12.7376	231.3633	0.926623	11.0433	13.1133	35.58652	61.702	57.345
1981Q4	77.036	13.2044	231.8633	0.949503	12.4267	13.26	36.78304	60.841	54.847
1982Q1	76.3223	13.5378	198.4933	0.975347	15.1833	14.1433	32.27789	62.213	53.942
1982Q2	75.6855	14.1047	156.55	1.062134	15.9167	14.2867	34.30967	61.778	49.074
1982Q3	75.6661	14.5048	194.7067	1.134493	16.31	13.8367	33.59293	60.814	48.016
1982Q4	74.0665	15.0383	250.5933	1.113211	14.9533	11.7667	33.51359	57.811	47.677
1983Q1	72.9233	15.4385	285.9667	1.069504	11.11	11.41	29.39278	57.729	53.485
1983Q2	73.2262	15.872	314.57	1.074171	11.7233	12.4533	29.83736	62.750	59.486
1983Q3	74.0703	16.2721	322.3433	1.093213	14.73	13.2767	30.77109	68.091	62.012
1983Q4	75.949	16.6389	295.57	1.159909	16.2167	13.52	29.14207	70.949	59.573
1984Q1	77.2377	17.0057	334.59	1.217005	17.75	13.9033	29.75725	72.390	58.177
1984Q2	78.8423	17.6726	347.6833	1.258857	17.75	14.68	29.58132	75.327	54.698
1984Q3	77.5355	18.1727	323.6967	1.55378	20.75	16.01	28.08141	72.541	49.094
1984Q4	77.6554	18.7729	340.72	1.792554	21.0833	16.3133	27.55261	67.421	48.402
1985Q1	77.1927	19.5732	339.8033	2.014446	21.75	17.2	27.76356	58.433	48.920
1985Q2	76.6314	20.5402	386.57	1.939877	19.17	16.0967	27.02604	60.983	49.983
1985Q3	76.4291	21.1404	405.9	2.232274	15.9633	16.08	27.28533	60.671	46.823
1985Q4	77.2464	22.0407	475	2.608889	13.3733	17.79	28.33065	64.813	45.056
1986Q1	76.3261	23.3411	534.5033	2.127533	12.0467	17.3633	17.79878	64.988	47.830
1986Q2	76.8531	24.108	573.7367	2.2997	11.05	17.2833	12.82363	69.495	48.546
1986Q3	77.026	25.1751	731.0333	2.4507	9.83667	15.2633	12.39707	67.567	47.687
1986Q4	77.3494	26.2087	772.1	2.232133	8.78333	15.5533	14.72543	70.402	47.608
1987Q1	77.912	27.2091	850.12	2.050333	8.69667	15.16	17.92522	75.150	50.330
1987Q2	78.1898	28.2427	926.4267	2.0135	8.66667	15.4433	18.68407	87.373	55.316
1987Q3	78.4751	29.1764	1074.253	2.063567	8.69333	15.2467	19.10435	94.456	63.379
1987Q4	79.4385	30.1767	749.3567	1.972367	8.8	15.3367	18.05837	98.048	71.110
1988Q1	80.6324	30.9103	637.38	2.063533	9.84333	16.43	15.82813	95.803	81.886
1988Q2	81.205	31.8439	714.7267	2.232867	11.35	16.34	16.21231	101.730	102.470
1988Q3	82.2971	32.8109	786.0667	2.452267	12.5367	16.0667	14.44174	94.725	90.395
1988Q4	83.0699	33.9113	880.74	2.378433	14.3933	16.65	13.43891	89.056	95.254
1989Q1	83.5843	35.1117	1067.17	2.480933	15.5133	16.7333	17.484	94.335	96.648
1989Q2	83.947	36.5789	1209.357	2.7103	16.77	17.28	18.63143	96.751	87.303
1989Q3	84.0144	37.8459	1315.49	2.710633	17.14	17.02	17.5338	104.231	79.155
1989Q4	83.4945	39.013	1317.87	2.5922	17.92	16.57	19.365	101.088	75.138
1990Q1	83.5614	40.4135	1545.997	2.590867	17.9833	15.5867	19.84733	102.984	69.251
1990Q2	83.4924	41.6806	1546.243	2.6551	17.9933	16.332	15.96418	106.764	73.181
1990Q3	83.4222	43.0143	1480.577	2.575333	17.6533	16.368	26.40391	102.135	80.981
1990Q4	83.4997	44.7149	1292.917	2.5453	17.5533	16.3167	32.52946	96.991	73.388

1991Q1	82.8355	46.2487	1352.403	2.615033	17.12	15.74	20.789	92.716	68.282
1991Q2	82.6486	47.9827	1574.487	2.818467	16.72	16.05	18.79407	98.692	63.846
1991Q3	82.6165	49.7166	1740.697	2.851633	16.6433	16.6867	19.87011	94.001	60.918
1991Q4	82.4744	51.9173	1800.073	2.800033	16.25	16.9	20.50467	90.055	58.302
1992Q1	81.8964	53.5845	1836.187	2.8459	15.7933	16.64	18.20066	87.334	60.033
1992Q2	81.3941	55.1851	1866.493	2.8399	14.49	16.07	20.12231	94.708	62.101
1992Q3	80.4518	56.7523	1721.213	2.7718	12.75	14.6167	20.13815	93.129	64.161
1992Q4	79.7681	57.5192	1575.663	3.002733	12.05	14.4333	19.18707	95.594	57.793
1993Q1	80.4748	58.6195	1758.68	3.123033	11.53	14.5	18.18378	99.393	56.759
1993Q2	81.3575	61.0537	1985.273	3.223733	11.5067	14.8767	18.24626	108.963	52.749
1993Q3	82.5287	62.0874	1991.507	3.381867	11.6867	13.7933	16.49207	107.738	52.368
1993Q4	83.1401	62.9543	2143.183	3.372967	10.5233	12.7	15.06652	106.549	49.097
1994Q1	83.0216	64.2881	2411.837	3.475127	10.1467	12.6667	13.95667	107.114	54.148
1994Q2	83.9223	65.4218	2651.727	3.632033	10.64	13.82	16.05231	118.585	57.953
1994Q3	84.8662	67.7559	2801.423	3.602233	10.7833	15.9567	16.77663	120.158	64.046
1994Q4	86.2827	69.123	2842.533	3.537833	12.1467	16.8833	16.52837	119.297	74.336
1995Q1	86.5944	70.6902	2557.747	3.5727	12.8667	16.8533	16.89544	124.667	78.376
1995Q2	86.9789	72.3908	2715.263	3.646867	13.4967	16.85	18.13868	129.380	74.985
1995Q3	87.3543	72.991	2726.29	3.648033	13.9467	16.0233	16.19163	115.167	77.503
1995Q4	87.6991	73.6579	3007.1	3.650533	13.8	14.7	16.98783	111.091	73.138
1996Q1	88.9297	75.2918	3457.967	3.815967	14.0267	14.3033	18.64791	109.584	70.407
1996Q2	90.5954	76.7923	3603.783	4.336	15.3233	16.03	19.47308	114.951	69.225
1996Q3	91.6234	78.5595	3592.107	4.508833	15.3933	15.5433	20.52685	119.897	62.771
1996Q4	92.4924	80.3935	3624.96	4.661667	15.4033	16.0567	23.16957	118.728	63.161
1997Q1	92.7582	82.5275	3916.48	4.473833	15.9433	15.3367	21.18133	118.729	69.182
1997Q2	93.3255	83.9947	4142.537	4.476	15.6367	15.0133	18.06527	114.686	69.421
1997Q3	93.5205	85.3284	4260.567	4.6622	14.8633	14.21	18.52413	108.640	69.298
1997Q4	93.6617	85.9286	3757.053	4.842333	14.5867	14.23	18.71359	104.169	63.604
1998Q1	93.7801	87.0624	4209.11	4.944333	13.89	13.4767	14.07722	95.755	58.747
1998Q2	93.9127	88.2961	4655.77	5.212	13.9867	13.66	13.2922	98.787	56.722
1998Q3	93.7069	91.9306	3548.863	6.165	20.1167	17.0467	12.41652	93.705	54.486
1998Q4	93.7974	93.7312	3376.93	5.767667	18.1367	16.3067	11.09522	87.794	52.249
1999Q1	94.66	94.4315	3595.17	6.120867	15.52	15.1033	11.11967	90.711	49.611
1999Q2	95.4133	94.7316	4151.38	6.114833	13.51	14.8833	15.32549	90.369	52.930
1999Q3	96.4553	94.9983	4197.343	6.082833	11.65	15.2	20.31065	93.604	58.151
1999Q4	97.516	95.5652	4696.693	6.147167	10.7233	14.42	24.04457	98.314	60.825
2000Q1	98.6129	97.0657	5290.533	6.333667	9.93	13.6367	26.63108	97.944	65.165
2000Q2	99.5203	99.3998	4708.79	6.859567	10.1267	14.4633	26.81523	99.586	61.314
2000Q3	100.506	101.267	5042.293	7.050333	10.18	13.7133	30.54108	98.060	63.322
2000Q4	101.361	102.267	4879.077	7.6474	10.2033	13.3333	30.19938	98.034	60.994
2001Q1	102.019	103.6738	5336.57	7.813033	10.1467	12.1233	26.24846	99.301	61.096
2001Q2	102.529	104.7983	5590.587	8.0438	10.2367	11.8067	27.64846	104.641	58.688
2001Q3	102.802	105.3965	5267.733	8.473133	9.38	10.82	25.87708	91.806	53.603
2001Q4	103.592	106.6401	5493.103	10.42523	8.94333	10.8767	20.18682	84.482	51.686
2002Q1	104.667	109.6001	6081.067	11.442	9.59667	12.0433	21.41313	86.768	54.609

2002Q2	106.048	112.9209	6724.39	10.37233	11.0667	11.91	25.49677	93.638	54.976
2002Q3	107.262	116.3412	5919.97	10.44917	11.6367	11.1933	26.69152	99.778	53.178
2002Q4	108.126	120.1739	6074.403	9.393333	12.35	10.8567	26.57955	99.252	54.515
2003Q1	108.784	121.3518	5527.11	8.193483	12.5667	10.0367	30.78063	95.363	57.687
2003Q2	109.343	121.785	5310.283	7.710183	12.1667	9.65	25.79215	92.555	57.352
2003Q3	109.974	121.7589	5813.503	7.265967	10.1867	9.59	28.26424	95.196	60.399
2003Q4	110.683	120.9641	6438.69	6.651233	7.74	9.18667	29.12258	98.569	67.385
2004Q1	112.3586	122.1005	6960.795	6.61392	7.61	9.423333	31.2318	100.152	79.293
2004Q2	113.9287	122.7985	6474.056	6.542854	7.77	10.15667	35.21699	99.147	79.302
2004Q3	115.7916	123.3239	6906.083	6.445892	7.483333	9.693333	40.74495	100.785	81.569
2004Q4	117.0281	124.7622	7708.019	5.922437	7.266667	8.833333	44.72681	97.082	86.654
2005Q1	118.2178	125.6571	8007.574	6.003955	7.24	8.086667	47.85232	98.935	96.216
2005Q2	120.3393	126.7638	8258.538	6.399525	6.82	8.31	52.7805	99.165	96.372
2005Q3	121.9803	128.0195	9572.075	6.453015	6.73	8.02	61.82716	100.793	98.772
2005Q4	122.7971	129.3082	10418.6	6.490529	6.833333	7.85	57.76533	101.107	108.640
2006Q1	124.6637	130.452	12329.88	6.128178	6.65	7.33	62.65352	104.068	127.655
2006Q2	126.7147	131.8874	12320.14	6.69567	6.853333	7.793333	70.40733	108.921	157.174
2006Q3	128.5206	134.6024	12372.96	7.219425	7.573333	8.603333	70.57393	110.761	164.957
2006Q4	130.5202	136.508	13815.04	7.250447	8.28	8.023333	60.64093	111.161	175.000
2007Q1	132.5929	138.2279	15205.13	7.251146	8.546667	7.58	58.60835	117.152	176.182
2007Q2	133.6175	141.1042	16187.52	7.061549	8.6	7.773333	68.64131	117.407	201.561
2007Q3	135.2717	143.9381	15873.46	6.985458	9.156667	8.386667	74.64576	109.428	183.773
2007Q4	137.254	148.056	16480.88	6.766702	10.15667	8.2	88.67391	112.671	171.732
2008Q1	138.2361	153.786	16161.9	7.60937	10.32333	8.736667	96.44437	116.257	190.099
2008Q2	139.7813	157.3495	16894.92	7.685761	10.76333	9.67	122.9046	118.162	191.894
2008Q3	140.4064	161.7808	14870.96	7.759989	11.29333	9.446667	116.8168	118.638	175.685
2008Q4	139.8068	164.3551	12290.29	9.740936	10.85	8.546667	57.13889	100.410	118.375
2009Q1	137.5486	166.637	12721.41	9.759409	9.5	8.18	45.6498	86.092	107.683
2009Q2	136.5697	169.5119	13393.97	8.229221	7.73	8.716667	59.72794	85.403	120.602
2009Q3	137.1763	172.2201	14843	7.748072	7.163333	8.87	68.96119	98.122	150.868
2009Q4	138.3543	174.3352	15631.03	7.520197	7.01	9.046667	75.54543	106.100	166.969
2010Q1	139.8554	176.0114	15896.43	7.52732	7.046667	9.09	77.21481	114.970	191.133
2010Q2	140.9351	177.1838	16113.54	7.608837	6.57	8.903333	79.44066	122.410	200.765
2010Q3	142.1842	178.2888	16643.28	7.20884	6.326667	8.29	76.93491	122.952	193.209
2010Q4	143.7223	180.3227	18158.13	6.92025	5.736667	8.176667	87.28442	140.101	224.173
2011Q1	145.4047	182.6777	18453.45	6.991616	5.523333	8.72	105.1645	161.593	248.642
2011Q2	146.0985	185.3509	18399.87	6.796227	5.456667	8.596667	117.1267	164.597	241.753
2011Q3	146.7907	190.0947	18222.97	7.187437	5.49	8.3	112.1519	152.970	233.054
2011Q4	147.9952	191.2405	19035.41	8.07727	5.48	8.463333	108.9598	134.856	195.428
2012Q1	148.9275	193.8111	19885.33	7.67947	5.503333	8.333333	118.3063	135.581	205.355
2012Q2	150.1955	196.0335	19839.01	8.230053	5.566667	8.24	108.8631	136.629	194.171
2012Q3	150.6555	198.1062	20686.96	8.334138	5.12	7.466667	109.4362	131.864	178.522
2012Q4	151.4518	201.9911	21932.04	8.673455	4.953333	7.56	110.0427	132.055	186.089
2013Q1	151.7881	204.8292	22449.61	9.02572	5.05	7.313333	112.6017	133.145	199.388

Brazil Dataset

date	RGDP	CPI	nomEQ	FXdol	Rshort	Rlong	POILdol	PRAWMATdol	PMETALdol
1979Q1	57.24466	2.59E-10	NA	8.02E-12	33	NA	21.38	58.091	61.191
1979Q2	60.27407	3.08E-10	NA	8.98E-12	33	NA	30.98626	63.368	66.698
1979Q3	63.4638	3.68E-10	NA	9.98E-12	33.3333	NA	35.74185	71.727	66.557
1979Q4	66.82232	4.38E-10	NA	1.24E-11	35	NA	40.31522	68.040	74.124
1980Q1	70.35858	5.22E-10	NA	1.65E-11	42.701	NA	38.92582	74.539	84.040
1980Q2	68.53229	6.13E-10	NA	1.82E-11	29.0188	NA	38.21978	67.190	72.555
1980Q3	66.7534	7.14E-10	NA	2E-11	46.4102	NA	34.81522	72.958	72.082
1980Q4	65.02069	8.71E-10	NA	2.24E-11	71.1999	NA	39.62011	72.542	66.401
1981Q1	63.33295	1.05E-09	NA	2.59E-11	80.589	NA	39.13056	67.010	62.526
1981Q2	64.30202	1.25E-09	NA	3.07E-11	79.6635	NA	35.20978	65.465	59.323
1981Q3	65.28591	1.47E-09	NA	3.65E-11	94.4391	NA	35.58652	61.702	57.345
1981Q4	66.28486	1.72E-09	NA	4.32E-11	104.253	NA	36.78304	60.841	54.847
1982Q1	67.2991	2.07E-09	NA	5.04E-11	100.694	NA	32.27789	62.213	53.942
1982Q2	65.96957	2.48E-09	NA	5.86E-11	102.529	NA	34.30967	61.778	49.074
1982Q3	64.66631	2.98E-09	NA	6.94E-11	125.036	NA	33.59293	60.814	48.016
1982Q4	63.3888	3.48E-09	NA	8.43E-11	154.382	NA	33.51359	57.811	47.677
1983Q1	62.13652	4.36E-09	NA	1.19E-10	146.359	NA	29.39278	57.729	53.485
1983Q2	62.98198	5.37E-09	NA	1.74E-10	255.899	NA	29.83736	62.750	59.486
1983Q3	63.83894	7.05E-09	NA	2.33E-10	213.817	NA	30.77109	68.091	62.012
1983Q4	64.70756	9.08E-09	NA	3.17E-10	196.847	NA	29.14207	70.949	59.573
1984Q1	65.58801	1.18E-08	NA	4.17E-10	259.735	NA	29.75725	72.390	58.177
1984Q2	66.81311	1.54E-08	NA	5.54E-10	214.582	NA	29.58132	75.327	54.698
1984Q3	68.0611	2.05E-08	NA	7.33E-10	273.289	NA	28.08141	72.541	49.094
1984Q4	69.33239	2.79E-08	NA	9.99E-10	281.675	NA	27.55261	67.421	48.402
1985Q1	70.62744	3.84E-08	NA	1.38E-09	334.767	NA	27.76356	58.433	48.920
1985Q2	71.8779	4.93E-08	NA	1.91E-09	296.184	NA	27.02604	60.983	49.983
1985Q3	73.15051	6.58E-08	NA	2.49E-09	213.235	NA	27.28533	60.671	46.823
1985Q4	74.44565	9.29E-08	NA	3.3E-09	282.43	NA	28.33065	64.813	45.056
1986Q1	75.76372	1.34E-07	NA	4.65E-09	320.365	NA	17.79878	64.988	47.830
1986Q2	76.97639	1.46E-07	NA	5.06E-09	16.7249	NA	12.82363	69.495	48.546
1986Q3	78.20847	1.55E-07	NA	5.06E-09	34.4193	NA	12.39707	67.567	47.687
1986Q4	79.46026	1.74E-07	NA	5.2E-09	49.386	NA	14.72543	70.402	47.608
1987Q1	80.7321	2.47E-07	NA	6.67E-09	431.604	NA	17.92522	75.150	50.330
1987Q2	80.39348	4.11E-07	NA	1.15E-08	795.532	NA	18.68407	87.373	55.316
1987Q3	80.05629	5.66E-07	NA	1.73E-08	161.459	NA	19.10435	94.456	63.379
1987Q4	79.72051	7.75E-07	NA	2.2E-08	308.908	NA	18.05837	98.048	71.110
1988Q1	79.38614	1.23E-06	NA	3.36E-08	576.434	NA	15.82813	95.803	81.886
1988Q2	79.9114	2.05E-06	NA	5.54E-08	766.487	NA	16.21231	101.730	102.470
1988Q3	80.44013	3.73E-06	NA	9.87E-08	1302.92	NA	14.44174	94.725	90.395
1988Q4	80.97237	7.57E-06	NA	1.96E-07	2125.65	NA	13.43891	89.056	95.254
1989Q1	81.50812	1.49E-05	NA	3.54E-07	875.922	NA	17.484	94.335	96.648
1989Q2	82.75937	2.18E-05	NA	4.21E-07	748.624	NA	18.63143	96.751	87.303
1989Q3	84.02982	4.77E-05	NA	9.34E-07	3883.02	NA	17.5338	104.231	79.155

1989Q4	85.31978	0.000139	NA	2.44E-06	20112.3	NA	19.365	101.088	75.138
1990Q1	86.62954	0.000657	NA	9.23E-06	61846.3	NA	19.84733	102.984	69.251
1990Q2	80.57121	0.001338	NA	1.92E-05	110.565	NA	15.96418	106.764	73.181
1990Q3	84.24972	0.001895	NA	2.61E-05	362.847	NA	26.40391	102.135	80.981
1990Q4	83.79919	0.002907	NA	4.55E-05	794.604	NA	32.52946	96.991	73.388
1991Q1	79.86328	0.004865	NA	7.87E-05	396.448	NA	20.789	92.716	68.282
1991Q2	79.97202	0.00634	NA	0.0001	208.937	NA	18.79407	98.692	63.846
1991Q3	79.54389	0.009098	NA	0.000138	518.938	NA	19.87011	94.001	60.918
1991Q4	76.5592	0.015913	NA	0.000278	2265.83	NA	20.50467	90.055	58.302
1992Q1	77.29335	0.030646	NA	0.000548	1883.19	NA	18.20066	87.334	60.033
1992Q2	78.31219	0.055314	NA	0.000973	1189.38	NA	20.12231	94.708	62.101
1992Q3	78.89867	0.101194	NA	0.001741	1584.73	NA	20.13815	93.129	64.161
1992Q4	79.76126	0.193711	NA	0.003344	1639.83	NA	19.18707	95.594	57.793
1993Q1	80.83558	0.395735	NA	0.006635	1945.08	NA	18.18378	99.393	56.759
1993Q2	81.84235	0.824485	NA	0.01389	2484.24	NA	18.24626	108.963	52.749
1993Q3	82.94648	1.87911	NA	0.031311	3566.38	NA	16.49207	107.738	52.368
1993Q4	83.39811	4.62453	NA	0.077627	5142.05	NA	15.06652	106.549	49.097
1994Q1	83.59875	12.6823	NA	0.208552	7763.81	NA	13.95667	107.114	54.148
1994Q2	83.51031	37.5386	NA	0.608818	11381	NA	16.05231	118.585	57.953
1994Q3	87.63887	56.9675	NA	0.904667	80.7401	NA	16.77663	120.158	64.046
1994Q4	91.68839	60.8741	NA	0.851333	57.0237	NA	16.52837	119.297	74.336
1995Q1	91.89932	63.9424	NA	0.868333	53.5342	NA	16.89544	124.667	78.376
1995Q2	90.74542	68.0871	NA	0.913333	63.5333	NA	18.13868	129.380	74.985
1995Q3	89.20083	72.0588	NA	0.947	55.2096	NA	16.19163	115.167	77.503
1995Q4	90.3468	74.9084	NA	0.965267	41.2127	NA	16.98783	111.091	73.138
1996Q1	90.9637	77.6879	NA	0.9831	32.682	NA	18.64791	109.584	70.407
1996Q2	91.42331	80.0798	NA	0.997	27.124	NA	19.47308	114.951	69.225
1996Q3	94.62761	82.2179	NA	1.015533	25.8337	NA	20.52685	119.897	62.771
1996Q4	92.7611	82.9739	NA	1.032567	24.165	NA	23.16957	118.728	63.161
1997Q1	94.13185	84.7302	NA	1.052333	22.1322	NA	21.18133	118.729	69.182
1997Q2	95.54484	86.2983	NA	1.070767	21.2223	NA	18.06527	114.686	69.421
1997Q3	96.28041	86.9228	NA	1.089933	20.8878	NA	18.52413	108.640	69.298
1997Q4	96.41718	87.3757	NA	1.109333	35.7692	NA	18.71359	104.169	63.604
1998Q1	94.6491	88.6691	NA	1.129	33.2767	NA	14.07722	95.755	58.747
1998Q2	96.64005	89.5226	NA	1.150533	22.9267	NA	13.2922	98.787	56.722
1998Q3	96.40185	89.2057	NA	1.173467	24.6167	NA	12.41652	93.705	54.486
1998Q4	94.84887	88.967	NA	1.199233	37.1833	NA	11.09522	87.794	52.249
1999Q1	94.92653	90.7116	NA	1.8709	37.8033	NA	11.11967	90.711	49.611
1999Q2	95.64726	92.4472	NA	1.727733	28.4133	NA	15.32549	90.369	52.930
1999Q3	95.78735	94.1136	NA	1.881267	19.8767	NA	20.31065	93.604	58.151
1999Q4	97.1832	96.406	NA	1.913567	18.95	NA	24.04457	98.314	60.825
2000Q1	99.07881	97.8532	NA	1.7674	18.8867	NA	26.63108	97.944	65.165
2000Q2	99.19484	98.5328	NA	1.811233	18.39	NA	26.81523	99.586	61.314
2000Q3	100.1024	101.23	NA	1.821233	16.6433	NA	30.54108	98.060	63.322
2000Q4	101.6981	102.384	NA	1.9496	16.4333	NA	30.19938	98.034	60.994

2001Q1	102.0895	103.93	NA	2.044033	15.36	NA	26.24846	99.301	61.096
2001Q2	101.2832	105.429	NA	2.3277	16.5767	NA	27.64846	104.641	58.688
2001Q3	100.884	107.9441	NA	2.588	18.8767	NA	25.87708	91.806	53.603
2001Q4	101.1051	110.0503	NA	2.502033	19.0533	NA	20.18682	84.482	51.686
2002Q1	101.9498	111.8521	NA	2.385667	18.9127	NA	21.41313	86.768	54.609
2002Q2	103.1661	113.6555	NA	2.578033	18.28	NA	25.49677	93.638	54.976
2002Q3	104.852	116.1857	NA	3.424967	17.9678	NA	26.69152	99.778	53.178
2002Q4	106.0849	121.7654	NA	3.6113	21.2899	NA	26.57955	99.252	54.515
2003Q1	104.3681	129.3424	NA	3.5323	25.6835	NA	30.78063	95.363	57.687
2003Q2	103.8983	132.8114	NA	2.9195	26.2378	NA	25.79215	92.555	57.352
2003Q3	105.5032	133.8652	NA	2.947967	23.2919	NA	28.26424	95.196	60.399
2003Q4	107.0277	135.6413	NA	2.8926	18.2528	NA	29.12258	98.569	67.385
2004Q1	109.9001	138.0778	NA	2.902801	16.26943	NA	31.2318	100.152	79.293
2004Q2	111.8794	140.1056	NA	3.05941	15.84182	NA	35.21699	99.147	79.302
2004Q3	112.6518	143.1027	NA	2.932242	15.90957	NA	40.74495	100.785	81.569
2004Q4	113.9874	145.4554	NA	2.735758	16.9562	NA	44.72681	97.082	86.654
2005Q1	114.5989	148.353	NA	2.616898	18.45875	NA	47.85232	98.935	96.216
2005Q2	116.8116	151.0305	NA	2.41513	19.55569	NA	52.7805	99.165	96.372
2005Q3	115.0817	151.9841	NA	2.313814	19.69226	NA	61.82716	100.793	98.772
2005Q4	116.6748	154.3158	NA	2.256527	18.78622	NA	57.76533	101.107	108.640
2006Q1	119.1127	156.527	NA	2.15973	17.22263	NA	62.65352	104.068	127.655
2006Q2	119.1369	157.5173	NA	2.179502	15.69066	NA	70.40733	108.921	157.174
2006Q3	120.9392	157.8107	NA	2.156906	14.60265	NA	70.57393	110.761	164.957
2006Q4	122.5725	159.1626	NA	2.140989	13.59521	NA	60.64093	111.161	175.000
2007Q1	124.8173	161.2166	NA	2.094369	12.93328	NA	58.60835	117.152	176.182
2007Q2	126.9334	162.6994	NA	1.956567	12.34642	NA	68.64131	117.407	201.561
2007Q3	128.6231	164.1456	NA	1.886753	11.45806	NA	74.64576	109.428	183.773
2007Q4	130.7633	165.9114	NA	1.763938	11.17985	NA	88.67391	112.671	171.732
2008Q1	132.7748	168.6465	NA	1.728515	11.17888	NA	96.44437	116.257	190.099
2008Q2	135.2127	171.7118	NA	1.626103	11.69538	NA	122.9046	118.162	191.894
2008Q3	137.9484	174.3998	NA	1.695187	12.89108	NA	116.8168	118.638	175.685
2008Q4	130.9725	176.2389	NA	2.252872	13.65493	NA	57.13889	100.410	118.375
2009Q1	130.0392	178.3977	NA	2.336809	12.56246	NA	45.6498	86.092	107.683
2009Q2	131.938	180.5984	NA	2.0311	10.2694	NA	59.72794	85.403	120.602
2009Q3	134.8507	182.0708	NA	1.831758	8.768613	NA	68.96119	98.122	150.868
2009Q4	138.3265	183.6898	NA	1.74832	8.649848	NA	75.54543	106.100	166.969
2010Q1	141.5449	187.0695	NA	1.822255	8.649833	NA	77.21481	114.970	191.133
2010Q2	143.5081	189.8151	NA	1.782745	9.349629	NA	79.44066	122.410	200.765
2010Q3	144.6989	190.4439	NA	1.727286	10.54628	NA	76.93491	122.952	193.209
2010Q4	145.753	193.9493	NA	1.686281	10.66	NA	87.28442	140.101	224.173
2011Q1	147.4748	198.4869	NA	1.649197	11.21495	NA	105.1645	161.593	248.642
2011Q2	148.2231	202.3329	NA	1.568018	11.91808	NA	117.1267	164.597	241.753
2011Q3	147.7886	204.0358	NA	1.667507	12.19037	NA	112.1519	152.970	233.054
2011Q4	148.0541	206.9421	NA	1.791385	11.33323	NA	108.9598	134.856	195.428
2012Q1	148.3196	209.9294	NA	1.758156	10.19304	NA	118.3063	135.581	205.355

2012Q2	148.8668	212.4492	NA	1.973946	8.765133	NA	108.8631	136.629	194.171
2012Q3	149.6472	214.7238	NA	2.031665	7.769327	NA	109.4362	131.864	178.522
2012Q4	150.4599	218.5481	NA	2.066323	7.176109	NA	110.0427	132.055	186.089
2013Q1	150.8702	223.2604	NA	1.990993	7.129719	NA	112.6017	133.145	199.388

China Dataset

date	RGDP	CPI	nomEQ	FXdol	Rshort	Rlong	POILdol	PRAWMATdol	PMETALdol
1979Q1	14.51002	25.39334	NA	1.57197	5.4	NA	21.38	58.091	61.191
1979Q2	14.93829	25.4377	NA	1.579452	5.4	NA	30.98626	63.368	66.698
1979Q3	15.3792	25.48206	NA	1.537257	5.4	NA	35.74185	71.727	66.557
1979Q4	15.83312	25.52642	NA	1.515511	5.4	NA	40.31522	68.040	74.124
1980Q1	16.03686	25.65321	NA	1.511322	5.4	NA	38.92582	74.539	84.040
1980Q2	16.24323	25.77999	NA	1.497157	5.4	NA	38.21978	67.190	72.555
1980Q3	16.45225	25.90678	NA	1.460748	5.4	NA	34.81522	72.958	72.082
1980Q4	16.66396	26.03357	NA	1.509427	5.4	NA	39.62011	72.542	66.401
1981Q1	16.87361	26.42332	NA	1.591821	5.4	NA	39.13056	67.010	62.526
1981Q2	17.0859	26.81307	NA	1.710723	5.4	NA	35.20978	65.465	59.323
1981Q3	17.30085	27.20282	NA	1.761965	5.4	NA	35.58652	61.702	57.345
1981Q4	17.51851	27.59258	NA	1.736629	5.4	NA	36.78304	60.841	54.847
1982Q1	18.00126	27.75693	NA	1.803162	5.76	NA	32.27789	62.213	53.942
1982Q2	18.49732	27.92128	NA	1.84825	5.76	NA	34.30967	61.778	49.074
1982Q3	19.00704	28.08564	NA	1.932738	5.76	NA	33.59293	60.814	48.016
1982Q4	19.53081	28.24999	NA	1.967152	5.76	NA	33.51359	57.811	47.677
1983Q1	20.02683	28.38617	NA	1.94793	5.76	NA	29.39278	57.729	53.485
1983Q2	20.53546	28.52235	NA	1.982344	5.76	NA	29.83736	62.750	59.486
1983Q3	21.057	28.65853	NA	1.978454	5.76	NA	30.77109	68.091	62.012
1983Q4	21.59178	28.79471	NA	1.974265	5.76	NA	29.14207	70.949	59.573
1984Q1	22.5466	28.90271	NA	2.04795	5.76	NA	29.75725	72.390	58.177
1984Q2	23.54365	29.01071	NA	2.155741	5.76	NA	29.58132	75.327	54.698
1984Q3	24.58478	29.11872	NA	2.390953	5.76	NA	28.08141	72.541	49.094
1984Q4	25.67196	29.22672	NA	2.662374	5.76	NA	27.55261	67.421	48.402
1985Q1	26.26432	29.43333	NA	2.819551	6.84	NA	27.76356	58.433	48.920
1985Q2	26.87035	30.46667	NA	2.843262	6.84	NA	27.02604	60.983	49.983
1985Q3	27.49037	30.8	NA	2.905636	7.2	NA	27.28533	60.671	46.823
1985Q4	28.12469	31.13333	NA	3.148898	7.2	NA	28.33065	64.813	45.056
1986Q1	28.70184	31.83333	NA	3.198833	7.2	NA	17.79878	64.988	47.830
1986Q2	29.29082	31.86667	NA	3.235	7.2	NA	12.82363	69.495	48.546
1986Q3	29.8919	32.16667	NA	3.697533	7.2	NA	12.39707	67.567	47.687
1986Q4	30.5053	32.96667	NA	3.713533	7.2	NA	14.72543	70.402	47.608
1987Q1	31.48044	33.56667	NA	3.718933	7.2	NA	17.92522	75.150	50.330
1987Q2	32.48675	34.23333	NA	3.7166	7.2	NA	18.68407	87.373	55.316
1987Q3	33.52523	34.63333	NA	3.718933	7.2	NA	19.10435	94.456	63.379
1987Q4	34.5969	35.63333	NA	3.721933	7.2	NA	18.05837	98.048	71.110
1988Q1	35.43487	37.06667	NA	3.722	7.2	NA	15.82813	95.803	81.886

1988Q2	36.29313	39.1	NA	3.718967	7.2	NA	16.21231	101.730	102.470
1988Q3	37.17218	42.53333	NA	3.722033	8.64	NA	14.44174	94.725	90.395
1988Q4	38.07253	45.4	NA	3.7209	8.64	NA	13.43891	89.056	95.254
1989Q1	38.13823	47.43333	NA	3.722	11.34	NA	17.484	94.335	96.648
1989Q2	38.20405	48.8	NA	3.722033	11.34	NA	18.63143	96.751	87.303
1989Q3	38.26998	48.96667	NA	3.7216	11.34	NA	17.5338	104.231	79.155
1989Q4	38.33602	48.83333	NA	4.0552	11.34	NA	19.365	101.088	75.138
1990Q1	38.87513	49.46667	NA	4.723033	11.34	NA	19.84733	102.984	69.251
1990Q2	39.42181	49.86667	NA	4.723333	10.08	NA	15.96418	106.764	73.181
1990Q3	39.97619	50.03333	NA	4.721667	8.64	NA	26.40391	102.135	80.981
1990Q4	40.53836	50.6	NA	5.06	8.64	NA	32.52946	96.991	73.388
1991Q1	41.63427	50.5	NA	5.227367	8.64	NA	20.789	92.716	68.282
1991Q2	42.75981	51.4	NA	5.316567	7.56	NA	18.79407	98.692	63.846
1991Q3	43.91578	52.26667	NA	5.3569	7.56	NA	19.87011	94.001	60.918
1991Q4	45.10301	52.93333	NA	5.3889	7.56	NA	20.50467	90.055	58.302
1992Q1	46.80678	53.26667	NA	5.463067	7.56	NA	18.20066	87.334	60.033
1992Q2	48.57491	54.3	NA	5.503	7.56	NA	20.12231	94.708	62.101
1992Q3	50.40983	55.4	NA	5.4856	7.56	NA	20.13815	93.129	64.161
1992Q4	52.31406	57.33333	NA	5.629333	7.56	NA	19.18707	95.594	57.793
1993Q1	53.9119	59.06667	NA	5.799667	7.56	NA	18.18378	99.393	56.759
1993Q2	55.55853	61.86667	NA	5.719	9.18	NA	18.24626	108.963	52.749
1993Q3	57.25546	64.26667	NA	5.719	10.98	NA	16.49207	107.738	52.368
1993Q4	59.00421	67.16667	NA	5.785033	10.98	NA	15.06652	106.549	49.097
1994Q1	60.86973	72.13333	NA	8.70219	10.98	NA	13.95667	107.114	54.148
1994Q2	62.26049	75.53333	NA	8.689963	10.98	NA	16.05231	118.585	57.953
1994Q3	62.2394	80.83333	NA	8.679	10.98	NA	16.77663	120.158	64.046
1994Q4	61.55088	85.1	NA	8.547033	10.98	NA	16.52837	119.297	74.336
1995Q1	64.08958	88.3	NA	8.433133	10.98	NA	16.89544	124.667	78.376
1995Q2	65.90097	90.56667	NA	8.34	10.98	NA	18.13868	129.380	74.985
1995Q3	68.11554	92.76667	NA	8.307	10.98	NA	16.19163	115.167	77.503
1995Q4	68.6755	94.56667	NA	8.3144	10.98	NA	16.98783	111.091	73.138
1996Q1	70.09563	96.56667	NA	8.298367	10.98	NA	18.64791	109.584	70.407
1996Q2	70.91216	98.86667	NA	8.319533	9.18	NA	19.47308	114.951	69.225
1996Q3	72.46639	100.1333	NA	8.3366	7.47	NA	20.52685	119.897	62.771
1996Q4	74.84952	101.0667	NA	8.329567	7.47	NA	23.16957	118.728	63.161
1997Q1	75.90458	101.4333	NA	8.325133	7.47	NA	21.18133	118.729	69.182
1997Q2	77.58282	101.9333	NA	8.322633	7.47	NA	18.06527	114.686	69.421
1997Q3	77.47607	102.3667	NA	8.308467	7.47	NA	18.52413	108.640	69.298
1997Q4	80.93884	101.9667	NA	8.311167	5.67	NA	18.71359	104.169	63.604
1998Q1	81.29229	101.5667	NA	8.289567	5.22	NA	14.07722	95.755	58.747
1998Q2	82.72242	101.2667	NA	8.278967	5.22	NA	13.2922	98.787	56.722
1998Q3	83.88653	101	NA	8.279133	4.77	NA	12.41652	93.705	54.486
1998Q4	88.16758	100.7333	NA	8.2779	3.78	NA	11.09522	87.794	52.249
1999Q1	88.06956	100.0667	NA	8.278833	3.78	NA	11.11967	90.711	49.611
1999Q2	89.25799	99.26667	NA	8.2788	2.25	NA	15.32549	90.369	52.930
1999Q3	91.18006	99.6	NA	8.277267	2.25	NA	20.31065	93.604	58.151

1999Q4	94.11199	99.76667	NA	8.278433	2.25	NA	24.04457	98.314	60.825
2000Q1	96.0217	100.0667	NA	8.278367	2.25	NA	26.63108	97.944	65.165
2000Q2	99.31576	99.4	NA	8.2781	2.25	NA	26.81523	99.586	61.314
2000Q3	101.168	99.9	NA	8.2793	2.25	NA	30.54108	98.060	63.322
2000Q4	103.4945	100.6	NA	8.277633	2.25	NA	30.19938	98.034	60.994
2001Q1	106.7693	100.7545	NA	8.278033	2.25	NA	26.24846	99.301	61.096
2001Q2	108.6302	100.9236	NA	8.277067	2.25	NA	27.64846	104.641	58.688
2001Q3	110.7141	100.7343	NA	8.276933	2.25	NA	25.87708	91.806	53.603
2001Q4	113.401	100.5342	NA	8.276833	2.25	NA	20.18682	84.482	51.686
2002Q1	116.2338	100.1006	NA	8.2801	1.98	NA	21.41313	86.768	54.609
2002Q2	119.7925	99.81537	NA	8.287067	1.98	NA	25.49677	93.638	54.976
2002Q3	123.3833	99.90373	NA	8.2868	1.98	NA	26.69152	99.778	53.178
2002Q4	126.4374	100.0046	NA	8.2822	1.98	NA	26.57955	99.252	54.515
2003Q1	130.6989	100.5748	NA	8.287167	1.98	NA	30.78063	95.363	57.687
2003Q2	131.9343	100.4984	NA	8.283867	1.98	NA	25.79215	92.555	57.352
2003Q3	138.183	100.6599	NA	8.2871	1.98	NA	28.26424	95.196	60.399
2003Q4	140.8043	102.6607	NA	8.285167	1.98	NA	29.12258	98.569	67.385
2004Q1	146.591	103.321	NA	8.285434	1.98	NA	31.2318	100.152	79.293
2004Q2	151.268	104.7498	NA	8.2851	1.98	NA	35.21699	99.147	79.302
2004Q3	157.2341	105.7868	NA	8.285	1.98	NA	40.74495	100.785	81.569
2004Q4	161.4294	105.132	NA	8.2848	2.25	NA	44.72681	97.082	86.654
2005Q1	166.5875	106.1572	NA	8.284833	2.25	NA	47.85232	98.935	96.216
2005Q2	171.869	106.3546	NA	8.2848	2.25	NA	52.7805	99.165	96.372
2005Q3	177.4598	106.7093	NA	8.110324	2.25	NA	61.82716	100.793	98.772
2005Q4	184.8359	106.8848	NA	8.088002	2.25	NA	57.76533	101.107	108.640
2006Q1	191.5402	107.0319	NA	8.0532	2.25	NA	62.65352	104.068	127.655
2006Q2	197.8948	107.8922	NA	8.019466	2.25	NA	70.40733	108.921	157.174
2006Q3	203.665	108.2844	NA	7.956503	2.52	NA	70.57393	110.761	164.957
2006Q4	211.8594	109.9214	NA	7.857537	2.52	NA	60.64093	111.161	175.000
2007Q1	224.7529	110.5944	NA	7.755934	2.79	NA	58.60835	117.152	176.182
2007Q2	231.5988	112.5914	NA	7.668013	3.06	NA	68.64131	117.407	201.561
2007Q3	236.8452	114.9971	NA	7.547525	3.87	NA	74.64576	109.428	183.773
2007Q4	245.9655	117.0718	NA	7.408618	4.14	NA	88.67391	112.671	171.732
2008Q1	252.7013	119.7848	NA	7.12847	4.14	NA	96.44437	116.257	190.099
2008Q2	262.2763	120.5926	NA	6.939747	4.14	NA	122.9046	118.162	191.894
2008Q3	269.3613	120.2893	NA	6.836576	4.14	NA	116.8168	118.638	175.685
2008Q4	274.3216	118.4493	NA	6.841782	2.25	NA	57.13889	100.410	118.375
2009Q1	270.6888	118.3512	NA	6.844551	2.25	NA	45.6498	86.092	107.683
2009Q2	282.5999	118.5706	NA	6.835509	2.25	NA	59.72794	85.403	120.602
2009Q3	293.6736	119.3119	NA	6.836843	2.25	NA	68.96119	98.122	150.868
2009Q4	303.126	120.6744	NA	6.83384	2.25	NA	75.54543	106.100	166.969
2010Q1	313.925	121.2064	NA	6.833473	2.25	NA	77.21481	114.970	191.133
2010Q2	324.1196	122.0454	NA	6.818925	2.25	NA	79.44066	122.410	200.765
2010Q3	332.8336	123.5919	NA	6.761501	2.25	NA	76.93491	122.952	193.209
2010Q4	339.587	126.183	NA	6.659565	2.75	NA	87.28442	140.101	224.173
2011Q1	352.1396	127.7646	NA	6.57855	3	NA	105.1645	161.593	248.642

2011Q2	360.8094	129.8922	NA	6.496334	3.25	NA	117.1267	164.597	241.753
2011Q3	371.8363	131.1419	NA	6.411449	3.5	NA	112.1519	152.970	233.054
2011Q4	379.8573	131.2788	NA	6.358095	3.5	NA	108.9598	134.856	195.428
2012Q1	379.2206	132.4154	NA	6.307978	3.5	NA	118.3063	135.581	205.355
2012Q2	387.6066	132.7655	NA	6.346283	3.25	NA	108.8631	136.629	194.171
2012Q3	396.0191	133.6323	NA	6.353791	3	NA	109.4362	131.864	178.522
2012Q4	405.933	134.5278	NA	6.238508	3	NA	110.0427	132.055	186.089
2013Q1	407.4599	135.2117	NA	6.226663	3	NA	112.6017	133.145	199.388

India Dataset

date	RGDP	CPI	nomEQ	FXdol	Rshort	Rlong	POILdol	PRAWMATdol	PMETALdol
1979Q1	30.82627	15.4649	14.87564	8.141061	7.26	NA	21.38	58.091	61.191
1979Q2	31.14699	15.84296	15.92381	8.125875	7.26	NA	30.98626	63.368	66.698
1979Q3	31.47105	16.38572	14.96018	7.949018	7.26	NA	35.74185	71.727	66.557
1979Q4	31.79849	16.90878	15.09849	8.087542	7.26	NA	40.31522	68.040	74.124
1980Q1	32.12933	17.335	15.92679	7.94392	7.26	NA	38.92582	74.539	84.040
1980Q2	32.95101	17.73672	15.97863	7.871994	7.26	NA	38.21978	67.190	72.555
1980Q3	33.79371	18.16458	16.88405	7.699381	7.26	NA	34.81522	72.958	72.082
1980Q4	34.65796	18.71368	17.30033	7.74328	7.26	NA	39.62011	72.542	66.401
1981Q1	35.54431	19.45152	19.91372	8.062059	7.26	NA	39.13056	67.010	62.526
1981Q2	35.55757	20.15893	23.23567	8.357951	7.26	NA	35.20978	65.465	59.323
1981Q3	35.57083	20.65867	25.51084	8.9291	8.067	NA	35.58652	61.702	57.345
1981Q4	35.5841	21.11483	27.10198	9.072226	8.067	NA	36.78304	60.841	54.847
1982Q1	35.59737	21.40029	29.10391	9.138774	8.067	NA	32.27789	62.213	53.942
1982Q2	36.45784	21.58132	28.30896	9.296321	8.067	NA	34.30967	61.778	49.074
1982Q3	37.33911	22.1529	27.15131	9.511033	8.067	NA	33.59293	60.814	48.016
1982Q4	38.24168	22.67625	28.64677	9.642074	8.067	NA	33.51359	57.811	47.677
1983Q1	39.16607	23.31306	28.02895	9.8271	8.067	NA	29.39278	57.729	53.485
1983Q2	39.48693	24.22936	28.86775	9.946621	8.067	NA	29.83736	62.750	59.486
1983Q3	39.81043	25.03938	29.92456	10.08536	8.067	NA	30.77109	68.091	62.012
1983Q4	40.13657	25.6365	30.23581	10.28841	8.067	NA	29.14207	70.949	59.573
1984Q1	40.46539	26.19631	31.29939	10.67472	8.067	NA	29.75725	72.390	58.177
1984Q2	40.89127	26.28424	30.32858	10.9046	8.067	NA	29.58132	75.327	54.698
1984Q3	41.32163	26.81989	32.15379	11.50817	8.067	NA	28.08141	72.541	49.094
1984Q4	41.75652	27.11123	33.90058	12.08361	8.067	NA	27.55261	67.421	48.402
1985Q1	42.19598	27.39213	38.0326	12.75884	8.067	NA	27.76356	58.433	48.920
1985Q2	42.96065	27.90984	49.56627	12.42093	8.067	NA	27.02604	60.983	49.983
1985Q3	43.73917	28.23927	61.49661	11.97429	8.067	NA	27.28533	60.671	46.823
1985Q4	44.5318	28.77439	62.13533	12.01702	8.067	NA	28.33065	64.813	45.056
1986Q1	45.3388	29.59327	75.85035	12.23667	8.067	NA	17.79878	64.988	47.830
1986Q2	45.42462	30.26308	77.23522	12.47667	8.067	NA	12.82363	69.495	48.546
1986Q3	45.51061	30.75157	73.12965	12.55333	8.067	NA	12.39707	67.567	47.687
1986Q4	45.59677	31.5082	67.97024	13.07533	8.067	NA	14.72543	70.402	47.608

1987Q1	45.68308	32.09315	69.62368	12.93333	8.067	NA	17.92522	75.150	50.330
1987Q2	46.96193	32.69133	60.02649	12.74333	8.067	NA	18.68407	87.373	55.316
1987Q3	48.27657	33.6475	60.84562	13.11333	8.067	NA	19.10435	94.456	63.379
1987Q4	49.62802	34.41864	55.25575	12.97667	8.067	NA	18.05837	98.048	71.110
1988Q1	51.0173	35.14558	54.13775	13.06333	8.067	NA	15.82813	95.803	81.886
1988Q2	51.48247	35.89723	64.93835	13.59667	8.067	NA	16.21231	101.730	102.470
1988Q3	51.95187	36.63581	76.16154	14.32667	8.067	NA	14.44174	94.725	90.395
1988Q4	52.42556	37.65245	86.83416	14.92	8.067	NA	13.43891	89.056	95.254
1989Q1	52.90357	37.95157	83.84489	15.30333	8.067	NA	17.484	94.335	96.648
1989Q2	54.1267	38.49996	93.24766	16.13333	8.067	NA	18.63143	96.751	87.303
1989Q3	55.3781	39.0962	92.96566	16.59	8.067	NA	17.5338	104.231	79.155
1989Q4	56.65844	39.46198	92.95807	16.83	8.067	NA	19.365	101.088	75.138
1990Q1	57.96837	40.24171	90.09667	16.99	8.067	NA	19.84733	102.984	69.251
1990Q2	57.86647	41.62098	103.1067	17.31	8.067	NA	15.96418	106.764	73.181
1990Q3	57.76475	42.68014	141.4167	17.56667	8.067	NA	26.40391	102.135	80.981
1990Q4	57.66321	44.35153	137.3	18.12	8.067	NA	32.52946	96.991	73.388
1991Q1	57.56184	46.27343	123.1967	18.97333	8.067	NA	20.789	92.716	68.282
1991Q2	58.22609	46.79197	138.6233	20.7	8.067	NA	18.79407	98.692	63.846
1991Q3	58.898	48.81624	180.65	25.85	8.873	NA	19.87011	94.001	60.918
1991Q4	59.57767	50.43509	198.0333	25.78333	9.68	NA	20.50467	90.055	58.302
1992Q1	60.26518	52.45418	370.0133	26.93333	9.68	NA	18.20066	87.334	60.033
1992Q2	61.12289	53.35375	426.15	28.20333	9.68	NA	20.12231	94.708	62.101
1992Q3	61.99281	54.40488	304.16	28.12667	9.68	NA	20.13815	93.129	64.161
1992Q4	62.87511	54.79469	261.87	28.31667	9.68	NA	19.18707	95.594	57.793
1993Q1	63.76997	55.51989	225.2467	29.88	9.68	NA	18.18378	99.393	56.759
1993Q2	64.71319	56.40534	198.54	31.11	9.517	NA	18.24626	108.963	52.749
1993Q3	65.67036	57.44098	249.15	31.13	9.163	NA	16.49207	107.738	52.368
1993Q4	66.64168	59.31459	328.1233	31.13	7.933	NA	15.06652	106.549	49.097
1994Q1	67.62737	60.80037	443.5467	31.13107	7.8	NA	13.95667	107.114	54.148
1994Q2	69.13875	62.25878	437.64	31.21907	7.617	NA	16.05231	118.585	57.953
1994Q3	70.6839	63.78916	461.0933	31.13333	8.15	NA	16.77663	120.158	64.046
1994Q4	72.26358	65.18157	427.2033	31.22333	9.667	NA	16.52837	119.297	74.336
1995Q1	73.87857	66.76784	344.63	31.40333	13.167	NA	16.89544	124.667	78.376
1995Q2	74.66243	68.54559	340.8233	31.39	13.167	NA	18.13868	129.380	74.985
1995Q3	75.45461	70.70161	350.6233	32.23	12.667	NA	16.19163	115.167	77.503
1995Q4	76.25519	71.78213	298.23	35.16667	12.75	NA	16.98783	111.091	73.138
1996Q1	77.06427	72.63298	311.3767	35.27667	13	NA	18.64791	109.584	70.407
1996Q2	79.59695	74.91497	375.7367	34.79	12.433	NA	19.47308	114.951	69.225
1996Q3	82.21285	76.83609	345.3633	35.70667	9.417	NA	20.52685	119.897	62.771
1996Q4	84.91473	78.34716	302.07	35.72333	9	NA	23.16957	118.728	63.161
1997Q1	83.99594	80.33779	344.5833	35.86667	8	NA	21.18133	118.729	69.182
1997Q2	81.6436	80.65851	394.7567	35.79667	7.114	NA	18.06527	114.686	69.421
1997Q3	84.57666	80.82916	426	36.10667	6.907	NA	18.52413	108.640	69.298
1997Q4	86.99209	82.65665	389.57	38.05	6.782	NA	18.71359	104.169	63.604
1998Q1	87.96374	87.5604	366.6367	39.15333	9.717	NA	14.07722	95.755	58.747

1998Q2	89.02834	88.98819	380.5867	41.23667	8.148	NA	13.2922	98.787	56.722
1998Q3	90.83655	93.38834	337.5833	42.47667	9.813	NA	12.41652	93.705	54.486
1998Q4	92.45361	97.38726	323.8467	42.39333	9.608	NA	11.09522	87.794	52.249
1999Q1	93.83253	95.38963	367.5667	42.49167	9.342	NA	11.11967	90.711	49.611
1999Q2	93.71698	95.27174	391.8167	42.995	8.675	NA	15.32549	90.369	52.930
1999Q3	96.21311	96.07625	511.2733	43.47667	9.342	NA	20.31065	93.604	58.151
1999Q4	98.13727	97.84664	564.0633	43.43167	9.467	NA	24.04457	98.314	60.825
2000Q1	98.9695	98.85872	728.65	43.58667	9.083	NA	26.63108	97.944	65.165
2000Q2	99.71623	100.2743	539.7767	44.30167	8.708	NA	26.81523	99.586	61.314
2000Q3	100.2925	100.0593	490.9567	45.58667	10.258	NA	30.54108	98.060	63.322
2000Q4	100.5107	100.845	444.3467	46.63833	9.483	NA	30.19938	98.034	60.994
2001Q1	102.9488	101.2973	463.49	46.52167	8.7	NA	26.24846	99.301	61.096
2001Q2	104.114	102.5938	393.7833	46.945	7.558	NA	27.64846	104.641	58.688
2001Q3	106.7022	104.4132	339.1333	47.37833	7.008	NA	25.87708	91.806	53.603
2001Q4	107.3536	105.2833	345.49	47.97833	6.75	NA	20.18682	84.482	51.686
2002Q1	108.4363	106.3843	396.6767	48.7	6.288	NA	21.41313	86.768	54.609
2002Q2	108.8465	107.2776	403.43	48.95333	6.255	NA	25.49677	93.638	54.976
2002Q3	109.3324	108.6132	376.8067	48.51833	5.798	NA	26.69152	99.778	53.178
2002Q4	112.9825	109.4933	386.6267	48.215	5.432	NA	26.57955	99.252	54.515
2003Q1	115.015	110.3188	396.52	47.68833	5.768	NA	30.78063	95.363	57.687
2003Q2	119.2194	112.4171	415.2233	46.99067	4.717	NA	25.79215	92.555	57.352
2003Q3	120.4455	112.3202	545.2333	45.97167	4.662	NA	28.26424	95.196	60.399
2003Q4	120.1948	113.1458	692.7033	45.66733	4.447	NA	29.12258	98.569	67.385
2004Q1	123.0613	114.6251	753.327	44.77121	4.265	NA	31.2318	100.152	79.293
2004Q2	125.5426	115.5092	688.0808	45.26516	4.381667	NA	35.21699	99.147	79.302
2004Q3	128.8685	117.043	695.1155	46.29646	4.61	NA	40.74495	100.785	81.569
2004Q4	130.6325	117.8498	809.3387	44.86176	5.208333	NA	44.72681	97.082	86.654
2005Q1	134.0178	119.45	838.3913	43.8317	5.216667	NA	47.85232	98.935	96.216
2005Q2	136.3006	120.169	872.162	43.65023	5.213333	NA	52.7805	99.165	96.372
2005Q3	139.8508	121.4058	1035.288	43.91473	5.288333	NA	61.82716	100.793	98.772
2005Q4	144.4151	123.7063	1122.223	45.43497	5.77	NA	57.76533	101.107	108.640
2006Q1	146.8719	125.246	1340.287	44.56472	6.48	NA	62.65352	104.068	127.655
2006Q2	150.0875	127.8201	1394.832	45.99775	5.796667	NA	70.40733	108.921	157.174
2006Q3	153.7928	129.347	1485.762	46.42038	6.496667	NA	70.57393	110.761	164.957
2006Q4	158.859	132.0666	1730.967	44.85214	6.816667	NA	60.64093	111.161	175.000
2007Q1	159.9096	134.0069	1723.815	43.88092	7.375	NA	58.60835	117.152	176.182
2007Q2	162.8916	136.0183	1859.939	40.99397	7.148333	NA	68.64131	117.407	201.561
2007Q3	166.4189	137.981	2045.328	40.42659	6.398333	NA	74.64576	109.428	183.773
2007Q4	169.1559	139.2958	2595.148	39.57051	7.216667	NA	88.67391	112.671	171.732
2008Q1	172.4304	142.3542	2261.841	39.81959	7.241667	NA	96.44437	116.257	190.099
2008Q2	174.4934	146.7401	2085.017	42.05613	7.808333	NA	122.9046	118.162	191.894
2008Q3	176.8248	150.3937	1794.778	44.06699	9.008333	NA	116.8168	118.638	175.685
2008Q4	180.3774	153.5198	1131.404	49.34779	6.216667	NA	57.13889	100.410	118.375
2009Q1	184.9355	155.5332	1140.808	49.93269	4.675	NA	45.6498	86.092	107.683
2009Q2	190.6443	159.9399	1669.387	48.86468	3.241667	NA	59.72794	85.403	120.602

2009Q3	190.944	168.0091	2027.932	48.50757	3.341667	NA	68.96119	98.122	150.868
2009Q4	195.9501	174.0155	2177.881	46.78457	3.336667	NA	75.54543	106.100	166.969
2010Q1	202.5795	179.152	2165.161	45.94435	4.041667	NA	77.21481	114.970	191.133
2010Q2	206.9268	181.9735	2225.137	46.18715	4.576667	NA	79.44066	122.410	200.765
2010Q3	209.7383	185.2803	2393.682	46.26642	6.016667	NA	76.93491	122.952	193.209
2010Q4	215.4858	190.0422	2528.85	45.13166	6.916667	NA	87.28442	140.101	224.173
2011Q1	217.5843	195.0594	2367.871	45.21009	7.183333	NA	105.1645	161.593	248.642
2011Q2	220.136	198.2948	2332.974	44.93558	7.916667	NA	117.1267	164.597	241.753
2011Q3	222.842	202.2698	2124.781	46.34151	8.366667	NA	112.1519	152.970	233.054
2011Q4	226.1789	206.0473	2029.399	51.50383	8.666667	NA	108.9598	134.856	195.428
2012Q1	229.1115	208.9087	2164.938	50.14963	8.9	NA	118.3063	135.581	205.355
2012Q2	231.5131	218.4685	2090.862	55.28107	8.316667	NA	108.8631	136.629	194.171
2012Q3	233.6023	222.017	2189.315	55.17761	8.156667	NA	109.4362	131.864	178.522
2012Q4	236.838	226.9143	2344.663	54.67698	8.15	NA	110.0427	132.055	186.089
2013Q1	239.1363	233.298	2410.174	53.84593	8.0329	NA	112.6017	133.145	199.388