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FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

DEPARTMENT OF ECONOMICS

**The Impact of Quantitative Easing on Capital Flows to the  
BRICS Economies**

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A mini-thesis submitted to the Department of Economics, University of the Western Cape, in partial fulfilment of the requirements for the degree of Master of Economics.

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## **Declaration**

I, **Malindi Msoni**, hereby declare that this mini-thesis titled “The Impact of Quantitative Easing on Capital Flows to the BRICS Economies” has not been previously submitted in part or in its entirety before for any degree or examination in any other university. Therefore, the contents of this mini-thesis, except where referenced, are the product of my own work under the supervision of Prof. Lieb J. Loots. I also declare that all the sources used or quoted in this paper have been indicated and acknowledged as complete references.

Signed: 14 June, 2018

Date: .....

## **Abstract**

A possible effect of quantitative easing (QE) undertaken by the United States of America (USA) Federal Reserve Bank (Fed) may have been an increase in capital flowing into emerging market economies (EMEs). The 2008 global financial crisis created an environment in which traditional monetary policies – cutting policy rates – became ineffective in stimulating growth. Faced with this policy environment, several high-income countries including the USA resorted to unconventional monetary policies notably QE, to grow their economies. While QE was effective in lowering interest rates in high-income countries, some argued that investors switched to higher yielding assets, mostly EME assets. Therefore, QE is perceived to have increased capital flows into EMEs.

Using a dynamic panel data model with fixed effects this mini-thesis investigates empirically whether QE worked through unobservable channels to increase gross private capital inflows to Brazil, Russia, India, China and South Africa (BRICS) in the period 2000-2015. The study finds evidence in support of the view that QE increased capital inflows to EMEs. The results reveal that gross private capital inflows to the BRICS increased during the QE intervention period and that the increase was higher in the first period of QE than in subsequent QE periods. The empirical results also reveal differences in the way types of capital flows responded to QE; portfolio flows, and in particular equity flows were the most responsive to QE.

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**Keywords:** Quantitative easing, Capital flows, Emerging market economies, BRICS, Pull factors, Push factors.

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## Table of Contents

<b>Declaration .....</b>	i
<b>Abstract.....</b>	ii
<b>Key Words.....</b>	ii
<b>Acknowledgements .....</b>	iii
<b>List of Tables .....</b>	vii
<b>List of Figures.....</b>	vii
<b>List of Abbreviations .....</b>	viii
<b>Chapter 1: Introduction .....</b>	1
1.1    Background .....	1
1.2    The Problem Statement .....	3
1.3    Study Objectives .....	3
1.4    Rationale of the Study .....	4
1.5    Data and Methodology .....	4
1.6    Ethical Clearance Statement.....	5
1.7    Structure of the Study.....	5
<b>Chapter 2: Literature Review.....</b>	7
2.1    Introduction .....	7
2.2    Theoretical Framework .....	7
2.2.1    Understanding Quantitative Easing .....	7
2.2.2    Capital Flows .....	11
2.3    Empirical Literature Review .....	17
2.3.1    Causes of the Global Financial Crisis .....	17
2.3.2    Responses to the Global Financial Crisis.....	20
2.4    Effect of Quantitative Easing on Capital Flows to the BRICS Economies .....	23

2.4.1	Defining the BRICS countries .....	23
2.4.2	Capital Flows to the BRICS Countries .....	25
2.4.3	The Impact of Quantitative Easing on Capital Flows to EMEs.....	29
2.5	Conclusion.....	32
<b>Chapter 3: Methodology .....</b>	<b>34</b>	
3.1	Introduction .....	34
3.2	Approaches to Estimating the Impact of Quantitative Easing .....	34
3.2.1	Event Studies and Vector Autoregressive Models.....	35
3.2.2	Dynamic Panel Models .....	36
3.2.3	Concluding Remarks on Estimation Techniques .....	39
3.3	Methodological Debates in the Capital Flows Literature.....	39
3.4	Model Estimation Techniques.....	41
3.4.1	The Basic Panel Data Regression Model.....	41
3.4.2	Stationarity and Non-Stationarity in Panel Data.....	43
3.4.3	Fixed Effects and Random Effects Models .....	48
3.4.4	Model Adequacy Tests .....	52
3.5	Application of the Dynamic Panel Model.....	54
3.5.1	Dynamic Panel Model with a Lagged Dependent Variable.....	55
3.5.2	Modelling the Impact of QE on Capital Flows to the BRICS Economies.....	61
3.6	Data and Description of Key Variables.....	62
3.6.1	Gross Private Capital Inflows .....	62
3.6.2	Capturing the Effect of Quantitative Easing .....	63
3.6.3	Pull and Push Factors.....	63
3.7	Conclusion.....	66
<b>Chapter 4: Empirical Analysis and Results .....</b>	<b>68</b>	

4.1	Introduction .....	68
4.2	Econometric Results and Main Findings .....	68
4.2.1	Panel Unit Root Tests .....	68
4.2.2	Fixed Effects or Random Effects .....	70
4.2.3	Model Adequacy Tests .....	72
4.2.4	Baseline Regression Results .....	73
4.2.5	Robustness of the Baseline Regression.....	81
4.3	Conclusion.....	83
<b>Chapter 5: General Conclusion .....</b>	<b>85</b>	
5.1	Introduction .....	85
5.2	Main Findings .....	86
5.2.1	Push Factors Dominate Pull Factors .....	87
5.2.2	Quantitative Easing Increased Capital Inflows to the BRICS .....	87
5.2.3	The Impact of QE was Greater on Portfolio Flows .....	87
5.2.4	Robustness Checks.....	87
5.3	Limitations of the Study .....	88
5.4	Areas for Further Research .....	88
<b>References.....</b>	<b>90</b>	
<b>Appendix.....</b>	<b>103</b>	

## **List of Tables**

Table 4.1: Panel Unit Root Test Results for BRICS Countries .....	69
Table 4.2: Time Series Unit Root Test Results.....	70
Table 4.3: Hausman Specification Test Results .....	71
Table 4.4: Breusch & Pagan Lagrangian Multiplier Test for Random Effects .....	72
Table 4.5: Test for Autocorrelation and Heteroscedasticity .....	73
Table 4.6: Baseline Regression Results Unbalanced Quarterly Panel 2001Q1-2015Q4.....	74
Table 4.7: Pairwise Correlations.....	76
Table 4.8: Decomposition of Gross Capital Inflows (2001Q1-2015Q4).....	80
Table 4.9: Robustness Regressions for Gross Capital Inflows (2001Q1-2015Q4) .....	82

## **List of Figures**

Figure 2.1: Gross Domestic Product (Current Million US\$).....	24
Figure 2.2: Total Gross Inflows to BRICS Countries (Billion US\$).....	26
Figure 2.3: Total Gross Inflows to BRICS Countries, Components (Billion US\$).....	27
Figure 2.4: Policy Interest Rates (%) .....	28
Figure 2.5: Real GDP Growth (%) .....	29
Figure 4.1: Impact of Push and Pull Factors on Gross Capital Inflows to the BRICS .....	78

## **List of Abbreviations**

BIS	Bank for International Settlements
BOE	Bank of England
BOJ	Bank of Japan
BOPS	Balance of Payments Statistics
BRICS	Brazil, Russia, India, China and South Africa
CDOs	Collateralised Debt Obligations
DSP	Difference Stationary Process
ECB	European Central Bank
EMEs	Emerging Market Economies
ESOs	Employee Stock Options
FDI	Foreign Direct Investment
G6	Group of Six
GFC	Global Financial Crisis
GMM	General Method of Moments
GSE	Government Sponsored Enterprise
IFS	International Financial Statistics
IIF	Institute for International Finance
IIP	International Investment Position
IMF	International Monetary Fund
IV	Instrumental Variables
LBS	Locational Banking Statistics
LCFIs	Large Complex Financial Institutions
LSDV	Least Squares Dummy Variable
LSDVC	Bias Corrected Least Squares Dummy Variable
MBS	Mortgage-backed Securities
MEP	Maturity Extension Programme
NEER	Nominal Effective Exchange Rate
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
QE	Quantitative Easing

RHS	Right Hand Side
RWM	Random Walk Model
TSP	Trend Stationary Process
UBS	Union Bank of Switzerland
US	United States
USA	United States of America
VAR	Vector Autoregressive Models
VIX	Volatility Index
WDI	World Development Indicators
ZLB	Zero Lower Bound

# **Chapter 1**

## **Introduction**

### **1.1 Background**

The core of monetary policy has changed significantly over the past three decades. While money targets were the dominant anchor for monetary policy in the early 1980s, they were abandoned by the late 1980s owing to the perceived instability of money at the time (Lyonnet & Werner, 2012:94). Consequently, several central banks adopted interest rate targets as an anchor for monetary policy. However, the interest-rate-based approach encountered a major empirical challenge when successive interest rate cuts failed to stimulate economic growth in Japan. Similarly, Joyce, Miles, Scott and Vayanos (2012:271) show that with interest rates at or close to zero during the 2008 global financial crisis (GFC), the interest rate approach faced further challenges when reductions in the policy rate could not influence market rates in the expected way and were thus unable to stimulate growth. The ineffectiveness of interest rate cuts to stimulate growth resulted in policy makers in developed countries to implement unconventional monetary measures called quantitative easing (QE).

The term QE was first used in 1994 by Professor Richard Werner in his numerous publications in which he provided policy recommendations for the recovery of the Japanese economy following the recession (Lyonnet & Werner, 2012:96). Different scholars have applied varying emphases when defining QE. For example, Calderon (2012:1) defines QE as a monetary policy aimed at increasing the supply of money through purchases of government and agency securities so as to inject capital into financial institutions. Others, for instance Chen, Curdia and Ferrero (2011:1) and Blinder (2010:2), define QE as a policy implemented to spur real economic activity in periods when conventional monetary tools, particularly nominal interest rates, are ineffective as a result of the zero lower bound (ZLB) constraint. But regardless of how it is defined, QE aims to ease liquidity and credit conditions so as to stimulate borrowing and eventually demand in an ailing economy, as was the case in the wake of the 2008 GFC<sup>1</sup>.

The 2008 GFC resulted in what is considered by many (e.g. Joyce, Lasaosa, Stevens & Tong 2011:271; Mishkin 2011:2) to be the most severe world-wide economic downturn since the great

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<sup>1</sup> See Chapter 2 for a more detailed discussion of the origin and meaning of QE.

depression of the 1930s. As Mishkin (2011:22) shows, what started out as a somewhat manageable crisis in the United States (US) real estate market in 2007 grew into a financial crisis that threw not only the USA but the world economy into a recession. As the crisis intensified, central banks, particularly those in the first world, responded by aggressively cutting policy rates, often to levels that were constrained by the ZLB (Minegishi & Courneade, 2010:8). It was hoped that exceptionally low interest rates would lower inter-bank borrowing rates, which would then encourage economic activity through lower market interest rates. However, Minegishi and Courneade (2010:10) show that as uncertainty in the financial markets grew, economic agents became extremely risk averse, with most banks simply hoarding liquidity. This behaviour by economic agents reduced the volume of transactions and significantly weakened the influence of policy rate reductions on the economy (Minegishi & Courneade, 2010:10). Chapter 2 elaborates on this situation.

Faced with this policy environment, there was a growing realisation in most countries, especially developed countries, that further monetary stimulus was required to support growth. Klyuev, de Imus and Srinivasan (2009:6) indicate that developed-market central banks, first in the United States of America (USA) and later overseas, responded by pursuing QE. As Calderon (2012:1) shows, the majority of these central banks, albeit to varying degrees, increased their balance sheets dramatically, through government bond purchases. The US Federal Reserve Bank (Fed) has to date implemented three rounds of QE namely, QE1, QE2 and QE3, corresponding to the first, second and third rounds of QE, respectively. According to Hormann and Schabert (2010:1), the expectation was that QE would lower long-term interest rates, and thus increase lending and subsequently real economic activity. However, Lim, Mohapatra and Stocker (2014:2) argue that this was not the case, as lower interest rates caused most investors to switch to higher-yielding assets – most notably emerging market economy (EME) assets. Chapter 2 provides a more detailed discussion of this.

Studies such as the one conducted by Fratzscher, Lo Duca and Straub (2013:5) show that although QE was successful in inducing investors to reallocate their portfolios in favour of more risky domestic assets, it also facilitated rebalancing in favour of foreign assets. Following a sharp decline in capital flows during the 2008 GFC, EMEs recorded a sudden surge in capital inflows between 2009 and 2010 (Ghosh, Kim, Qureshi & Zaldunendo, 2012:2). However, by mid-2011 there was a sharp reversal of capital flows, depleting most of the EMEs' foreign currency gains and leaving them to deal with rapidly depreciating currencies (*ibid.*). Brazil, Russia, India, China and South Africa (BRICS) became the preferred destination for these capitals flows in the aftermath of the 2008

financial crisis (BRICS, 2012:43). Bernanke (2010:8) notes that the volatility of capital flows raised notable concerns among policy makers in EMEs that accommodative monetary policy in developed economies were producing negative spillover effects on their economies.

## **1.2 The Problem Statement**

In the aftermath of the 2008 GFC, QE is argued to have increased the amount of global liquidity and capital flows into EMEs, among other things. A growing number of empirical studies (e.g. Burns, Kida, Lim, Mohapatra & Stocker, 2014; Lim *et al.*, 2014; Park, Ramayandi & Shin, 2014; Ahmed & Zlate, 2013; Fratzcher *et al.*, 2013) find evidence in support of QE effects on capital flows into a host of EMEs. These capital flows, which are mostly made up of portfolio investments are prone to sudden and volatile movements, thus putting emerging economies at risk of financial instability, overheating, exchange rate volatility and inflationary pressures. In the light of these concerns and developments this study aims to establish the impact of QE in the US on gross private capital inflows to the BRICS economies.

## **1.3 Study Objectives**

As explained above, a number of EME governments expressed concern that QE may have increased capital flows into their countries, creating the risk of economic and financial instability, among other things. As the BRICS economies were among the EMEs that enjoyed strong growth following the GFC, they are believed to have seen an increase in capital inflows into their economies. This study aims to establish empirically whether QE increased gross private capital inflows to the BRICS economies. In particular, the study aims to address the following objectives:

1. To establish whether QE episodes had any extra effects on gross private capital inflows to the BRICS economies over and above what is observed through the traditional drivers of capital flows;
2. To determine which factors – push or pull – were more important in driving capital inflows to the BRICS economies;
3. To examine whether the effects of QE were different for various components of capital flows.

## **1.4 Rationale of the Study**

Economic theory states that the free flow of capital across national borders generates immense benefits for all countries, as it results in an efficient allocation of resources that raises productivity and economic growth (Ahmed & Zlate, 2013:1). However, empirical evidence has shown that large capital flows can create severe problems for developing and emerging economies. The Asian crisis of 1997/98, which was partly triggered by an earlier version of QE in Japan, provides an excellent example of the risk that rapid capital inflows and subsequent capital reversals may have on EMEs. With the inevitable tapering of QE and likely positive improvements in interest rates in high-income countries, a much more pervasive problem may await the emerging economies, unless there is a much more coordinated and careful handling of the risks associated with QE.

Understanding the risks associated with unconventional policy instruments such as QE requires in-depth empirical analyses of its transmission mechanisms, its effectiveness, adverse effects and the duration of such effects, among other things. Despite the growing number of studies examining the impact of QE on capital inflows to EMEs, the debate on the effects of the Fed's unconventional monetary policy is still ongoing, especially in light of policy normalisation in the USA. This study therefore aims to contribute to this debate by investigating the effect of QE on capital inflows to the BRICS economies.

## **1.5 Data and Methodology**

The study uses a dynamic panel data model with fixed effects to assess the effect of QE on gross private capital inflows to the BRICS economies. This model draws on several studies in the literature, both recently and in the past (e.g. Burns *et al.*, 2014; Lim *et al.*, 2014; Park *et al.*, 2014; Ahmed & Zlate, 2013; Taylor & Salvano, 1997). A dynamic panel model is generally described as one that includes at least one lagged dependent variable. The model includes fixed effects to take care of time invariant factors, for example, size and location of the country, which may influence the pattern of capital flows. However, the inclusion of a lagged dependent variable together with fixed effects introduces complications in the estimation of the model and renders standard panel data estimates, such as the least squares dummy variable (LSDV) estimator, biased and inconsistent.

Nevertheless, several instrumental variable (IV) and general method of moments (GMM) estimation approaches have been developed to take care of this complication. Notable examples include: the Anderson and Hsiao (AH) (1982) IV, Arellano and Bond (AB) (1991), GMM and the bias-corrected LSDV (LSDVC) estimators. This study uses an estimation technique that uses the AB and the Blundell and Bond (BB) estimators. A detailed description of the model employed in the study is given in Chapter 4.

The main dependent variable of interest, namely gross private capital inflows, hence forth capital inflows, is modelled as a function of several push and pull factors, and dummy variables capturing the influence of QE. The analyses conducted in this paper are for the period 2000Q1 to 2015Q4. Data on capital inflows were obtained from the International Monetary Fund's (IMF) Balance of Payment Statistics (BPS) database and supplemented by bank lending data from the Bank of International Settlements' (BIS) Locational Banking Statistics (LBS). Data on push and pull factors were obtained from the IMF's International Financial Statistics (IFS), the World Development Indicators (WDI) and national sources. Chapter 3 elaborates in detail on the variables used in this study and their sources.

## **1.6 Ethical Clearance Statement**

This study uses official published data and thus eliminates the possibility that ethical standards were compromised. Moreover, the researcher adhered strictly to all the rules and regulations required when conducting a study of this nature.

## **1.7 Structure of the Study**

The study is organized into five chapters. Chapter 1 presents a general introduction and background to the study. The chapter also states the objectives and rationale of the study. Chapter 2 reviews the literature on the conceptual and theoretical framework underpinning QE. The chapter also presents a review of the empirical literature on the effects of QE on emerging market capital inflows. Chapter 3 presents a review of the most commonly used approaches for examining the impact of QE on capital flows. The chapter also describes the estimation techniques related to panel data analysis and outlines the baselined model used in the study. It also discusses the variables included in this baseline model.

Chapter 4 provides the empirical results of the study. Finally, Chapter 5 summarises the various discussions presented in the thesis and offers a conclusion.

## **Chapter 2**

### **Literature Review**

#### **2.1 Introduction**

As indicated in the preceding chapter, this study aims to establish empirically if QE increased capital flows to the BRICS economies. Although successful in lowering long-term yields and stimulating growth in advanced economies, QE is argued to have increased liquidity in the global economy and capital inflows to EMEs. In order to establish a base for the examination of the effect of QE on gross private capital inflows to the BRICS, this chapter sets out the theoretical and empirical framework for QE.

The chapter begins by defining the key concepts used throughout the study – QE and capital flows. The latter includes the factors that drive capital flows – characterised as push and pull factors. This is followed by an account of the GFC and how the Fed responded to the recession that followed. This discussion serves as a background to the implementation of QE. Finally, this chapter reviews the empirical studies on the impact of QE on EMEs in general and the BRICS in particular. The findings of most studies suggest a sizeable increase in capital inflows to the BRICS during QE operations.

#### **2.2 Theoretical Framework**

Examining the effects of QE on capital flows requires an understanding of the concept itself. Moreover, as most of the factors affecting capital flows are argued to have been affected by QE, it is also necessary to have an understanding of capital flows and the various factors that influence their pattern. This section is a discussion on two key concepts: QE and capital flows.

##### **2.2.1 Understanding Quantitative Easing**

###### **2.2.1.1 The Origin of Quantitative Easing**

Lyonnet and Werner (2012:96) have documented the origin of the term QE. According to them, the term QE has been used as analogous to an increase in narrow money, often interpreted as ‘printing

money’ in the media. The term QE is the literal translation of the Japanese expression “ryōteki kanwa”, short for “ryōteki kin’yū kanwa<sup>2</sup>”. After almost a decade of recession, on 19 March 2001 – the day recognised as the first time a central bank conducted QE – the BOJ announced its intention to increase the amount of bank reserves it held by 1 trillion yen, to be achieved, in part, by purchasing long-term government bonds.

The expression “quantitative easing” was used for the first time in 1994 (before its use by the BOJ) by Werner (1994) in his various publications and presentations (Werner, 1995b:3). In his publications in the early 1990s Werner (1994) predicted the likely collapse of the banking sector in Japan and an imminent economic slow-down (Lyonnet & Werner, 2012:96). In the following years, as the Japanese recession intensified, Werner (1994) made recommendations for economic recovery, which he based on a model he created in his earlier work. In these recommendations he stated that neither dramatic interest rate cuts, nor fiscal expansion through bond issuance, would end the recession (Lyonnet & Werner, 2012:96).

According to Werner (1995a:1; 1995b:2), unless the BOJ implemented a policy that would increase the “quantity of credit creation” in the banking sector, the Japanese economy would continue to spiral into recession. However, because the longer term “quantity of credit creation” did not translate easily into Japanese, Werner (1995b:3) used the expression “quantitative easing” in order to emphasise the quantitative nature of the policy. Since then, the phrase QE has been defined much more rigorously.

### **2.2.1.2 Defining Quantitative Easing**

Following the use of the term “QE” by Werner (1995b:3), it has been defined more comprehensively and precisely by various authors. For example, Palley (2011:2) defines QE as a monetary intervention that involves the acquisition of long-term government securities and private sector assets by a central bank. Borio and Disyatat (2010:53) emphasise the central bank’s use of its balance sheet to directly influence financial markets during periods when the short-term overnight rate is unable to do so. Blinder (2010:1) acknowledges that QE entails changing the composition and size of the

---

<sup>2</sup> The literal English translation “quantitative monetary easing”

central bank's assets and liabilities, but points specifically to the use of QE to improve overall credit conditions through increased liquidity.

Likewise, Calderon (2012:1) acknowledges that changes balance sheets of central banks increase money supply, and that this increase is achieved through purchases of government bonds and other agency securities. Moreover, Calderon (2012:1) argues that by increasing the size and altering the composition of their balance sheets, central banks aim to inject capital into financial institutions and subsequently increase liquidity and lending. Thus most definitions of QE suggest an increase in liquidity in order to improve credit conditions or to encourage lending.

The need for QE has been discussed by several studies (for example Joyce *et al.*, 2012; Fuduka, 2011; Blinder, 2010; Minegishi & Cournede, 2010). Although monetary policy has for some time been anchored on short-term nominal interest rates, Blinder (2010:2) and Borio and Disyatat (2010:55) argue that during dire economic conditions cutting the policy rate all the way to zero is ineffective in stimulating growth. Mainstream monetary policy typically involves the use of the nominal interest rate to provide lending to commercial banks in the interbank market, in order to regulate market interest rates and influence the economy (Joyce *et al.*, 2012:271). Under normal economic conditions, nominal interest rates are effective in maintaining relatively low and stable inflation and in stimulating growth in output.

However, Joyce *et al.* (2012:272) and Wieland (2009:3) point out that in periods of extreme economic conditions, cutting nominal interest rates to influence economic fundamentals is impractical due to the ZLB limit. The ZLB is a macroeconomic term that refers to a situation when the short-term nominal interest rate is at, or close to, zero – thereby limiting the central bank's ability to influence economic growth.

During economic recessions, when an economy is experiencing deflation, monetary policy makers are particularly concerned with reducing the real interest rate in an attempt to enhance aggregate demand (Blinder, 2010:2; Wieland, 2009:4). However, as Blinder (2010:2) notes, when nominal interest rates reach zero, real interest rates remain stuck at the level of inflation, which is usually low. With nominal interest rates stuck at zero and inflation falling further, the real interest rate rises further and this in turn reduces aggregate demand. This vicious cycle of deflation and rising real interest rates is what led the central banks in developed countries to implement QE. According to

Krishnamurthy and Vissing-Jorgensen (2011:2) QE allows central banks to influence long-term interest rates and therefore encourage economic activity.

Central banks can circumvent the ZLB constraint by purchasing long-term government and private agency assets, thereby increasing the liquidity in the financial system. Successive purchases of long-term government and agency securities raise the price of financial assets and consequently lower longer-term interest rates. This argument constitutes the basic logic of QE. Blinder (2010:3) argues that, ideally, QE aims to affect long-term rates, because policy makers consider long-term rates as having a greater impact on spending than short-term rates. Assuming that arbitrage is imperfect along a yield curve, Blinder (*ibid.*) argues that purchases of government bonds and not short-term treasury bills can put significant downward pressure on long-term rates.

### **2.2.1.3 How Quantitative Easing Influences Capital Flows**

While the previous section gave an overall description of how QE influences long-term interest rates, this section attempts to describe the intermediate channels along which this influence passes. Unlike with standard monetary policies, the channels through which QE influences capital flows are somewhat obscure. Nevertheless, some scholars (e.g. Lim *et al.*, 2014; Fratzscher *et al.*, 2013) have identified three key channels through which large-scale asset purchases (LSAP) influence capital flows.

#### **2.2.1.3.1 Portfolio Balance Channel**

A central channel through which QE affects capital flows is the portfolio balance channel (Lim *et al.*, 2014:8; Bauer & Neely, 2013:12; Fratzscher *et al.*, 2013:10). Central bank purchases of assets with longer durations, usually mortgage-backed bonds, reduce the quantity of these assets in the balance sheets of private agencies as they are substituted for safe long-term government bonds. Assuming imperfect substitutability between assets, a reduction in the number of longer-duration assets increases demand for other risky assets, including those of developing countries, as investors rebalance their portfolios (Lim *et al.*, 2014:6). According to Joyce *et al.* (2011:117), LSAPs by the central bank would be expected to lower the return on bonds and lead investors to seek other long-term risky assets which typically have higher yields, including EMEs' assets.

#### 2.2.1.3.2 Liquidity Channel

In addition to the portfolio balance channel, unconventional monetary policies may also influence cross-border capital flows through the liquidity channel. LSAPs by central banks may improve the general operations of financial markets and reduce the liquidity premium (Joyce *et al.*, 2011:118). The assets purchased through QE operations increase the amount of reserves held by private banks. Because reserve balances are more liquid, they are easier to trade than longer-term securities, thereby reducing the liquidity premium (Krishnamurthy & Vissing-Jorgensen, 2011:6). This allows commercial banks to give credit to investors including those from developing countries (Lim *et al.*, 2014:7).

#### 2.2.1.3.3 Confidence Channel

Unconventional monetary policies can also affect capital flows to EMEs through what is known as the confidence channel. This channel captures information about the central bank's expected policy rates and is sometimes referred to as the signalling channel (Joyce *et al.*, 2011:117). QE operations have been argued to play a signalling role in the sense that they serve as a more reliable indication of monetary authorities' commitment to maintain future interest rates low (Bauer & Rudebusch, 2013:9). Lim *et al.* (2014:8) also observe that in addition to signalling lower future policy rates, QE operations also contribute to reducing market volatility and hence economic uncertainty. Stable policy rates, reduced market volatility and reduced uncertainty all contribute to bolstering investment activities, including those to developing countries.

### 2.2.2 Capital Flows

The transmission mechanisms of QE discussed above are closely tied to the fundamental factors that drive capital flows. For example, the short-term Treasury bill rate and the yield curve have been used to proxy for the liquidity and portfolio channels, respectively (Lim *et al.*, 2014:11). The factors driving capital flows are generally categorised as push and pull factors (Ahmed, 2015:7). QE, particularly in the USA, is argued to have affected several of the drivers of capital flows to EMEs. This section presents a discussion of the various factors that influence the pattern of capital flows to EMEs.

### **2.2.2.1 What are Capital Flows?**

Capital flows refer to transactions that transfer ownership of assets between residents and non-residents and are recorded in the financial account of the balance of payments (BOP) (Burns *et al.*, 2014; Lim *et al.*, 2014; Bluedorn *et al.*, 2013; Broner, Didier, Erce & Schmukler, 2013). It is the convention in the capital flows literature to distinguish between “gross” and “net” capital flows. “Gross capital inflows” arise from the purchase and sale of domestic assets by foreign agents. They are recorded as net purchases of domestic assets by foreign agents in the financial account of the BOP (Broner *et al.* 2013:114). In other words, gross inflows are purchases of domestic assets by foreign residents (positive inflows) minus sales of domestic assets by foreign residents (negative inflows). The latter are recorded as negative inflows, even though intuitively they are outflows, since foreign agents are withdrawing funds from the domestic economy.

Conversely, “gross capital outflows” are defined as the net purchases of foreign assets by residents of a country. Gross outflows are purchases of foreign assets by residents (positive outflows) minus sales of foreign assets by residents (negative outflows) (Bluedorn *et al.*, 2013:7; Broner *et al.*, 2013:114). “Gross capital outflows”, just like “gross capital inflows”, is also a net concept, except that it reflects the balance of the buying and selling of foreign assets by domestic agents.

The sum of “gross capital inflows” and “gross capital outflows” result in what are known as total gross flows. However, the difference between “gross capital inflows” and “gross capital outflows” is known as “net capital flows” (Broner *et al.*, 2013:113). According to the IMF (2014:10), net flows, unlike gross flows, arise from the actions of both resident and non-resident investors. Net capital outflows occur when the acquisition of foreign financial assets by residents exceed the acquisition of domestic financial assets by non-residents. Net capital inflows result from an increase in non-residents’ acquisition of domestic assets or residents’ reduction in the holdings of foreign financial assets. Ghosh *et al.* (2012:3) point out that while it is common to assume that net inflows occur only from an increase in non-residents’ holdings of domestic assets, they equally can occur from a reduction in residents’ holdings of foreign assets.

### **2.2.2.2 Determinants of Capital Inflows**

The economic literature generally groups the determinants of capital flows to EMEs into push and pull factors (e.g. in Burns *et al.*, 2014:6; IMF, 2014b:3; Gosh *et al.*, 2012:6). The former refer to factors pertaining to source countries and the latter to recipient countries (Nier, Sedik & Mondino, 2014:3). Push factors reflect financial and real global conditions and other regulatory changes in the global economy that affect investors' propensity to invest in EMEs (Burns *et al.*, 2014:8). These include low interest rates, poor economic conditions and lower risk aversion in advanced economies (Ghosh *et al.*, 2012:6). Pull factors, on other hand, generally reflect improvements in developing countries' prospects that affect the returns or perceived risks of investing in these countries (Agenor, 1998:40). These could be improvements in the rates of return, credit ratings, and overall macroeconomic and institutional fundamentals. The relative importance of push and pull factors remains a topic of debate in the empirical literature, particularly because the significance of the two sets of factors differs across EMEs.

#### **2.2.2.2.1 Push Factors**

##### *Global Interest Rates*

Global interest rates are an important driver of capital flows to emerging economies. When interest rates in high-income countries increase relative to those in EMEs, the opportunity cost of investing in EMEs' assets increases such that all things being constant, capital flows to EMEs can be expected to fall (Burns *et al.*, 2013:35). Taylor (1997:454) suggests that the increase in capital flowing to EMEs in the late 1980s may have been due to the sharp drop in US interest rates during the same period. This suggests a negative relationship between capital inflows interest rates a priori.

Another important component of global interest rates is the yield curve, derived by subtracting short-term yields from long-term yields (Rutherford, 2002:631). Referring to unconventional monetary policies in the USA, Powell (2013:4) suggests that the yield curve may capture the influence that QE can have on long-term rates of return and therefore on portfolio rebalancing in favour of high-risk assets, including developing country assets. A flatter yield curve reduces the incentive to hold longer-term US assets, thus increasing the chances of rebalancing towards EMEs' assets in search of higher

yields. The IMF (2014:6) argues that this is particularly true for banks that often borrow short-term and lend long-term; a flatter yield curve, which implies a smaller gap between long- and short-term interest rates, is likely to trigger outflows in search of higher yields (IMF, 2014a:4). Thus a flatter yield curve is likely to result in more capital flows into EMEs, also suggesting a negative coefficient.

#### *Global Liquidity*

Aside from global interest rates, studies (e.g. Burns *et al.*, 2014:28; Lim *et al.*, 2014:28) have found global liquidity to be an important determinant of capital flows to EMEs. Money supply is often used as a proxy for global liquidity or available financing. Greater availability of financing reduces the liquidity premium (the compensation demanded by investors for holding illiquid assets) and raises the yields on liquid assets. An increase in the yields on liquid assets leads investors to substitute developing country assets with US assets suggesting a decrease in capital flows into developing countries (negative coefficient) (Burns *et al.*, 2014:36).

#### *Global Uncertainty and Risk Aversion*

Global uncertainty and risk aversion also play a significant role in shaping the behaviour of capital flows to EMEs. Global risk is underpinned by macroeconomic fundamentals, financial market participants' risk attitudes and possibly monetary policy in high-income countries (IMF, 2014a:6). Monetary easing in high-income countries, for example, reduces investors' perception of risk, and this is likely to be accompanied by an increase in capital inflows to EMEs. Capital inflows to EMEs plunged during the financial panic that followed the collapse of Lehman Brothers in 2008 and again in the second half of 2011 and May 2012, when the debt crisis in Europe worsened. These examples suggest an inverse relationship between global risk aversion and capital inflows to EMEs.

#### *Global Growth*

Global growth is used to capture the influence of real global economic conditions on capital inflows to EMEs. Global growth represents the real incentives for investing in EMEs' assets and is typically proxied by the weighted average real GDP growth of advanced economies. Stronger growth in advanced economies is likely to increase investment opportunities in general, therefore also in EMEs, and hence increased capital flows to EMEs. However, as seen in Burns *et al.* (2014:36), the

relationship between growth in high-income countries and capital inflows to emerging economies can be ambiguous. This is because, in addition to increasing capital flows to EMEs, faster and stable growth can make developed countries an attractive destination for financial investments, thereby discouraging investments in EMEs' assets. Moreover, others (e.g. Chen, Curdia, & Ferrero, 2011:4) have found positive effects of QE on US and global growth.

#### 2.2.2.2.2 Pull Factors

##### *Interest Rate Differentials*

Differences in interest rates between high and low income countries also play a huge role in explaining the behaviour of capital inflows (Nier *et al.*, 2014:6). Interest rate differentials determine the attractiveness of domestic assets relative to foreign assets, and hence cross-border capital flows (IMF, 2014b:6). Neoclassical economic theory states that capital should respond to differences in rates of returns between countries (Ghosh *et al.*, 2012:7). This typically implies that capital should move from capital-abundant advanced countries with low rates of return to capital-scarce emerging economies with high rates of return.

Rates of return are typically high in developing countries compared to major financial markets in high-income countries reflecting the high risk associated with developing country assets (Taylor, 1997:454). The interest rate differential captures such differences in short-term returns between EMEs and high-income countries. A positive interest rate differential reflects what theory says about returns in EMEs – they are usually higher than those in developed countries. During the post-crisis period a number of EME central banks raised their policy rates, while those in developed countries generally reduced their policy rates to levels nearing the ZLB (Ahmed & Zlate, 2013:12). The result of this was an increase in the return differential.

The easing of monetary policy in high-income countries causes interest rates there to fall prompting financial investors to reallocate their portfolios in favour of assets with higher rates of return, most notably EMEs' assets (Powell, 2013:4). This results in an increase in capital inflows to EMEs. Likewise, higher interest rates in EMEs can draw capital flows from high-income countries. This suggests a positive coefficient on the interest rate differential variable.

### *Economic Growth Differentials*

Differences in growth prospects between developing and developed countries are an important determinant of cross-border capital flows (Powell, 2013:5). When investing in any country, and especially in developing countries, investors consider the growth prospects in those countries as these affect the long-term return on their investment (Nier *et al.*, 2014:6). The literature (e.g. Burns *et al.*, 2014; Lim *et al.*, 2014; Ahmed & Zlate, 2013) shows that higher growth differentials between high-income countries and EMEs are associated with more capital flows to EMEs. Powell (2013:5) notes that the growth in capital inflows to EMEs after the GFC coincided with stronger growth in the EMEs relative to advanced economies. This suggests a positive coefficient a priori.

### *Sovereign Credit Ratings*

Sovereign credit ratings have also been identified as an important factor explaining the behaviour of capital flows into EMEs. Several studies (e.g. Burns *et al.*, 2014; Lim *et al.*, 2014; Park *et al.*, 2014; Ahmed & Zlate, 2013; Kim & Wu, 2008) include EMEs' sovereign credit ratings as one of the variables their analyses. Sovereign credit ratings reflect a number of important aspects of a country including economic growth, debt, inflation and the ability of individual countries to repay their debt (Kim & Wu, 2008:17). Moreover, as Bhatia (2002:4) points out, not only do sovereign credit ratings indicate a sovereign's ability to repay debt, but it also shows the country's willingness to pay-back debt. In other words, investors can gain insight into the quality of policies and institutions in a country from its credit rating (Burns *et al.*, 2014:38). In addition, they capture important aspects related to the opportunities and risks associated with investing in a developing country.

Empirical evidence suggests that an emerging economy with a favourable credit rating is likely to attract capital inflows, suggesting a positive coefficient a priori. For example Kim and Wu (2008:5) find that all the components of capital flows – that is FDI, portfolio and bank flows – to EMEs increased as long-term credit ratings improved in those countries. Improvements in short-term ratings, on the other hand, are found to be detrimental to capital flows, as they encourage governments to substitute long-term debt for short-term debt resulting in liquidity risks (*ibid.*).

The list of push and pull factors presented above does not constitute an exhaustive list. Several variables can be used as proxies for push and pull factors. Various studies have experimented with additional factors that can possibly affect the pattern of capital flows in addition to those listed above. However, this study only considers these factors listed above, as will be seen in Chapters 3 and 4. This decision is largely guided by the factors that have been identified as having statistically significant effects on capital flows in empirical work (e.g. Burns *et al.*, 2014 & Lim *et al.*, 2014).

## 2.3 Empirical Literature Review

Drawing on the theoretical framework discussed in Section 2.2, this section reviews the empirical literature on QE. First, an overview of the factors that may have caused the GFC and the consequences thereof are given to serve as background to the implementation of QE. Second, the policy responses of developed countries, including QE, are discussed in the following subsection. Lastly, the section reviews the literature on policy's impact on capital flows to the BRICS and EMEs in general.

### 2.3.1 Causes of the Global Financial Crisis

The recession that followed the 2008 GFC is considered by many (e.g. Joyce *et al.*, 2011:22; Kindleberger and Aliber, 2011:1; Mishkin, 2011:2) to be one of the worst worldwide recessions since the Great Depression of the 1930s. As shown by Mishkin (2011:22) and Allen and Carletti (2009:1), what began as problems in the US real estate market spread rapidly to the financial markets and later to the real economy. According to Acharya and Richardson (2009:195), there is almost universal consensus that the principal cause of the crisis was an unprecedented increase in the supply of credit, which fuelled a housing price bubble.

Several reasons account for the growth in credit supply and the collapse of the US housing market. Firstly, Acharya and Richardson (2009:195) remark on the dramatic increase in the US debt to national income ratio from 3.75:1 in 2002, to a record high of 4.75:1 in 2007. This increase in debt was fuelled by a range of policies intended to create incentives for the poor to purchase houses, including tax deductions on mortgage interest payments, among other things (Allen and Carletti, 2009: 6). Jickling (2009:2) argues that these factors, together with growing global demand, especially

in Asia, for US mortgage-backed securities (MBS), eased US credit conditions considerably. Lax credit conditions increased the demand for US houses and consequently led to a dramatic increase in US house prices (*Ibid.*). House prices grew at an extraordinary rate of 11 percent annually, until they reached their peak in 2006 and then began to fall (Acharya and Richardson, 2009:196).

Apart from the credit boom and the bursting of the housing bubble, there are other factors that caused the financial crisis. Crotty (2009:565) argues that favourable developments in the real estate market created perverse incentives among key players in almost all the financial institutions, including commercial and investment banks, to take on more risk than they normally would. McCarthy (2009:1) points to the way that commercial banks and in some instances mortgage brokers issued loans (mortgages) to less credit-worthy borrowers (home owners) with a high default risk, known as subprime mortgages.

Moreover, securitisation of these mortgages, which resulted in what are called mortgage-backed securities (MBS), gave further impetus to the rapid growth of credit markets. Estimates show that securitisation grew from about US\$767 billion in the last quarter of 2001 to a record high US\$1.4 trillion in December 2006 (Archarya & Richardson, 2009:196). According to Jobst (2008:1), securitisation is a process through which particular types of financial assets are pooled by financial institutions (e.g. investment banks) and transformed into securities using some financial restructuring. One innovation in this regard was the ‘originate and distribute’ model.

Prior to the securitisation of mortgages through the ‘originate and distribute’ model, mortgages were originated and held by brokers and commercial banks. However, Allen and Carletti (2009:3) show that under the ‘originate and distribute model’ mortgages originated by brokers and commercial banks were sold to financial entities, usually investment banks, for securitisation. The authors (*ibid.*) point out that these mortgages were secured by claims on the properties of the borrowers, usually houses, whose prices were at the time escalating.

According to Crotty (2009:565), the rapid growth of securitisation created serious repercussions for the entire global financial system when the market for asset-backed securities collapsed in 2007. Crotty (2009:565) and Jickling (2009:3) argue that several of the players in the financial markets contributed to the creation and sale of bad assets, and felt secure that they would not be held accountable for their actions. The conduct of rating agencies was partly responsible for the

deteriorating quality of these assets. As pointed out by Acharya and Richardson (2009:196), rating agencies graded a host of subprime MBS “AAA”, making these assets even more appealing to investors. The actions of the rating agencies were in part the result of the use of inefficient economic models, conflict of interest as some of the agencies were interested in generating fees, and also in part because of the lack of effective regulation (Jickling, 2009:3). The heavy reliance on agency ratings as a criterion for selecting investments has been identified as a major contributor to the crisis.

While rating agencies contributed significantly to the GFC, ultimately it was the behaviour of the large, complex financial institutions (LCFIs), in particular investment banks that aggravated the problems in the financial sector. According to Acharya and Richardson (2009:200) and Crotty (2009:568) LCFIs often had to retain the riskiest part of the securities – commonly known as “toxic waste” – in order to assure potential investors that the assets being issued were safe.

In addition to reducing moral hazard, LCFIs held on to risky assets, for example, the collateralised debt obligations (CDOs), for the simple reason that they could be maintained off-balance-sheet and were thus not subject to capital adequacy requirements (Archarya & Richardson, 2009:200). This allowed LCFIs to take on more risky loans, raising considerably the concentration of risk held by these institutions, leading Jickling (2009:3) to conclude that the ‘originate to distribute model’ created to manage risk itself became a creator of substantial risk.

Following the bursting of the housing price bubble that led to a series of subprime defaults, Acharya and Richardson (2009:207) note that the value of MBS plummeted sharply, leaving LCFIs with little choice but to include the assets held in the off-balance-sheet on their balance sheets. McCarthy (2009:10) and Crotty (2009:568) note that a combination of mortgage defaults and balance sheets filled with devalued asset-backed securities severely reduced bank capital. This led most banks, particularly the largest and most renowned in the world, to declare insolvency since they held less capital compared to their liabilities (Jickling, 2009:3). Moreover, giant investment banks that had accumulated distressed AAA-ranked MBS – for example the Union Bank of Switzerland (UBS), Fannie Mae, Bear Stearns, Lehman Brothers and Freddie Mac – also declared insolvency (Archarya & Richardson, 2009:208).

According to McCarthy (2009:5), the huge losses resulting from distressed assets and the collapse of the major financial institutions set off a financial panic that spread to global financial markets.

Contagion set in as market participants became extremely risk averse, bringing the operations of financial markets almost to a stop (Archarya & Richardson, 2009:209). The panic in the financial markets significantly reduced credit, thus increasing the effect of the crisis on the real economy (Archarya & Richardson, 2009:196). Moreover, households that had accumulated unsustainable levels of debt in relation to their ability to service the debts also saw a rapid fall in their net worth (McCarthy, 2009:10).

In spite of concerted efforts by policy makers to contain the financial panic, Jickling (2009:1) argues that the financial crisis intensified in 2008, causing a deep recession first in the USA, then other developed countries and eventually the rest of the world. In the USA alone quarterly growth of industrial output decreased by close to 11.7 percentage points between the first and last quarters of 2008 (McCarthy, 2009:10). In the euro area growth in industrial output fell by 18.7 percentage points in 2008 alone (*ibid.*). According to McCarthy (2009:11), in Japan the decline in output growth was even more dramatic, from -2.8 percent to -39.9 percent in the first and last quarters of 2008, respectively.

The GFC had far-reaching consequences that spilled over into the global financial and real sectors, leaving the world economy to grapple with a severe recession. Inevitably, authorities world-wide were confronted with an urgent need to generate significant policy responses. Because of the nature of the recession, a number of developed countries responded with unprecedented policies.

### **2.3.2 Responses to the Global Financial Crisis**

#### **2.3.2.1 Traditional Monetary Policies**

As the financial crisis worsened in the developed world, falling output and aggregate demand elicited unprecedented policy reactions from developed-country central banks (Lim *et al.*, 2014:5). The US Federal Reserve Bank – together with the central banks of other major developed countries – responded by rapidly cutting policy rates often to levels effectively constrained by the ZLB. Moreover, some of the central banks openly pledged to keep policy rates at extremely low levels for a long period of time (Minegishi & Cournede, 2010:5).

These extremely low policy rates were expected to reduce the cost of borrowing for banks and consequently stimulate real economic activity through lower lending rates (Lim *et al.*, 2014:5 and Minegishi & Courneude, 2010:8). However, the state of the financial markets during the 2008 crisis severely limited this transmission mechanism of traditional monetary policy. This was attributed to two main reasons. Firstly, Fawley and Neely (2013:51) observe that nominal interest rates are in effect constrained by zero; with policy rates at or near zero, policy makers were left with little choice but to consider other forms of monetary policy.

Secondly, the usual channel of influence of traditional monetary tools was weakened by the turmoil in the financial system itself. According to Joyce *et al.* (2012:272), the huge amounts of losses that were incurred after the bursting of the housing bubble left key financial institutions insolvent and called into question the credibility of borrowers in the capital markets. Minegishi and Courneude (2010:9) argue that as a result of these disruptions, financial institutions became extremely uncertain about their liquidity needs and at the same time became extremely risk averse, causing money market rates to rise significantly. Moreover, with most banks hoarding liquidity, the volume of financial transactions shrank significantly. As Joyce *et al.* (2012:272) argue the end result was a breakdown in the typical relationship between policy rates and market rates.

The breakdown in the usual relationship between policy rates and market rates, and the ZLB limit on interest rates, led to the conclusion that conventional monetary policy was ineffective in bringing about economic recovery. Successive cuts in the policy rates failed to influence market rates in the usual way, and the breakdown in financial intermediation implied that the usual channel of influence of interest rates had been compromised (Minegishi & Courneude, 2010:9; Joyce *et al.*, 2012:272). This challenge facing central banks in developed countries led them to consider QE (QE) (Lim *et al.*, 2014:5).

### **2.3.2.2 Unconventional Monetary Policy**

Given the breakdown in the relationship between policy rates and market rates, and given that financial conditions still required further stimulus, policy makers in developed countries explored a range of unconventional measures. These measures were classified into four broad categories: 1) increasing liquidity provision to financial institutions; 2) direct intervention into the broader financial

market; 3) LSAPs; and 4) direct support to particular financial institutions (Minigeshi & Cournede, 2010:7). As Fratzscher, Lo Duca and Straub (2013:7) argue, these measures, which have been widely labelled as QE, significantly changed the composition and size of developed-country central bank balance sheets.

The aim of QE as it was originally implemented by the BOJ was to increase liquidity in the banking system by directly purchasing government securities from banks (Joyce *et al.*, 2012:274). Joyce *et al.* (*ibid.*) argue that by injecting enough cash reserves into the banking system, the BOJ hoped that the reserves would ultimately encourage credit creation, stimulate real activity and help push asset prices up, and consequently minimise deflationary pressures. After the 2008 GFC, with interest rates at or close to zero, the Fed – the most active – the ECB, the BOE and the BOJ began to pursue non-standard monetary measures in the form of QE, albeit at varying levels (Fawley & Neely, 2013:52).

Fawley and Neely (2013:51) investigate the motivation for QE programmes of the Fed, BOJ, BOE and the ECB. They find that the initial motivation of all four central banks was to eliminate financial distress and improve the operations of financial institutions by providing adequate liquidity to these institutions. However, Fawley and Neely (*ibid.*) and Zhu (2012:13) argue that, as the crisis intensified, the objectives of these policies broadened to include reaching inflation targets, lowering borrowing costs and easing credit conditions so as to promote economic growth and employment.

This study focuses on unconventional monetary policies conducted in the USA as the Fed has been one of the most active central banks in implementing QE policies. QE in the USA primarily took the form of large-scale financial asset purchases (LSAPs) over three episodes between 2008 and 2013 (Lim *et al.*, 2014:5). The first round of QE (QE1) was conducted from December 2008 to 2009. This round of QE was primarily aimed at improving the operations of financial markets (Fratzscher *et al.*, 2013:2). During QE1 the Fed purchased assets totalling US\$1,722 trillion (Moore, Nam, Suh & Tepper, 2013:6). The Fed purchased US\$1.25 trillion Agency MBS, US\$172 billion of Agency debt and US\$300 billion of Treasury securities (Moore, Nam, Suh & Tepper, 2013:6; Zhu, 2012:13;).

The second round of QE (QE2) took place from November 2010 to June 2011. This round of QE saw the Fed buying additional longer-term Treasury bonds worth US\$600 billion (Fratzscher *et al.*, 2013:2). The principal aim of QE2 was to lower bond yields as well as to increase the prices of assets in riskier market segments (Zhu, 2012:13). In so doing, the Fed hoped to encourage real economic

activity through positive welfare effects. The third round of QE (QE3) was launched in late 2012 and ended in the second quarter of 2013. QE3 focused on monthly purchases of US\$40 billion MBS and US\$45 billion Treasury securities, which expanded Fed's assets by almost US\$1 trillion by quarter three of 2013 (Lim *et al.*, 2014:37). All three episodes of QE had varying effects on US financial markets and financial markets worldwide.

For example, Zhu (2012:13) finds that the announcement of QE1 resulted in sizeable reductions in corporate bond yields and depreciation of the nominal effective exchange rate (NEER) of the US dollar. Others like Fratzscher *et al.* (2013) and Fratzscher (2012) find that QE1 measures resulted in significant increases in bond and equity prices, and that they lowered long-term bond and equity rates of return in the USA. According to Fratzscher (2012:342), higher bond and equity prices in the USA induced significant capital movements from EMEs in favour of US securities, resulting in the appreciation of the US dollar. In contrast, Treasury bond purchases under QE2 pushed-up equity and bond prices worldwide, causing substantial capital movements out of bond markets in the US and other advanced economies into EME equity markets in search of yields and higher returns (Fratzscher *et al.*, 2013:2).

## **2.4 Effect of Quantitative Easing on Capital Flows to the BRICS Economies**

The extended rounds of QE in the USA and other developed countries raised concerns among several EMEs and developing countries of potential spillover effects, especially through increased cross-border capital flows. These concerns were not unfounded as aggregate gross capital inflows grew substantially between 2009 and 2013 (Lim *et al.*, 2014:5). This section summarises the findings of studies that have examined the effects of QE on capital flows to EMEs in general and in particular the BRICS economies. The section begins with a brief description of the BRICS countries.

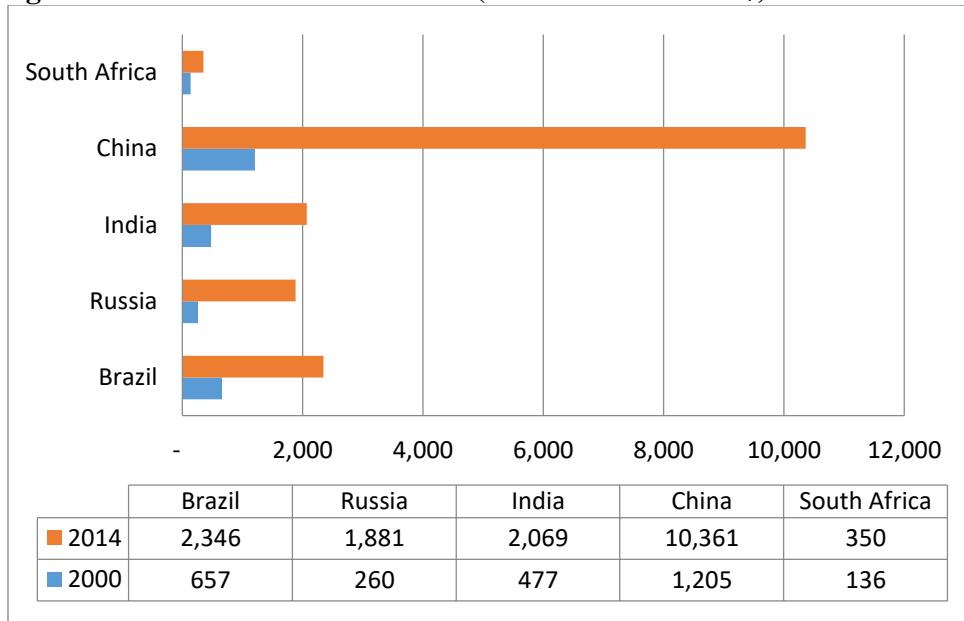
### **2.4.1 Defining the BRICS countries**

The acronym BRIC was used for the first time in 2001 to represent the alliance between the major emerging economies, namely Brazil, Russia, India and China (Singh & Dube, 2013:5). The acronym was coined by O'Neill (2001:6) in a Goldman Sachs paper titled, "Building Better Global Economic BRICs", which examined the growth prospects of the BRIC economies. O'Neill (2001:3) predicted a

growing share of the BRICs in world GDP, from approximately 23.3 percent in 2000 to 27 percent in 2011.

South Africa joined the BRIC alliance in 2010, thereby expanding the BRIC acronym to BRICS (Blais, Purcell & Caldwell, 2012:93). Since then, the acronym has been used to represent Brazil, Russia, India, China and South Africa. According to Blais *et al.* (2012:93), the BRICS, when viewed together, have risen to the fore over the past two decades as a significant force to reckon with, largely because of their growing market share and abundant resources. Gross Domestic Product (GDP) measured in current prices more than doubled for each BRICS country between 2000 and 2014 (see Figure 2.1). However, collectively, the share of BRICS economies in global GDP is reported to have fallen to 22 percent in 2015 (BRICS, 2015:42).

**Figure 2.1: Gross Domestic Product (Current Million US\$)**



Source: Own Construction Using Data from the BRICS 2015 Statistical Publication

The increasing importance of the BRICS economies in the global economy made these countries the preferred destination of capital flows after the GFC (Munhoz, de Paula Pereira & de Deus, 2013:466). The GFC, which started in the USA and spread to other high-income countries, also affected the BRICS economies. The 2012 BRICS Report gives an overview of the effects of the GFC on the BRICS. The report shows that the crisis resulted in substantial losses in output in all the BRICS countries, with Russia experiencing the sharpest fall in growth. It also reports that rising

global risk aversion resulted in rapid capital flow reversals from the BRICS, leaving their financial markets vulnerable. Notwithstanding the decline in output, a combination of prudent fiscal and monetary policies saw the BRICS economies emerge more resilient to the crisis than other emerging economies (BRICS, 2012:87).

Several factors and in particular accommodative monetary policies in developed countries are argued to have resulted in the rebalancing of international investment portfolios in favour of EMEs' assets. This is discussed in the next section.

#### **2.4.2 Capital Flows to the BRICS Countries**

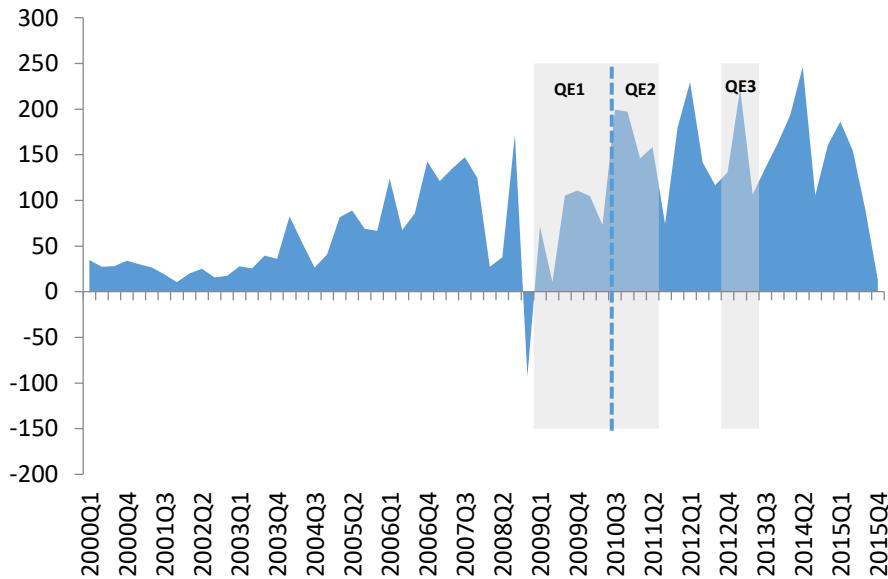
Even though QE was meant to promote growth in developed countries, Lim *et al.* (2014:2) argue that the policy had profound implications for developing countries. The authors' note that with interest rates at the ZLB in the USA and other major developed countries, investors began to consider other sources of yield. EMEs and in particular the BRICS, having enjoyed significant growth and stable political-economic environments since 2000, became the preferred destination for investment.

Consequently, EMEs and the BRICS in particular saw an increase in capital flows after 2000. Figure 2.2 below shows the pattern of cumulative gross inflows to the BRICS countries during the period 2000-2015. Capital inflows to the BRICS economies rose from a modest US\$35 billion in the first quarter of 2000 to US\$222 billion in the first quarter of 2013, representing an increase of almost 534 percent (see Figure 2.2). After growing moderately, capital inflows to the BRICS fell sharply at the start of 2008, from US\$125 billion in the last quarter of 2007 to US\$27 billion at the beginning of 2008. They rose sharply to US\$172 billion around the third quarter of 2008 and fell sharply again at the start of the GFC. In the latter half of 2009 capital flows to these countries grew sharply, driven largely by the strong economic recovery in these economies. Ahmed and Zlate (2013:5) observe a similar pattern for a subset of EMEs.

As the global economic outlook worsened with the intensification of the European debt crisis, capital inflows to EMEs reduced significantly in the latter part of 2011, leaving policymakers in EMEs to deal with rapidly depreciating currencies (Ahmed & Zlate, 2013:5). Similarly, the BRICS recorded a sharp decline in capital inflows during quarter three of 2011, but rose towards the close of 2011 and

early 2012 (see Figure 2.2). This growth is partly attributed to the easing of financial conditions in the advanced economies, which improved investors' perception. Overall, gross capital flows to the BRICS have remained volatile since 2008.

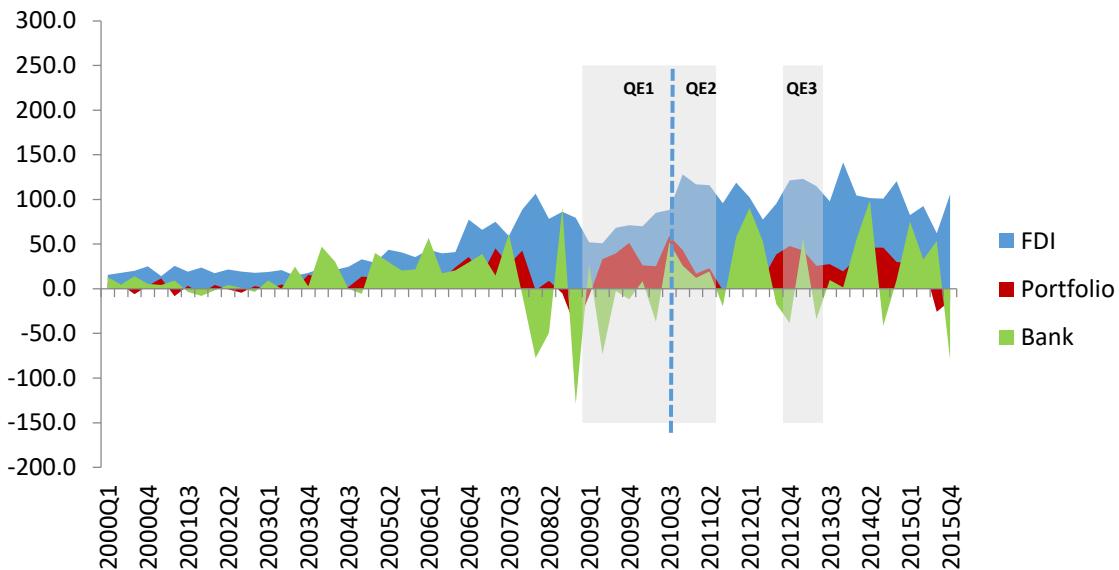
**Figure 2.2: Total Gross Inflows to BRICS Countries (Billion US\$)**



Source: Author's Own Construction using IMF BPS data

An analysis of the behaviour of the distinct components of gross capital flows to the BRICS countries reveals some interesting patterns. Figure 2.3 shows gross capital inflows disaggregated by type of flow. Portfolio and bank flows were very volatile compared to FDI flows, which have remained fairly stable over the period. Figure 2.3 shows significant volatility in bank lending, although smaller in magnitude. Similarly, portfolio flows to the BRICS economies remained volatile especially during the global financial crisis. Portfolio inflows fell sharply in 2008; they turned negative in Russia, India and South Africa. In contrast to portfolio flows and bank lending, FDI inflows remained fairly stable during the financial crisis, reflecting the positive outlook on growth and the soundness of the financial system. FDI inflows grew substantially in all the BRICS countries. The increase in FDI flows was more substantial for China (BRICS, 2012:44). FDI inflows fell in mid-2008 but rebounded towards the end of 2010.

**Figure 2.3: Total Gross Inflows to BRICS Countries, Components (Billion US\$)**

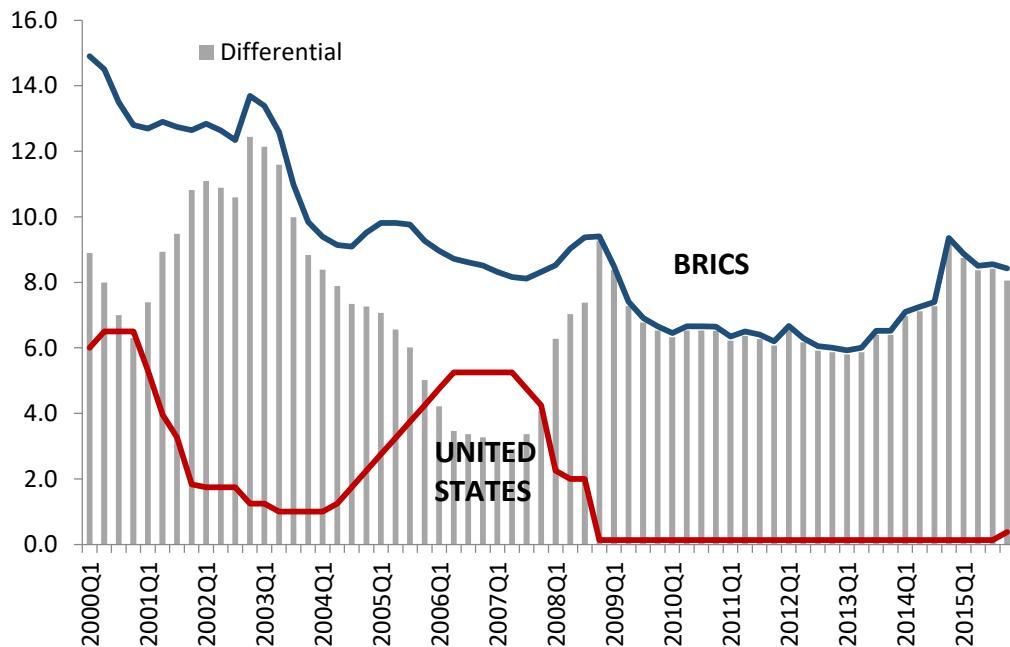


Source: Author's own construction using IMF BPS data

Capital flows to EMEs have generally remained volatile, especially in the years after the 2008 GFC (Figure 2.2). While such volatility in capital flows to EMEs is nothing new, as shown by historical experience, Ghosh *et al.* (2012:3) argue that recent events in the advanced economies, in particular QE policies in the USA, resulted in a renewed interest in the drivers of capital flows to EMEs. Debates concerning what determines capital flows date back as far as the mid-1930s, when the USA was contending with rapidly rising capital inflows. These debates were responsible for the establishment of the post-war “international monetary order” and the IMF’s Articles of Agreement (Qureshi, 2012:2). A similar debate resumed in the 1990s, when the liberalisation of capital flows in EMEs, particularly those in Latin America and Asia, saw a rapid rise in private portfolio flows from foreign investors.

Recent literature on the factors driving capital flows reveals that capital flows respond to a number of push and pull factors. Byrne and Feiss (2011:4) find that US long-run real interest rates significantly influence the pattern of capital flows to EMEs. Differences in interest rates between the USA and EMEs contributed to the flow of capital in search of higher yields (Ahmed & Zlate, 2013:12). Ghosh *et al.* (2012:14) show that capital flow surges to EMEs corresponded with lower interest rates and global risk perception in the USA. Figure 2.4 below shows the difference between nominal policy rates in the BRICS and the USA. Even though interest rate differentials fluctuated in the period 2002–2012, they were positive in favour of the BRICS.

**Figure 2.4: Policy Interest Rates (%)**

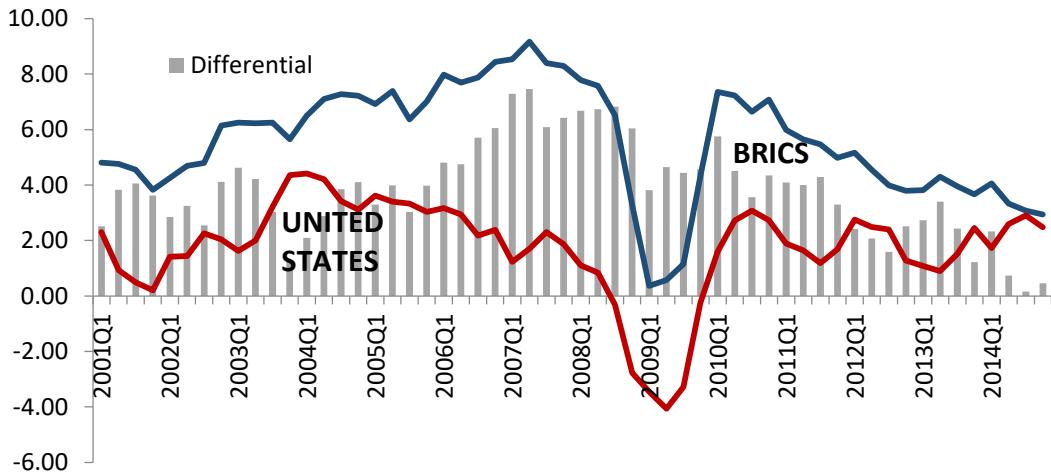


Source: Author's Own Construction using IMF IFS data

Differences in growth rates between advanced and developing countries have also been cited as a possible explanation for the growth in capital flows to emerging economies. According to Ghosh *et al.* (2012:9), rapidly growing economies such as the BRICS have a higher probability of receiving huge capital flows, because they are likely to have large financial needs, greater potential for high productivity and returns, as well as good institutional capacity. What Chinn (2012:9) calls the ‘two-speed recovery’, where emerging economies recovered faster than advanced economies from the GFC, is partly responsible for huge capital flows to EMEs in the last decade. For example, Ghosh *et al.* (2012:14) demonstrate that during capital flow surges, output was growing rapidly and the current and capital accounts of recipient countries tended to be more open in general.

Figure 2.5 shows that real growth rates in the BRICS countries (blue line) have been constantly higher than in the USA (red line). Figure 2.5 also shows that the growth differential widened between 2009 and 2010, reflecting faster recovery in these countries. Ahmed and Zlate (2013:11) observed a similar pattern for a subset of EMEs.

**Figure 2.5: Real GDP Growth (%)**



Source: Author's Own Construction using IMF IFS data

The BRICS Report (2012:43) shows that in the BRICS countries both global and domestic factors were important in explaining the growth in capital inflows. External factors included excess global liquidity and lower interest rate regimes pursued in the advanced economies. In addition, an improvement in investor confidence towards the EMEs and the search for higher yields are said to have led to the rebalancing of capital flows in favour of EMEs. The BRICS Report (2012:44) also shows that while domestic factors such as the longer-term view on growth were important in explaining FDI flows to the BRICS, portfolio and equity flows were largely explained by global risk factors and, more recently, QE.

#### 2.4.3 The Impact of Quantitative Easing on Capital Flows to EMEs

Until recently very few studies had attempted to test empirically the effect of QE on capital flows to EMEs. Ahmed and Zlate (2013:4) note that most discussions on unconventional monetary policies in the West are based on findings of studies examining the effect of long-term US interest rates, on capital flows. For example Fratzcher *et al.* (2012) and Zhu (2012) consider the impact of the Fed's announcements of QE programmes on EMEs' financial markets and not on their actual operations. A few exceptions (e.g. Burns *et al.*, 2014; Lim *et al.*, 2014; Fratzcher *et al.*, 2013) model actual QE operations and balance sheet changes.

The empirical literature on the effect of QE on capital flows to EMEs are generally categorised into three groups. The first group includes studies that modelled the Fed's QE announcements using event

study methods. These studies (e.g. Fratzcher *et al.*, 2013; Zhu, 2012;) examined the behaviour of financial assets in specified time windows around the Fed's QE announcements. For example, one of the key findings of Fratzcher *et al.* (2013:6) suggests that the Fed's announcement of QE operations had smaller effects in general on capital flows than actual Fed operations. These results further suggest that investors' reactions were not only based on Fed announcements, but on other factors too. A major caveat to these studies is that they focused on the period preceding the 2008 GFC, and hence do not cover the period during which unconventional monetary policies were pursued (Ahmed & Zlate, 2013:5).

In contrast to modelling the Fed's announcements, the second group of studies (e.g. Burns *et al.*, 2014; Lim *et al.*, 2014; Fratzcher *et al.*, 2013) model actual QE interventions within a panel data framework. These studies, in addition to examining the effect of QE, also examine the relevance of push and pull factors in explaining the behaviour of capital flows. What distinguishes these studies from others is that they analyse the impact on foreign markets, including EMEs, of actual market operations and not just the announcements of the Fed's asset purchases.

Fratzcher *et al.* (2013:5) find significant differences between the impact of QE1 and QE2 on net private capital inflows to 65 countries, including EMEs. They find that the first phase of QE contributed significantly to the decline in long-term yields in the USA and the rest of the global economy. They also find that QE1 led a number of investors to reallocate their portfolios in US equity and bond funds, and consequently contributed to the appreciation of the US dollar. These results appear consistent with the sharp drop in capital inflows to EMEs in the latter part of 2008 (Figure 2.2), a period during which investor uncertainty had heightened, especially following the collapse of Lehman Brothers. Fratzcher *et al.* (2013:6) find that, in contrast to QE1, the QE2 measures, particularly US Treasury purchases announced in 2009, were generally ineffective in lowering yields outside the USA. This caused substantial capital outflows from global bond markets in favour of EME equities as well as an overall depreciation of the US dollar.

Burns *et al.* (2014:7) find that all three episodes of QE led to an increase in capital inflows for, 60 developing countries. Their results show that 13 percent of the changes in capital inflows was due to the effects of QE. However, they find that the influence of QE diminishes with each successive episode. This suggests that QE1 had a greater impact on capital inflows than subsequent QE

episodes. This is in contrast to Fratzcher *et al.* (2013:6), whose findings suggest that QE1 resulted in a sharp decline in inflows to EMEs, while QE2 increased the amount of inflows to EMEs.

Although helpful in explaining the large swings in capital flows to EMEs, Fratzcher *et al.* (2013:6) find that QE had relatively small effects on capital flows when compared to other factors such as the speedy recovery of growth in EMEs. In particular, they find that US QE measures together explain only 5 and 6 percent of net equity inflows and net bond outflows in EMEs between mid-2007 and 2011, respectively. Fratzcher *et al.* (2013:6) therefore argue that it is possible that QE policies played a much bigger role in explaining the pattern of capital flows to EMEs than they did in accounting for the overall size of the flows. Nevertheless, they infer from their results that monetary policies in developed countries create a lot of externalities for financial markets in developing countries.

Also examining the impact of QE on capital inflows to EMEs, Lim *et al.* (2014:13), like Burns *et al.* (2014), find that QE episodes increased the volume of gross capital inflows to 60 EMEs in addition to the increase observed through standard channels, such as interest rates. Lim *et al.* (2014:13) also find that of the total increase in gross inflows during the QE periods, 13 percent is attributable to QE. Moreover, just as in Burns *et al.* (2014), they also observe a diminishing effect of the respective QE episodes on gross capital inflows to developing countries. The size of the effect of the various QE episodes reduces from QE1 to QE2 and is actually insignificant for QE3.

Park *et al.* (2014:5) also observe a similar pattern for 60 developing countries. They confirm the findings of Burns *et al.* (2014) and Lim *et al.* (2014) that the relative significance of the various QE episodes diminishes as you move from QE1 to QE3, suggesting that the first round of QE had a greater impact on capital flows than the other two episodes. They also confirm the findings of the other studies that capital inflows were especially large during the first round of QE.

As alluded to in the previous section, a discussion on the relative importance of push and pull factors in explaining the pattern of capital flows to EMEs has taken centre stage in the capital flows literature. Burns *et al.* (2014:7) find that both push and pull factors are important determinants of capital flows to developing countries. They find, for example, that US interest rates, global risk and QE account for almost 60 percent of the growth in capital flows to EMEs. The remaining 40 percent is explained by factors such as developing countries' sovereign credit ratings, growth and growth

differentials. Lim *et al.* (2014:25) and Park *et al.* (2014:6) observe that, when decomposed into their constituent components, portfolio flows and in particular bond flows are more sensitive to “*push*” factors including QE.

The final group of studies examine the impact of the withdrawal of accommodative monetary policies – QE tapering – in the West. There was growing concern that the tapering of QE would result in a sharp drop in capital inflows, resulting in several macroeconomic challenges (Lim *et al.*, 2014:3). Burns *et al.* (2014) and Lim *et al.* (2014) have studied this aspect of QE tapering quite extensively. For example, using a vector autoregressive (VAR) model, Lim *et al.* (2014:29) create a scenario in which QE normalises over three years (2014-2016); they assume in this scenario a gradual normalisation of long-term interest rates. Both Lim *et al.* (2014:29) and Burns *et al.* (2014:7) illustrate that capital inflows to developing countries reduced by between 10 to 12 percent over the three-year period.

Park *et al.* (2014:11) use a slightly different approach to that of Burns *et al.* (2014) and Lim *et al.* (2014), to identify the impact of QE tapering. They investigate the effect of various country-specific factors on exchange rate depreciation. These include the current account deficit, real exchange rate appreciation, private capital inflows, GDP growth, inflation and domestic credit expansion, among many other things. However, their results reveal that only inflation led to exchange rate depreciation during QE tapering. While the effects of QE tapering are still very much debated in the literature, they are not the focus of this study.

## 2.5 Conclusion

In an attempt to stimulate growth, policy makers in the USA and other major developed countries responded by first employing standard monetary tools, notably policy rate cuts. However, disruptions in the financial markets and the effective zero limit of nominal interest rates weakened the usual channel of influence of nominal market rates. It was in light of this that they responded with unconventional monetary policies that are collectively called QE. QE, as it is commonly called, primarily took the form of large-scale purchases of financial assets, with the US Fed being the most active.

Although successful in bringing about an end to the recession in developed economies, successive rounds of QE are argued to have increased the amount of global liquidity and eventually capital inflows to emerging economies. The BRICS economies, having recovered fairly quickly from the global financial crisis, became the preferred destination for capital inflows.

The transmission mechanism of QE to capital flows is argued to take place through the portfolio balance, liquidity and confidence channels. However, the impact of QE on capital flows through these channels has to be balanced against the standard drivers of capital flows, which are grouped into push and pull factors. As this chapter has shown, QE had effects on capital inflows to EMEs over and above those occurring through standard observable push and pull factors.

Studies examining the impact of QE on capital inflows to EMEs have evolved from those that only modelled QE announcements of QE to those that modelled actual QE operations and finally to those that investigated the effect of QE tapering on capital flows. The key findings of event studies show that QE announcements alone are not sufficient to explain the impact of QE on capital inflows. The major studies that modelled actual QE operations reveal that QE had a sizeable impact on capital inflows. Finally, the studies examining the effects of QE tapering find that capital inflows to developing countries fell by close to 12 percent over 3 years. The next chapter sets out the methodological framework for analysing the effect of QE on capital flows to the BRICS countries.

## **Chapter 3**

### **Methodology**

#### **3.1 Introduction**

Chapter 2 presented a summary of the theory and empirical work associated with the spillover effects of QE on EMEs' capital flows. This chapter builds on this by discussing common approaches for estimating the impact of QE on capital flows to EMEs. Most studies have generally relied on event studies, dynamic panel fixed effects models and vector autoregressive models as discussed in Section 3.2 of this chapter.

This chapter provides a detailed discussion of the commonly used approaches in estimating the impact of QE. Section 3.2 gives a very brief overview of two of these approaches, namely event studies and vector autoregressive models. However, in order to demonstrate that the relevant literature has been reviewed and understood, detailed discussions of these two approaches are presented in Appendix A1 and A2. Most of Section 3.2 is dedicated to an in-depth discussion of the third approach – the dynamic panel data model – as it is the approach adopted for the analysis in this study.

Section 3.3 complements this discussion by summarising the debates on aspects related to the modelling of capital flows, for example the choice between gross or net capital inflows. Section 3.4 outlines the various model estimation techniques employed in the estimation of the effect of QE on capital flows to the BRICS. Section 3.5 provides a description of the data and variables employed in the study. Finally, Section 3.6 provides concluding remarks.

#### **3.2 Approaches to Estimating the Impact of Quantitative Easing**

The majority of studies related to QE in developed countries examine its impact on asset prices domestically or in other developed countries, very few have considered its impact on EMEs' assets. Because QE is a relatively novel approach, there is still some division in the literature on the appropriate approaches for quantifying the spillover effects of QE on EMEs' capital flows. A review of the literature reveals a tendency to use a mix of approaches in examining the spillover effects of QE.

Chapter 2 identified three categories of studies in the QE literature. The first includes those that model the impact of the Fed’s announcements on EMEs’ assets using event study methods, for example in Ghosh *et al.*, (2012). This group of studies examines the spillover effects of QE within specified time windows around the Fed’s QE announcements. The second group of studies examines the behaviour of EME assets by regressing measures of net or gross capital flows on dummy variables for actual QE episodes and several push and pull factors (e.g. Khatiwada, 2017; Burns *et al.*, 2014; Park *et al.*, 2014; Ahmed & Zlate, 2013). These studies have relied on dynamic panel data methods. The third category of studies includes those that estimate the impact of QE within structural models that aim to assess the short-term spillover effects of QE on EMEs’ assets. This section reviews these methods, devoting particular attention to their strengths and weaknesses.

### **3.2.1 Event Studies and Vector Autoregressive Models**

A number of studies in the empirical literature have used event studies and vector autoregressive models (VARs) to investigate the spillover effects of QE. While event studies have been popularly used to investigate the behaviour of yields around the Fed’s announcements of QE, VARs have been used to examine the impact of monetary policy normalisation or “QE tapering”. Both approaches have their own strengths and short-comings.

An event study is a tool used to examine the effect of an event or set of events on the value of a variable of interest (Nageswara Rao & Sreejith, 2014:40). Therefore, if the aim is to measure the impact of QE announcements on asset returns, an event study method is appropriate. Proponents of event studies base their arguments on their simplicity along with their ability to offer clarity on the impact of events. However, they have been criticised for example by Moore *et al.* (2013:6) who argue that an event such as the Fed’s announcement of QE can influence markets independent of the information contained in the statement. This could make a correct estimation of the impact of QE difficult. Even though more literature on event studies was reviewed, the length constraint of this thesis does not allow for it to be discussed here. A detailed discussion is attached in Appendix A1.

While event studies are suitable for examining the influence of a QE announcement, they are not appropriate for capturing the short-term effects of actual QE operations. VARs are more suitable for

this purpose. VARs are models in which all variables are partly explained by their lagged value, and the current and lagged values of all other variables in the model. They have been especially criticised for being atheoretical as they are guided by very little economic theory. For the same reason as with event studies, a detailed discussion of VARs is not presented in this chapter, but in Appendix A2.

The choice of which method to use usually depends on the nature of questions being investigated. Neither approach was found to be more useful for this study than the dynamic panel data model. It is discussed in detail in the section that follows.

### **3.2.2 Dynamic Panel Models**

The availability of large macroeconomic datasets has led many macroeconomists to gain interest in estimating dynamic panel models (Judson & Owen, 1999:9). This is especially because most economic relationships are inherently dynamic (Hsiao & Tahmisioglu, 2008:2699; Baltagi, 2005:135). Dynamic models are those that account for the role time plays in the behaviour of variables; they allow researchers to better understand and explain the adjustment of variables over time (Baltagi, 2005:135).

A dynamic panel model is by definition one that contains at least one lagged dependent variable as a regressor (Greene, 2003:307). The lagged variable is included to account for the persistent nature of most macroeconomic variables. Capital flows in particular have exhibited strong levels of persistence in most empirical studies, suggesting a robust positive relationship with their own past values (Becker & Noone, 2008:167). Lagged dependent variables of capital flows have been found to be highly significant in most model specifications (Lim *et al.*, 2014:13).

One fundamental advantage of dynamic panel models is their ability to model time-invariant differences among units (e.g. individuals, states or firms) described as unobserved heterogeneity or individual effects (Baltagi, 2005:135). These individual effects represent the influence of individual characteristics that are not included in the model but may be observed, for example race, location, sex, governance structures, and unobserved or hard to measure factors such as individual or country abilities or preferences that differ across individuals or countries, but remain constant over time

(Torres-Reyna, 2007:3; Greene, 2003:285;). Failure to capture such differences across countries may result in biased estimates.

The treatment of unobserved heterogeneity in panel models has an implication for how a dynamic panel model is specified. Greene (2003:285) and Baltagi (2005:11) show, that when unobserved individual effects are assumed to be correlated or uncorrelated with the independent variables, the model is constructed as a fixed effects (FE) or random effects (RE) model, respectively. The former is a suitable specification when the interest is on a particular group of countries and when inferences are restricted only to the countries observed (Baltagi, 2005:12). The latter on the other hand is suitable when dealing with a sample for which data have been randomly drawn from a large population (Greene, 2003:293).

The introduction of a lagged dependent variable complicates estimation. In either the FE or RE settings the complication arises from the relationship between the individual effects and the lagged variable, a problem known as endogeneity (Flannery & Hankins, 2013:1; Hsiao, 2003:70). The residuals in majority of panel data applications have one component which is assumed to be the unobserved heterogeneity, and is fixed across time, and another component which is random, with zero mean and constant variance (Baltagi, 2005:11; Nickell, 1981:1417). Because the dependent variable is a function of these residuals, it follows that the lagged dependent variable will also correlate with the residuals (Baltagi, 2005:135). It is therefore not uncommon that unobserved differences among countries affect even the past values of the dependent variable.

One major drawback of the dynamic FE model is that standard methods of estimation, for example, the ordinary least squares (OLS) and the least squares dummy variable (LSDV) are likely to be biased and inconsistent. The bias is estimated to be of order  $(1/T)$  and is assumed to reduce as the length of the panel  $T$  increases or tends to infinity ( $T \rightarrow \infty$ ). Judson and Owen (1999:10), for example, show that the LSDV approach performs better than alternative approaches when  $T$  is large ( $T>30$ ). However, when the time dimension is moderate, it does not perform better than other estimators. Still, Nickell (1981:1418) warns that biases may persist even when the number of time periods increases.

Notwithstanding this, econometric techniques have evolved to correct such biases. For example, the bias-corrected LSDV (LSDVC) estimator performs better for longer panels, although its applicability to unbalanced panels is limited and therefore alternatives may be required. An unbalanced panel arises when variables are not observed for all time periods for some countries (Ajmani, 2009:111). When the bias-corrected LSDV is not practical, the Anderson and Hsiao (1981) IV estimator or the Arellano and Bond (1991) GMM estimators provide good alternatives (Judson & Owen, 1999:10). The most appropriate technique for estimating the parameters, however, depends on the characteristics of the data available (Judson & Owen, 1999:10). The general approach in many studies has been to test all the estimators and identify the appropriate one.

Dynamic fixed effects models are a preferred method for investigating the behaviour of EMEs' capital flows and have been applied in many studies (e.g. in Lim *et al.*, 2014; Park *et al.*, 2014; Ahmed & Zlate, 2013; Chinn, 2013; Fratzscher *et al.*, 2013; IMF, 2013). The analysis of the spillover effects of QE on EMEs' assets arguably requires the use of country FE to capture the influence of unobserved differences among countries. Ahmed and Zlate (2013:10) argue that fixed effects in a model examining the determinants of capital flows would capture, for example, the growth differentials between developing and developed economies, arising from differences in their long-term growth potential.

The LSDVC approach has emerged as the most popular estimator for establishing the impact of QE on cross-border capital flows in the studies most relevant to this one (e.g. Lim *et al.*, 2014:9). The LSDVC estimator has also been applied to an unbalanced panel by Burns *et al.* (2014:38). Park *et al.* (2014:5), apply the AB GMM estimation technique. The AH IV estimator has not been used in the recent literature on QE.

Burn *et al.* (2014:5) argue that, although dynamic panel models are useful in explaining the long-term effects of QE on capital inflows to EMEs, they are less suited for capturing the short-term effects of global market conditions on capital inflows. Recent literature (e.g. Dahlhaus & Vasishtha, 2014; Lim *et al.*, 2014) has given particular attention to the effects of US monetary policy normalisation on capital flows to EMEs. These studies have modelled the 'policy normalisation shock' using VAR models which, according to Burns *et al.* (2014:5), are more suited to capturing the short-term dynamics of capital inflows in response to such a shock.

### **3.2.3 Concluding Remarks on Estimation Techniques**

This study uses the dynamic fixed effects model, as it has been widely applied in similar studies. While event study methods offer insights into the behaviour of assets around the time that QE was implemented, they are unable to give a long-term perspective on the effect of QE on capital flows to the BRICS. Moreover, while VARs are ideal for estimating the effects of QE tapering in the USA on capital flows to EMEs, this study's aim is to identify whether there were any unobservable effects of QE in addition to those channelled through the observables, and whether these effects were different for different types of capital flows.

## **3.3 Methodological Debates in the Capital Flows Literature**

Whether researchers decide to use panel data techniques or VAR methods, they are faced with other considerations which have been a source of significant debate in the capital flows literature. A fundamental debate confronting the capital flows literature is the choice between modelling gross or net inflows, and whether focusing on either one separately makes any difference to the results. The definitions of gross and net flows were provided in Chapter 2. Ahmed and Zlate (2013:5) argue that the decision to focus on either gross inflows or net inflows appears to depend on the nature of the questions of interest.

As De Gregorio (2012:1) points out, the use of gross versus net inflows has different implications for macroeconomic stability and financial stability. He notes that while the analyses of exchange rate pressures are associated with net inflows, issues of financial stability are much more associated with gross inflows. Similarly, Bluedorn *et al.* (2013:5) note that while net inflows are key determinants of the exchange rate, gross inflows are key determinants of financial asset prices, which affect financial stability. Therefore it would appear that modelling net capital inflows is more appropriate when exchange rate appreciation and overheating are a concern, while gross inflows are more suited for addressing financial stability concerns (Ahmed & Zlate, 2013:9).

Moreover, according to Forbes and Warnock (2012:236) the distinction between net and gross inflows is substantial, especially in light of the increase in the size and instability of gross flows compared to net flows, post the GFC. Because gross outflows and inflows each respond to distinct

factors, Forbes and Warnock (2012:236) argue that an analysis based only on net inflows is likely to underrepresent the dramatic changes of the last ten or so years and overlook important information contained in gross flows.

Furthermore, Bluedorn *et al.* (2013:4) observe discrepancies in the behaviour of gross and net inflows between emerging economies and advanced economies. For emerging economies, they note that net and gross inflows tend to move in the same direction – an increase in gross inflows translates in an increase in net inflows. This is mainly because gross outflows in emerging economies are not significant enough to counter the growth in gross inflows. Thus, the increase or decrease in net inflows in emerging economies is largely driven by foreign investors (Ghosh *et al.*, 2012:3). Advanced economies, however, present a different picture. Net inflows in advanced economies have remained relatively stable despite large movements in gross inflows. This is because gross outflows in advanced economies are large enough to offset the large movements in gross inflows, such that net inflows do not always move in tandem with gross inflows. Because gross inflows are the main drivers of net inflows in EMEs, this thesis focuses on the behaviour of gross inflows in the BRICS economies.

Another prominent issue in the literature is the way that capital flows are categorised. The IMF, for example, identifies five categories of capital flows, while the Institute for International Finance (IIF) identifies only four categories. The IMF (2009:121) classifies “capital flows into: foreign direct investment (FDI); portfolio investments (both bonds and equity); financial derivatives and employee stock options (ESOs); reserve assets; and other investments”. “The ‘other investments’ category is comprised of international loans and deposits, banking capital, trade credits and official government flows” (Bluedorn *et al.*, 2013:8). In contrast, the Institute of International Finance (IIF) classifies capital flows into FDI, portfolio equity and debt and other investment flows consisting of commercial bank and non-bank lending, official flows and reserves Koepe (2013:7).

The IMF classification has been widely used in the empirical literature. However the measurement of capital flows in the various studies is subject to the type of questions asked. For example, Burns *et al.* (2014:34) calculate capital inflows as the sum of FDI, portfolio debt and equity, financial derivatives plus bank lending. In contrast, Lim *et al.* (2014:10) in their measurement of capital flows focus only on direct investment flows and portfolio flows. Others like Bluedorn *et al.* (2013:8) include all the five functional categories in their calculation of capital flows. In some cases, the

categories employed in the calculation of capital flows will depend on the availability of data for the respective categories.

In addition, the literature distinguishes between private capital and official flows. Flows to the government and monetary authorities are designated as official flows. This study, like most others (e.g. Burns *et al.*, 2014:5), excludes official flows from the analysis, as they respond to an entirely different set of factors. The focus is on the behaviour of private flows, defined as capital flows received by the private sector. Moreover, lending originating from multilateral and bilateral institutions is excluded. The accumulation of reserves is also excluded from this calculation.

This paper focuses on the behaviour of gross private capital inflows as defined by the IMF. The sources of gross capital inflows and the way they are measured are discussed in the following sections of this chapter.

### **3.4 Model Estimation Techniques**

This study adopts the dynamic fixed effects model to address the objectives outlined in Chapter 1. This section therefore presents the issues related to panel data analysis. Section 3.4.1 outlines the basic panel data model and its key characteristics and their implications on econometric modelling and analysis. Section 3.4.2 outlines methods for establishing stationarity or non-stationarity in panel data. The choice between including RE or FE in the model is discussed in Section 3.4.3. The diagnostic tests required to ascertain the adequacy of the model specified in Chapter 4, are given in Section 3.4.4. These include the tests for heteroscedasticity and serial correlation.

#### **3.4.1 The Basic Panel Data Regression Model**

Panel or longitudinal data are those in which the behaviour of several entities (e.g. individuals, firms, or countries) is observed over a period of time (Greene 2003:283; Hsiao 2003:1). This type of data is described using two elements – the number of units (cross sections) and the number of time periods. Katchova (2013:4) distinguishes between three types of panels: short panels with many individuals and few time periods; long panels with few individuals and many time periods; and panels with many

individuals and many time periods. This characterisation of panel data is important when choosing an appropriate estimation technique, as will be shown in Chapter 4.

The model described in Equation 3.1. below, differs from other econometric models because it has double subscripts on its variables.  $y_{it}$  represents the observation for the  $i^{th}$  individual at time  $t$ , where  $N$  is the number of units and  $T$  is the number of periods. However,  $T$  may vary for each individual resulting in what is known as an unbalanced panel (Ajmani, 2009:111). The term  $X_{it}$  is the  $i^{th}$  observation on  $K$  independent variables, and includes observations variables that may influence the dependent variable  $y_{it}$ ;  $\alpha$  is a scalar, while  $\beta$  represents the vector of parameters of interest;  $u_{it}$  represents the disturbances.

$$y_{it} = \alpha + \beta X_{it} + u_{it}, \quad i = 1, \dots, N; t = 1, \dots, T \quad 3.1$$

The disturbances  $u_{it}$ , can be described as either a one-way error ( $u_{it} = \mu_i + \varepsilon_{it}$ ) or a two-way error ( $u_{it} = \mu_i + \lambda_t + \varepsilon_{it}$ ) component model. In both specifications  $\mu_i$  is assumed to contain a constant term and unobserved individual-specific characteristics that do not change over time but differ across individuals, hence the term FE (Greene, 2003:28; Ajmani, 2009:111). In the context of this study individual effects may include any permanent differences among the BRICS countries that are more or less constant over time, but have an influence on capital inflows. Ahmed and Zlate (2013:10) give an example of growth differentials of each EME relative to advanced economies that arise from their long-term differences in each country's growth potential.

The second term  $\lambda_t$  denotes the unobservable time effect. According to Baltagi (2005:33), the time effect does not vary across individuals and it captures time-specific effects excluded from the model. Ahmed and Zlate (2013:19) suggest that this could include, for example, any dampening effect of capital controls on capital after the GFC. The remainder disturbances are denoted by  $v_{it}$  and are assumed to be independent and identically distributed (IID) with zero mean and constant variance [ $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$ ]. The disturbances (error terms) of Equation 3.1 are the basis of many tests aimed at examining the behaviour of the model, as will be seen in subsequent sections of this chapter.

### 3.4.2 Stationarity and Non-Stationarity in Panel Data

Detecting stationarity is critical for any econometric analysis, because the stationarity or otherwise of data can strongly influence its properties (Brooks, 2008:207). A stationary process is one that has constant mean and variance, and a constant autocovariance structure for each lag<sup>3</sup> (Brooks, 2008:208). In other words, data are stationary if their mean, variance and autocovariance remain constant over time. When data exhibits such properties it is called a weakly stationary process. Weak stationarity implies that any shock to a series should be temporary such that with time the shock dies out and the series converges to its long-run equilibrium (Gujarati, 2004:798). Stationary series are particularly important if econometric findings are to be generalised to other time periods.

Even though most econometric analyses emphasise the need for stationary processes, most series are rarely stationary. In contrast to stationary series, non-stationary series tend to deviate from their mean and exhibit increasing variance as the sample size increases. The tendency of non-stationary data to diverge from their mean makes their use less appropriate for forecasting. According to Brooks (2008:319), the use of non-stationary data in economic regressions can result in spurious results – results that look good as defined by the coefficient estimates and fit of the model, but which are really valueless. Vinh and Fuhita (2007:11) note that most macroeconomic and financial data are usually non-stationary.

The most commonly used models for characterising non-stationarity include the random walk model (RWM) without drift and the RWM with drift. The former is an example of a difference stationary process (DSP), because it can be converted into a stationary process by taking its first difference (FD) (Gujarati, 2004:803). A series is integrated of order  $d$  [ $I(d)$ ], if it has to be differenced  $d$  times to become stationary (Gujarati, 2004:805). An RWM with drift is also known as an RWM with trend because it is stationary around a linear trend (Brooks, 2008:321). When the trend is stochastic (random), an RWM with drift is a DSP because it becomes stationary after differencing it once. However, when the trend is deterministic, Gujarati (2004:803) shows that such a series can be transformed into a stationary process through a procedure known as detrending.

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<sup>3</sup> Autocovariance determines how a variable  $y$  is related to its previous values. The autocovariance is described in terms of the distance between two time periods and not the time at which it is computed (Gujarati, 2004:797).

The RWM is likened to a unit root process – therefore non-stationarity, random walk and unit root are used interchangeably (Gujarati, 2004:801). While it is a dominant practice in time series modelling, testing for unit roots in panel data is fairly new (Im, Pesaran & Shin, 2003; Levin, Lin & Chu, 2002). Even though most of the time series unit root tests now apply to panel data analysis, the asymptotic behaviour of both  $N$  and  $T$  is critical in panel unit root tests (Baltagi, 2008:239).

The way in which  $N$  and  $T$  converge to infinity is critical when selecting the type of unit root test to use. Baltagi (2008:239) lists three main approaches for categorising the asymptotic behaviour of  $N$  and  $T$ . The first approach known as the sequential limit theory fixes one dimension, say  $N$ , and allows  $T$  to increase to infinity, thereby providing an intermediate limit. Starting from this intermediate limit,  $N$  is allowed to grow large. The second approach – the diagonal path limit theory – allows both  $N$  and  $T$  to increase, according to a specified diagonal path. The third and final approach, the joint limit theory, also lets both  $N$  and  $T$  to increase but at the same time. The joint limit theory has been identified as a more robust approach than either of the other two (Phillips & Moon, 2000:1064).

There are several methods for detecting unit roots in panel data and each test makes different asymptotic assumptions about  $N$  and  $T$ . Monte Carlo experiments by Hlouskova and Wagner (2005:5) reveal that the relative size of the panel has an important bearing on the performance of the respective tests. This study will discuss only three of the most commonly used approaches: the Levin-Lin-Chu (LLC) test, the Im-Pesaran-Shin (IPS) test and the Fisher-type Test based on the Augmented Dickey-Fuller (ADF) test. However, these tests not applicable when there is cross-sectional correlation<sup>4</sup> (Baltagi, 2008:241).

### **3.4.2.1 Levin-Lin-Chu Test**

The LLC test is among the few tests that apply the joint limit theory subject to certain restrictions (Levin, Lin & Chu, 2002:3). Unlike in time series unit root tests, the LLC test allows both fixed and time effects in the data-generating process (Maddala & Wu, 1999:632). The LLC test strongly assumes that autocorrelation given by the autoregressive parameter  $\rho$  is uniform across all cross-sectional units. Hlouskova and Wagner (2005:7) argue that this assumption does not allow for the

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<sup>4</sup> In the context of this study, this implies that capital inflows to Brazil are uncorrelated with capital inflows to China.

possibility that some cross-sectional units may contain unit roots while others may not. This assumption is made because the unit root test statistic is derived from a pooled regression as shown in Equation 3.2 below:

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{it-L} + \mu_i d_{it} + u_{it} \quad 3.2$$

where  $y_{it}$  is the dependent variable;  $\rho_i$  is the autoregressive parameter for each individual – it represents the coefficient on the first-order lag of  $y_{it}$  – and it is assumed to be identical for all individuals. The term  $d_{it}$  represents the deterministic components (fixed effects or time effects) and  $\mu_i$  the corresponding coefficients.  $\theta_{iL}$  is the vector of coefficients for the higher-order lags of  $y_{it}$ .  $p_i$  is the lag order and is allowed to differ across  $N$ .

The LLC test tests the null hypothesis ( $H_0$ ) that each series has a unit root ( $H_0: \rho_i = 0$  where  $i = 1, \dots, N$ ), against the alternative hypothesis ( $H_1$ ) that the series is stationary ( $H_1: \rho_i < 0$  where  $i = 1, \dots, N$ ). Levin *et al.* (2002:5) outline three key steps. In step 1 Augmented Dickey Fuller (ADF) regressions are run to derive two orthogonalised residuals. The residuals are then used in step 2 to derive the standard deviations for every single  $N$ . The pooled  $t$ -statistics are then generated in the third step.

A statistically significant  $t$ -statistic results in the rejection of  $H_0$  suggesting that a series is stationary. As both  $T$  and  $N$  grow to infinity, the LLC  $t$ -statistic has a limiting normal distribution (Levin *et al.*, 2002:18). However, in order for the LLC test to be successful,  $T$  should grow faster than  $N$  such that the ratio of  $N$  to  $T$  tends to zero ( $N_T/T \rightarrow 0$ ) (Baltagi, 2008:241). Because of this, the LLC is not suitable for datasets that have a large  $N$  and relatively small  $T$ . According to Levin *et al.* (2002:3), the test performs well for macro panels where  $N$  and  $T$  are in the range 10-250 and 25-250, respectively. When  $T$  is very large, the authors suggest running individual unit root time series tests on each cross-sectional unit, because the gains from aggregating are likely to be small.

The LLC test is not without its limitations. Firstly, the test has been criticised for relying heavily on the independence assumption across  $N$  and is thus impractical when cross-sectional correlation is present (Baltagi, 2008:242). However, it is possible in some cases to remove cross-sectional

autocorrelation by subtracting the averages across individuals. Secondly, the assumption that individuals have uniform first-order autoregressive coefficients is also somewhat restrictive. Thirdly, and more importantly for this study, the LLC test requires that the panel be strongly balanced, rendering it inappropriate for this study.

### 3.4.2.2 Im-Pesaran-Shin Test

The Im-Pesaran-Shin test (henceforth IPS test) unlike the LLC test allows for heterogeneous first-order autoregressive parameters ( $\rho$ ) among cross-sections (Baltagi, 2008:242). Like the LLC test, the IPS test also allows for serial correlation among the disturbances and different error variances across individual units (Im, Pesaran & Shin, 2003:54). It applies both the sequential limit theory and the diagonal limit theory.

The IPS test, like the LLC test, also tests the  $H_0$  that each series contains a unit root. However,  $H_1$  allows some, but not all, of the cross-sections to have unit roots. Though, as Baltagi (2008:242) shows, the individual series that are stationary need to be non-zero if the IPS test is to be consistent. While the IPS test is applicable to unbalanced panel data, it requires that there be no gaps in each series.

The IPS test also proceeds by running separate ADF regressions for each individual unit using Equation 3.2 above. As Maddala and Wu (1999:635) show, the same lag length should be applied to each ADF regression. The final test statistic, called the  $t$ -bar, is computed as the mean of individual test statistics (Im, Pesaran & Shin, 2003:53). Commenting on the interpretation of the test results, Im *et al.* (2003:73) caution that the rejection of  $H_0$  does not imply rejection for all units. It is rejected only for  $N_1 < N$ , individuals. A significant drawback of the IPS approach is that it does not point to the specific individuals for which the  $H_0$  is rejected.

Monte Carlo simulations reveal that the IPS test performs well even for  $T=10$  in the absence of serial correlation. However, when the disturbances are serially correlated, both  $N$  and  $T$  have to be adequately large (Im *et al.*, 2003:73). Baltagi (2008:243) notes that the likelihood of rejecting the  $H_0$  when it is true, increases when  $N$  is either small or large relative to  $T$  (Baltagi, 2008:243). However,

the IPS test outperforms the LLC test when the panel is small, even in the presence of serial correlation and heterogeneity.

### 3.4.2.3 The Fisher-type Test

Like the IPS test, the Fisher test also relaxes the assumption that  $\rho_i$  is identical for all cross-sectional units. According to Maddala and Wu (1999:637), both tests combine information from individual ADF tests to construct the unit root test statistic. The two tests are also comparable in that they have similar null and alternative hypotheses. However, they differ in the way they establish the presence of unit roots. The Fisher test, like the IPS test, does not require the data to be strongly balanced. Moreover, the Fisher test, is not restricted to the ADF test, it can apply any time series unit root test.

The Fisher-type test uses the  $p$ -values from the ADF regressions to construct a test for unit roots (Baltagi, 2008:244). The resulting test statistic follows the chi-square ( $\chi^2$ ) distribution with  $2N$  degrees of freedom (Maddala & Wu, 1999:636). Monte Carlo simulations by Maddala and Wu (1999:639) reveal that the Fisher test outperforms the IPS test for high values of  $T$  (50 or 100) and  $N$  (50 or 100). The Fisher test presents fewer distortions than the LLC and IPS tests in the presence of both heteroscedasticity and serial correlation (Maddala & Wu, 1999:644). The Monte Carlo tests by Maddala and Wu (1999:645) conclude generally that the Fisher test is simpler and outperforms the IPS and LLC tests. However, it has the disadvantage that the  $p$ -values have to be computed from simulations.

This study uses both the IPS and Fisher tests to detect unit roots. The main rationale for choosing these two approaches is that they are both tailored to accommodate unbalanced panel data, making them appropriate for this study. In addition, both tests allow for heterogeneity and serial correlation in the error terms which usually occur in most empirical work. Moreover, the two tests can account for individual-specific effects (fixed effects), which again makes them appropriate for this study, as the model described in Chapter 4 includes fixed effects.

### 3.4.3 Fixed Effects and Random Effects Models

The specific choice of model for analysing panel data depends on the treatment of unobserved individual effects (Ajmani, 2009:111). When  $\mu_i$  are assumed to be constant across individual units such that  $\mu_1 = \mu_2 = \dots = \mu_n = \mu$ , the model parameters can be computed using OLS. This type of estimation results in a pooled regression model represented by Equation 3.3 (Ajmani, 2009:111). It is the most restrictive and least used panel data model as it does not account for unobserved differences that exist in panel data.

$$y_{it} = \mu + \beta X_{it} + u_{it} \quad 3.3$$

However, when the assumption that  $\mu_1 = \mu_2 = \dots = \mu_n = \mu$  is relaxed, OLS estimation can no longer produce consistent and efficient estimates (Greene, 2003:284). When this assumption no longer holds, researchers opt to run what are called FE or RE models. Unlike the pooled OLS model, these two models allow for differences across units and include individual-specific time-invariant effects  $\mu_i$ . However, the two models differ in their assumptions. When the unobserved individual effects are assumed to be correlated with the observed regressors in the model, the appropriate model to use is the FE model depicted in Equation 3.4 (Ajmani, 2009:113).

$$y_{it} = \mu_i + \beta X_{it} + u_{it} \quad 3.4$$

The term “fixed effects” is used to refer to the fact that while  $\mu_i$  may differ for each country, they do not vary over time (Torres-Reyna 2007:9; Greene 2004:642). The FE model captures the unobserved individual effects as differences in the constant term, resulting in different intercept terms  $\mu_i$  to be estimated for each entity (Greene, 2003:287). Indeed the FE model is practical when differences between entities can be seen as parametric shifts of the regression. According to Ajmani (2009:123) and Baltagi (2005:12), the interpretations from the FE analysis should be applied only to the countries selected for the study.

FE models can be estimated using three main methods: the LSDV approach, the within-group and between-group effects approaches. The LSDV<sup>5</sup> model, also known as the covariance model, captures the unobserved individual effects by including dummy variables for each entity in the regression function (Ajmani, 2009:113; Torres-Reyna, 2007:17). The inclusion of dummy variables ensures that only the pure effect of the regressors on the regressand is estimated.

Although easy to apply, the LSDV model is not without problems. First, Baltagi (2005:13) shows that substantial degrees of freedom are lost as the number of entities  $N$  increases, since  $(N-1)$  extra parameters need to be estimated. Therefore, this approach may not be feasible for very large panels. Nevertheless, if  $N$  is small enough and  $T$  large enough, the LSDV model can produce consistent and efficient estimates using OLS estimation (Baltagi, 2005:13; Greene, 2003:287). Second, the inclusion of many dummy variables may worsen the problem of multicollinearity among the explanatory variables, making precise estimation of parameters difficult (Greene, 2004:646). Third, the LSDV model does not identify the effect of time-invariant variables such as geographical location, institutional and cultural characteristics.

Unlike the LSDV model, the within-group effects model considers the variation within each entity in the panel by using the individual-specific deviations of variables from their time-averaged values (Katchova, 2013:12). Despite this, the within-groups estimator still produces identical coefficients to the LSDV model on the non-dummy variables. One limitation of this model, however, is that it drops the individual-specific effects and their coefficients are therefore not identified (Ajmani, 2009:113). An advantage of the within-group effects approach is that it produces consistent estimates despite the correlation between unobserved individual effects and the regressors (Ajmani, 2009:13).

The between-group effects model, on the other hand, only considers the variation across entities in a panel. This model produces non-dummy coefficients that are different from the other two models. It relates the mean of the dependent variable to the means of the regressors and an overall constant individual effect (Ajmani, 2009:113). A major limitation of this type of estimation is that by averaging the observations, the number of observations collapses to  $N$ . Ajmani (2009:113) argues that fewer observations significantly reduce the degrees of freedom, especially when the regressors are many.

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<sup>5</sup> Greene (2003:287) points out that the “least squares” part of the name refers to the technique used to estimate the model, and not the model itself.

In contrast to the FE model, the RE model assumes that  $\mu_i$  are distributed independently of the observed regressors and are therefore not correlated with the regressors (Ajmani, 2009:111). According to Baltagi (2005:14), the RE model is an appropriate specification when the countries included in the model are drawn randomly from a large population. Therefore, the interpretations from the RE model can be generalised to the larger population. Torres-Reyna (2007:25) further argues that the RE model should be used when there is a possibility that differences across individuals have some influence on the dependent variable. Unlike the FE model, the RE model requires that these individual-specific characteristics be specified in the model. However, this becomes restrictive as some variables may not be observed, resulting in the omitted variable bias.

In the case of the RE model, the unobserved heterogeneity is divided into two components: a component ( $\mu$ ) that is fixed and the same for all countries, and a random disturbance ( $u_i$ ) that is specific to each of the individual units being studied (Ajmani, 2009:111). This results in the formulation represented in Equation 3.5. The disturbances  $u_i$  and  $\varepsilon_{it}$  are assumed to be IID  $(0, \sigma_u^2)$ . The main premise of the RE model is that any differences across entities that are not captured in the observed regressors are reflected in the disturbances  $u_i$  (Greene, 2004:647). If the RE model is the true model, the estimators are consistent and efficient.

$$y_{it} = \beta X_{it} + \mu + u_i + \varepsilon_{it} \quad 3.5$$

The most appropriate method for estimating the RE model is the generalised least squares (GLS) method. Greene (2004:649) notes that even though the GLS method is difficult to implement, it has now been incorporated into a number of modern statistical software packages that allow for estimation of the RE model. As a result, this section does not describe the specific mathematics related to this method. Moreover, it is highly unlikely that the RE model will be implemented for this study, for reasons discussed above.

An inevitable challenge facing many researchers using panel data is whether to include FE or RE in their model. From the preceding explanation, it is clear that this depends on whether one assumes that the unobserved individual-effects correlate with any of the regressors, or not (Greene, 2004:650). Formal tests have been devised that guide the decision to adopt either the FE or RE model.

The Hausman specification test is the most commonly used approach for determining whether the FE or RE model is more appropriate. It tests whether there is a significant difference between the FE model and the RE model. According to Ajmani (2009:128), the Hausman specification test tests the  $H_0$  that the unobserved individual-specific effects and the observed regressors are uncorrelated (strict exogeneity) against the  $H_1$  that they are correlated (strict endogeneity).

Under the  $H_0$ , both the FE estimator ( $\hat{\beta}_{FE}$ ) and the RE estimator ( $\hat{\beta}_{RE}$ ) are consistent estimators for the parameter  $\beta$ , but the FE estimator is inefficient (Greene, 2003:301). However, under the  $H_1$ , only the FE estimator is consistent for  $\beta$ . A significant difference between the RE and FE estimators leads to the rejection of the null hypothesis, which is taken to mean that the FE model is the appropriate one.

Formally, the Hausman specification test tests the following hypotheses:

$$H_0: \text{Cov}(\mu_i, X_{it}) = 0, \text{ RE model is the correct model}$$

$$H_1: \text{Cov}(\mu_i, X_{it}) \neq 0, \text{ FE model is the correct model}$$

The Hausman's test statistic is based on the Wald criterion and is given by:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})^T (Var\hat{\beta}_{FE} - Var\hat{\beta}_{RE})^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE}) \sim \chi^2(k) \quad 3.6$$

$\hat{\beta}_{FE}$  – FE estimator,

$\hat{\beta}_{RE}$  – RE estimator,

$Var\hat{\beta}_{FE}$  – variance of the FE model; and

$Var\hat{\beta}_{RE}$  – variance of the RE model.

While the results of the Hausman specification test are important in guiding the decision between the FE or RE models, ultimately the model selected will be guided by theory and empirical evidence. As alluded to earlier, several studies similar to this one, for example, Burns *et al.* (2014) and Lim *et al.* (2014), use the fixed effects model. They argue that the analysis of the effect of QE on capital flows to EMEs requires the use of FE to account for unobserved differences among countries.

Panel data regression models regardless of whether they include FE or RE can be extended to include a lagged dependent variable, resulting in what are known as dynamic panel models. Chapter 4 provides more information on dynamic panel models and the methods used to estimate them. However, even in the case of a dynamic panel model, a choice still has to be made between modelling FE or RE.

### **3.4.4 Model Adequacy Tests**

Once the decision to use either the FE or RE model has been made, there are other concerns that a researcher must address to ascertain the adequacy of the chosen model. This can be achieved through the use of diagnostic tests or checks. As Zeileis and Hothorn (2002:1) point out, the purpose of these diagnostic tests is not to ascertain whether the model is wrong, but rather to determine how serious any irregularities are. Some of the most common diagnostic tests in applied econometrics are tests for heteroscedasticity and serial correlation. These tests are often related to the behaviour of residuals of the estimated model. Examining the behaviour of residuals makes it possible to ascertain the appropriateness of a model. Consequently, a well-specified model is defined as one which exhibits well-behaved residuals that are normally distributed, serially uncorrelated and have homoscedastic residuals (Dlamini, 2008:60).

#### **3.4.4.1 Testing for Heteroscedasticity in Panel Data**

The standard ECM described in Equation 3.1 assumes that the regression error terms are homoscedastic with constant variance across time and individuals. However, Baltagi (2008:79) argues that an assumption such as this one may be very restrictive, especially in the case where individuals or countries or cross-sections may vary in size and hence exhibit diversity. Hsiao (2003:56) shows that in the ECMs heteroscedasticity can occur because the variance of the unobserved individual-specific effects  $\mu_i$  varies with each individual country  $i$  in the panel. Baum (2001:101) also argues that while error terms may be homoscedastic within cross-sectional units, their variance may vary across individual.

Baltagi (2008:79) notes that while assuming that the error terms are homoscedastic when they are not, does not necessarily result in inconsistent estimates of the regression parameters; it results in

inefficient estimates and biased standard errors. Because of this, it becomes necessary to check the error terms for heteroscedasticity. The Wald Statistic for groupwise heteroscedasticity is an example of a test that can be used to check for heteroscedasticity in the residuals of an FE regression model. This test tests the  $H_0$  of homoscedasticity ( $\sigma_i^2 = \sigma^2$  for  $i=1, \dots, N$ ) against the  $H_1$  of heteroscedasticity (Baum, 2001:101);  $\sigma_i^2$  denotes the cross-sectional unit's error variance for individual  $i$ . The Wald test statistic is defined as:

$$W = \sum_{i=1}^N \frac{(\hat{\sigma}_i^2 - \hat{\sigma}^2)^2}{V_i} \quad 3.7$$

The Wald test statistic is distributed as  $\chi^2(N)$  under the  $H_0$ . Simulations conducted by Baum (2001) reveal that the Wald test statistic performs poorly for panels with large  $N$  and small  $T$ . This is unlikely to be a problem in this study as  $T$  is significantly larger than  $N$ . This test statistic is also applicable to unbalanced panels. When the error terms are found to be heteroscedastic, a simple solution is to derive robust standard errors to correct for the heteroscedasticity (Baltagi, 2008:79).

#### 3.4.4.2 Testing for Serial Correlation in Panel Data

In addition to assuming that the disturbances are homoscedastic, standard panel data models also assume that the residuals are serially uncorrelated, conditional on  $\mu_i$ . According to Wooldridge (2002:176), the presence of serial correlation in the residuals implies that the errors in every time period contain a time-invariant omitted factor. The presence of serial correlation results in biased standard errors and less efficient regression estimates (Drukker, 2003:168). As a result of this, it becomes imperative to dictate serial correlation in the residuals.

This study uses the test proposed by Wooldridge (2002) to identify serial correlation in the error terms. Drukker (2003:168) finds this test to be more robust than other panel data serial correlation tests as it has fewer assumptions. Wooldridge's test is based on the first difference of the one-way ECM described in Equation 3.1, which assumes that there is no serial correlation among the disturbances. The test is therefore based on Equation 3.8 below.

$$\Delta y_{it} = \beta \Delta X_{it} + \Delta u_{it} \quad 3.8$$

Wooldridge's test proceeds by obtaining the residuals  $\hat{u}_{it}$ <sup>6</sup> from the regression described in Equation 3.7 above. Wooldridge assumes that if the disturbances are not serially correlated, then the correlation between them in time period  $t$  and its first-order lag equals -0.5 [ $\text{Corr}(\Delta u_{it}, \Delta u_{it-1}) = -0.5$ ]. Based on this assumption, the test regresses the first-differenced variables on their lags and tries to establish if the coefficient on these variables is equal to -0.5. Alternatively, one may conduct a  $t$  test on the coefficient on the lagged residuals. A statistically significant coefficient on the lagged residuals results in the rejection of the  $H_0$  of no serial correlation.

Most empirical analyses using panel data found serially correlated error terms. Hsiao (2003:57) notes that several cases exist where the effects of unobserved variables vary systematically over time and are therefore not well described by disturbances that are assumed to be constant over time. Therefore, Hsiao (2003:57) argues that it is more realistic to relax the assumption of no serial correlation. Nevertheless, a number of statistical packages have evolved to include techniques that correct for serial correlation.

### 3.5 Application of the Dynamic Panel Model

The preceding sections discussed the various approaches previously used in estimating the impact of QE on capital flows as well as the various estimation techniques related to panel data. In keeping with the objectives of this study, this section presents and describes the econometric model employed in estimating the effect of QE on the BRICS' capital inflows. This study adopts the dynamic panel model, described in Section 3.5.1 below. This modelling approach follows closely the one employed in Ahmed and Zlate (2013), Burns *et al.* (2014) and Lim *et al.* (2014).

Section 3.5.1 also describes the complication arising from the addition of a lagged dependent variable as a regressor, and documents some of the estimation techniques available for circumventing this complication. The lagged dependent variable introduces endogeneity into the model, rendering standard panel data estimates such as the LSDV biased and inconsistent. Several IV and GMM estimators have been developed to fit dynamic panel data models. This Section provides a summary of the most commonly used estimation techniques. These include: the AH IV estimator; the AB and

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<sup>6</sup> Residuals are the difference between the observed and predicted values of the dependent variable (Gujarati, 2004:59).

BB GMM estimators; and the LSDVC estimator (Kiviet, 1995). The study employs the dynamic panel data (DPD) estimator that fits dynamic panel models using the AB and BB estimators.

### 3.5.1 Dynamic Panel Model with a Lagged Dependent Variable

This study uses a dynamic panel model with FE, to examine the effect of QE on capital inflows to the BRICS economies. The formal representation of this model (Equation 3.9) is similar to the static model described in Equation 3.1, except that it contains a lagged dependent variable ( $y_{it-1}$ ) as an independent variable, as shown below:

$$y_{it} = \gamma y_{it-1} + \beta X_{it} + u_{it} \quad i = 1, \dots, n; t = 1, \dots, T \quad 3.9$$

Where  $y_{it}$  is the dependent variable,  $X_{it}$  is the set of independent variables,  $\gamma$  and  $\beta$  are parameters to be estimated. The absolute value of the autoregressive parameter ( $\gamma$ ) is assumed to be less than one ( $|\gamma| < 1$ ). The disturbance term  $u_{it}$  denotes the two-way error components disturbances as shown in Equation 3.10. The terms  $\mu_i$  and  $\lambda_t$  represent the unobserved individual and time specific effects, respectively. Equation 3.10 demonstrates that  $\mu_i$  remains the same for a given unit over time  $t$ , while  $\lambda_t$  is the same for a given time over individuals  $i$ . The remainder disturbances  $\varepsilon_{it}$  are assumed to be IID [ $\varepsilon_{it} \sim \text{IID}(0, \sigma_\varepsilon^2)$ ], with no correlation among the residuals ( $E(\varepsilon_{it}\varepsilon_{js}) = 0$ ).

$$u_{it} = \mu_i + \lambda_t + \varepsilon_{it} \quad i = 1, \dots, n; t = 1, \dots, T \quad 3.10$$

Equation 3.9 can be constructed as either an FE model or an RE model depending on the assumptions made about the relationship between  $\mu_i$  and  $X_{it}$ . When  $\mu_i$  are assumed to be correlated with  $X_{it}$ , the model is constructed as an FE model, while no correlation between the two results in the construction of an RE model (Hsiao, 2003:49). Whether it is an FE or RE dynamic panel model, the model described above (Equation 3.9) indicates that any influence that the independent explanatory variables  $X_{it}$  have on the outcome variable is now conditioned on the history of the dependent variable  $y_{it-1}$  (Greene, 2003:307).

### 3.5.1.1 Complications in Estimating the Dynamic Panel Model

Whether in the fixed or random effects settings, the relationship between  $y_{it-1}$  and  $\mu_i$ , results in complications when estimating dynamic panel models (Hsiao, 2003:70; Flannery & Hankins, 2013:1). According to Greene (2003:307), the presence of both  $y_{it-1}$  and  $\mu_i$ , violates the assumption of strict exogeneity of the independent variables. The endogeneity introduced by  $y_{it-1}$  renders standard panel data estimates biased (Nickell, 1981:1418).

For example, Hsiao (2003:70) notes that the LSDV model (see Section 3.2.2) under the FE formulation no longer produces consistent estimators, particularly for large panels covering a small number of periods. This bias has been estimated to be of order  $(1/T)$  and is assumed to reduce as  $T$  increases or tends to infinity ( $T \rightarrow \infty$ ) (Judson & Owen, 1999:10). Even when  $T$  is sufficiently large, Nickell (1981:1418) argues that biases may remain. He (ibid.) notes that in the RE formulation the consistency of the estimates relies on the initial values of the dynamic process ( $y_{it-1}$ ). Overall, the performance of the estimates in both the FE or RE settings depends on how  $T$  and  $N$  tend to infinity.

Despite the complications arising from endogeneity, several econometric techniques have been devised to correct for such biases. Several estimators are available as an alternative to the LSDV. Anderson and Hsiao (1981), for example, suggest two IV estimators based on the differenced dynamic panel model. Arellano and Bond (1991) and Blundell and Bover (1998) propose different GMM techniques for estimating dynamic panel data models. However, an important limitation of these estimators is that they are only practical when  $N$  is large. Kiviet (1995) developed the LSDVC as an alternative approach. These techniques are discussed below.

#### 3.5.1.1.1 Anderson and Hsiao Instrumental Variable

The basic idea of the IV approach is to identify variables (instruments) that are correlated with the regressors, and not with the disturbances. The principal objective behind finding these instruments is to eliminate the correlation between the independent variables and the disturbances. Standard panel data analysis assumes that the independent variables in the model are strictly exogenous with respect to  $\varepsilon_{it}$ . According to Arellano (2003:129), this implies that the independent variables are not correlated with the past, present and future values of  $\varepsilon_{it}$ .

However, there are special cases, such as in the dynamic panel data model, where the assumption of strict exogeneity is violated since  $y_{it-1}$  is correlated with  $\mu_i$ . As discussed in Chapter 3, it is not uncommon for  $y_{it-1}$  to be correlated with  $\mu_i$ , since  $y_{it}$  is also correlated with  $\mu_i$ . This, according to Arellano (2003:129), effectively implies that  $y_{it-1}$  is an endogenous variable. Therefore, procedures for IV estimation are applied to try and eliminate the effect of the correlation between  $y_{it-1}$  and  $\mu_i$ , on  $y_{it}$ . Anderson and Hsiao (1981) presented one of the first attempts to do so.

The AH approach is an appropriate method when the observed explanatory variables are weakly exogenous. The AH approach is conducted by differencing Equation 4.3 described below to eliminate  $\mu_i$ . This is achieved by subtracting from each term its previous value. First differencing both sides of equation 3.11 yields Equation 3.12 below or alternatively Equation 3.13. However, even after eliminating the fixed effects, Equation 3.11 still produces inconsistent estimators for finite samples or when  $T$  is fixed, because the  $y_{i,t-1}$  is still a function of  $\varepsilon_{i,t-1}$ , implying that  $\Delta y_{i,t-1}$  is correlated with the disturbances  $\Delta \varepsilon_{it}$ .

$$y_{it} = \gamma y_{i,t-1} + \beta X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad 3.11$$

$$y_{it} - y_{i,t-1} = \gamma(y_{i,t-1} - y_{i,t-2}) + \beta(X_{it} - X_{i,t-1}) + \mu_i \varepsilon_{it} - \varepsilon_{i,t-1} \quad 3.12$$

$$\Delta y_{it} = \gamma \Delta y_{i,t-1} + \beta \Delta X_{it} + \Delta \varepsilon_{it}, \quad t = 2, \dots, T \quad 3.13$$

Once the model is transformed, Anderson and Hsiao (1981) suggest two estimators that use  $y_{it-2}$ , as an instrument for the differenced model. They argue, for example, that if the disturbances  $\varepsilon_{it}$  are IID [ $\varepsilon_{it} \sim \text{IID}(0, \sigma_\varepsilon^2)$ ] (see Section 3.4.2) over  $i$  and  $t$ , then  $y_{i,t-2}$  or  $\Delta y_{i,t-2}$  would be a valid instrument for  $\Delta y_{i,t-1}$  (Baltagi, 2008:136). Hsiao (2003:87) notes, for instance, that while  $\Delta y_{i,t-2}$  is correlated with  $\Delta y_{i,t-1}$ , it is uncorrelated with  $\Delta \varepsilon_{it}$ , and is therefore a valid instrument. However, a model that uses instruments in levels rather than differences produces more efficient estimates.

Anderson and Hsiao (1981) propose a two-stage least squares (TSLS) approach for estimating  $\gamma$  and  $\beta$ . In the first stage all variables including  $y_{it-1}$  are regressed on the set of instruments using OLS; this is to ascertain how much of the variation in these variables is as a result of the instruments. In

stage two the values from the first stage are fitted into the original model to derive the instrumental variable estimates for  $\gamma$  and  $\beta$ . The estimators  $\hat{\gamma}$  and  $\hat{\beta}$  are then used to derive the variances of the residuals  $\hat{\sigma}_\varepsilon^2$  and the unobserved individual effects  $\hat{\sigma}_\alpha^2$ .

With reference to consistency, Hurlin (2010:46) notes that  $\hat{\gamma}$ ,  $\hat{\beta}$  and  $\hat{\sigma}_\varepsilon^2$  are consistent when both  $N$  or  $T$ , or both tend to infinity. The estimate of the variance of the unobserved fixed effects  $\hat{\sigma}_\alpha^2$  is consistent only when  $N$  tends to infinity and is inconsistent when  $N$  is fixed. Based on these observations, some researchers (e.g. Bruno, 2005:474) have concluded that the AH IV approach is best when  $N$  is large. Moreover, he argues that while this approach produces consistent estimators, it does not necessarily lead to efficient estimators as it does not utilise all available moment conditions.

### 3.5.1.1.2 Generalised Method of Moments Estimators

Several GMM estimators have been developed as alternatives to IV estimators, largely because they rely on more instruments and therefore improve the efficiency of estimates. The AB and BB estimators are examples of GMM-based techniques. Indeed most of the recent estimators build on the foundations of these estimators.

In contrast to the AH instrumental variable estimator, the AB estimator utilises all available instruments in a GMM context by taking into account all potential orthogonality conditions (Baum, 2013:8). Papoulis and Pillai (2002:211) describe two variables as orthogonal if they are uncorrelated or linearly independent. The AB approach derives more instruments by employing the orthogonality conditions that exist between  $y_{it}$  and  $\varepsilon_{it}$ . In the context of dynamic panel models, Blundell, Bond and Windmeijer (2015:58) argue that this implies making use of all lagged dependent variables that are uncorrelated to the differenced disturbances  $\Delta\varepsilon_{it}$ . By incorporating all available instruments, the GMM approach is argued to produce more efficient estimates than the AH method (Judson and Owen, 1999:10).

The AB approach, like the AH approach, is based on the first difference of Equation 3.13 (Hurlin, 2010:50). The AB approach identifies lagged dependent variables as instruments only if they are uncorrelated with the error terms. Monte Carlo simulations demonstrate that the GMM approach

produces more efficient estimates for  $\gamma$  and  $\beta$  than the TSLS estimator proposed by Anderson and Hsiao (1981).

One important draw back of the AB estimator is that the number of instruments increases as  $T$  increases. Judson and Owen (1999:13) argue that, as  $T$  gets larger, computation becomes more complicated and using all available instruments is impractical. While the GMM estimator is manageable when  $T$  is small – less than ten – it may be problematic for panels with larger time series. The panel data set used for this study has a large time dimension ( $T=64$ ) which is significantly larger than the  $T=10$  prescribed in the literature. A time dimension of this magnitude poses serious computational complications. The AB estimator is therefore more appropriate for large panels with shorter time series.

In addition to the computational challenges faced by the AB estimator for panels with a large  $T$ , Blundell and Bond (1998:138) observe that AB estimators suffer a severe small-sample bias for highly persistent data as a result of weak instruments. In other words, the AB estimator may not perform well when the autoregressive parameters are too large. Therefore, they suggest a system GMM estimator which makes use of additional moment conditions. Specifically, the approach uses differenced instruments for the level model and level instruments for the differenced model (Bruno, 2005:474). However, these additional instruments are valid only if the initial condition of strict exogeneity in the regressors holds. And like the AB estimator, the BB estimator is also suitable for large panels with short time series.

A third GMM estimator, known as the dynamic panel data (DPD) estimator, uses the AB and BB estimators. This estimator was developed to fit more complex models, particularly those with correlation in the errors or those with weakly exogenous variables (StataCorp, 2017:98). This approach is therefore more appropriate when the assumption of strict exogeneity in the regressors does not hold.

### 3.5.1.1.3 Bias-Corrected Least Squares Dummy Variable Approach

An important drawback of IV and GMM estimators is that they are only practical for large panels (Bruno, 2005:474). The foregoing discussion reveals that the GMM estimation technique suffers

serious complications for large  $T$ . This is common in macro panels, which tend to have a small number of units but longer time series. Judson and Owen (1999:13) show that while LSDV estimators produce just as efficient or better estimates than the IV and GMM estimators when  $T=30$ , they are biased in dynamic panel models, as was discussed in the preceding chapter.

Given the foregoing considerations, the LSDVC model was proposed as an alternative approach to the IV and GMM estimators. The LSDVC estimator is calculated as a bias correction to the LSDV estimator. Judson and Owen (1999:13) show that the LSDVC may outperform the IV and GMM estimators for smaller panels. Judson and Owen (1999:10) as well as Bruno (2005:475) find strong evidence suggesting that the LSDVC performs very well when  $N$  is small.

Although several procedures exist to correct for the bias of the LSDV estimator (Kiviet, 1995), these procedures are only feasible for balanced panels. The LSDVC estimator, although commonly applied to balanced panels, is also applicable to unbalanced panels (Bruno, 2005:476). In principle, the LSDVC estimator is derived by subtracting the estimated bias from the LSDV estimator as in Equation 3.14 below.  $\hat{\beta}_i$  in Equation 3.14 represents the approximated bias of the LSDV estimator. However, the approximation of the LSDV bias requires the values of the true population parameters of  $\gamma$  and  $\sigma_\varepsilon^2$ . To make bias correction possible, Bruno (2005:477) suggests the use of estimates from a consistent estimate, for example, the AH and AB estimators.

$$LSDVC_i^j = LSDV - \hat{\beta}_i^j, i = 1,2,3; j = AH, AB. \quad 3.14$$

However, the LSDVC has one major limitation. Its practicality is called into question when the assumption of strict exogeneity does not hold (Bruno, 2005:475). GMM estimators show more promise with weakly exogenous regression. Moreover, the LSDVC suffers complications when there are gaps in the data whether the panel is balanced or not (Bruno, 2005:481). Moreover, the computation of the bootstrap variance-covariance matrix requires a considerable amount of time and especially when the number of replications is high.

The performance of each of the estimators discussed above undoubtedly depends on the characteristics of the data being employed (Judson & Owen, 1999:10). The QE literature is mixed in terms of the preferred estimation techniques. While Burns *et al.* (2014:38) and Lim *et al.* (2014:9)

employ the LSDVC approach, Park *et al.* (2014) use the AB estimator. Others like Khatiwada (2017) employ a mix of techniques to estimate their model. This study adopts the DPD estimation technique as it is better suited to handle more complex data. Not only is the data set employed in this study unbalanced, it also has gaps. This study uses an unbalanced panel of quarterly data with a time dimension of  $T=64$ .

### 3.5.2 Modelling the Impact of QE on Capital Flows to the BRICS Economies

The baseline dynamic panel data model adopted in this study is described in Equation 3.15. The dependent variable ( $GCI_{it}$ ) and its constituent components (FDI, portfolio investments and bank lending) are modelled as a function of QE and a number of push and pull factors. This model is consistent with the recent literature on capital flows (Burns *et al.*, 2014; Lim *et al.*, 2014; Park *et al.*, 2014; Ahmed & Zlate 2013; Forbes & Warnock 2012; Fratzscher 2012) and with earlier literature on capital flows (e.g. Taylor & Sarno 1997).

$$gci_{it} = \gamma gci_{it-1} + \alpha gfc_t + \pi grc_{it} + \theta qe_t + \beta x_{it} + crisis_t + post\_crisis_t + \mu_i + \lambda_t + \varepsilon_{it} \quad 3.15$$

Where  $gci_{it}$  represents the log of total gross capital inflows or their sub-components expressed as a percentage of GDP. These are categorised into FDI ( $fdi_{it}$ ), portfolio equity ( $pe_{it}$ ), portfolio debt ( $pd_{it}$ ) and bank lending ( $bk_{it}$ ). The subscript  $i$  represents the  $i$ 'th country and  $t$  the  $t$ 'th quarter.  $gfc_t$  denotes global financial conditions and includes the US federal funds rate ( $fed\_rate$ ); the yield curve ( $yield\_curve$ ) – US 10-year bond yield ( $us\_10yr$ ) minus the 3-month treasury bill rate ( $us\_3mth$ ); the log of the US money supply ( $m2\_us$ ); and the VIX ( $vix$ ). Global real-side conditions ( $grc_{it}$ ) include a measure of advanced economy growth proxied by the US real GDP growth rate ( $us\_rgdp$ ) and the real GDP growth rate for each BRICS country ( $brics\_rgdp$ ).

The unobservable effects of QE in the USA on the BRICS are captured by the term  $qe_t$ .<sup>7</sup> Various specifications of the baseline model are explored. Separate QE dummies are used to represent each episode of QE;  $qe1$ ,  $qe2$  and  $qe3$ . The other specifications include a measure of QE ( $fed\_qe$ ) proxied by the Fed's asset expansion is included.

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<sup>7</sup> In other specifications of the baseline model, separate QE dummies are included for each phase of QE. Moreover, the model will also consider interaction dummies between the QE indicator and standard observable determinants of capital flows.

The vector  $x_{it}$  includes country-specific factors, namely the interest rate differential ( $i\_dif$ ) and growth differential ( $g\_dif$ ) of each BRICS country relative to the USA. The vector  $x_{it}$  also includes a measure of each country's institutional rating ( $brics\_cr$ ). The model also includes unobserved country-specific effects ( $\mu_i$ ) which capture the effects of any unobserved time invariant factors on capital flows to the BRICS economies. Finally, the term  $\varepsilon_{it}$  represents the disturbances which are assumed to be IID [ $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$ ]. The parameters to be estimated correspond to the vector  $[\gamma \alpha \pi \theta \beta]$ . The model described in Equation 4.7 is fitted using the DPD estimator using the Stata command XTDPD.

### 3.6 Data and Description of Key Variables

This study uses an unbalanced panel of available quarterly data for the period 2000Q1-2015Q4 to model gross private capital inflows to the BRICS economies. All variables included in this model are at quarterly frequency. All level variables are expressed in logarithms except for rates and dummy variables that are untransformed. This section provides a descriptive summary of all the variables used in this study. These variables are also listed in Table A1 in the Appendix.

#### 3.6.1 Gross Private Capital Inflows

The dependent variable, *total gross private capital inflows* ( $GCI_{it}$ ), is defined as the sum of changes in foreign holdings of FDI, portfolio investment and bank loans in the BRICS economies.  $GCI_{it}$  expressed in nominal US dollars is measured as a proportion of nominal GDP of each recipient country. This approach is similar to many studies, for example, Bluedorn *et al.* (2013:8), who argue that presenting capital flows as a portion of GDP is important for determining the macroeconomic relevance of these flows. Data for gross FDI and Portfolio inflows are obtained from the IMF's Balance of Payments Statistics (BPS).<sup>8</sup> These two flows are supplemented by bank lending data from the BIS LBS.

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<sup>8</sup> The IMF's BPS database provides country-level data on a quarterly basis on different types of capital flows measured in US dollars. It provides data for five functional categories of capital flows, namely direct investment; portfolio investment which includes both debt and equity; financial derivatives (other than reserves) and employee stock options; other investments and reserve assets.

### **3.6.2 Capturing the Effect of Quantitative Easing**

The independent variable of interest is a set of variables aimed at capturing the effects of QE. The effect of QE on gross capital inflows is captured using dummy variables representing the different episodes of QE (Burns *et al.*, 2014:36; Lim *et al.*, 2014:10). This is achieved by experimenting with alternative specifications of the QE dummy variable. First, one QE dummy variable is used to represent all three episodes of QE. This variable takes the value of one for quarters between 2009Q1 and 2011Q2 (included), and 2012Q4 and 2013Q2 (included). In other specifications, separate QE dummy variables are used to represent each of the three QE episodes (QE1, QE2 and QE3).

Following the approach used in Burns *et al.* (2014:36), a quarter is defined as belonging to a particular QE episode, if more than half of the days of the quarter were affected by that episode's implementation. Thus QE1 which started on 16 December, 2008 is identified as the period 2009Q1–2010Q3, while QE2 which started on 3 November, 2010 is identified as the period 2010Q4–2011Q2, and finally QE3 as the period 2012Q4–2013Q2. Statistically significant coefficients on these dummy variables will be an indication of other influences of QE in addition to those captured through the conventional channels.

Lastly, the model includes a measure of QE policies proxied by increases in the US Fed's assets acquired during all three episodes of QE. Similar to Lim *et al.* (2014:9), this study considers only QE operations by the US Federal Reserve Bank. Data on the Fed's expansion in assets are obtained from the Federal Reserve Bank.

### **3.6.3 Pull and Push Factors**

Chapter 2 identified the push and pull factors that influence the pattern of capital flows. The remaining independent variables are therefore those that account for global financial and real-side conditions, as well as factors specific to the BRICS that affect the allocation of funds to these economies. Below is a summary of the push and pull factors modelled in this study.

### **3.6.3.1 Push Factors**

#### **3.6.3.1.1 Global Financial Conditions**

Global financial conditions ( $GFC_t$ ) are captured by a measure of global interest rates, global money supply (liquidity) and global risk aversion. Specifically, global interest rates are proxied by the US federal funds rate, the US 3-month Treasury bill rate and the US 10-year bond yield, compiled from the IMF's IFS database. Also included in the model is the yield curve – the 10-year US government bond yield minus the 3-month US Treasury bill rate. Higher global interest rates are likely to reduce capital inflows to EMEs, suggesting a negative correlation between capital inflows and interest rates.

Similar to Burns *et al.* (2014:35) and Lim *et al.* (2014:11), this study uses the US money supply ( $M2^9$ ) as a measure of available liquidity.  $M2$  is used to measure available financing in order to minimise as much as possible the overlap with modifications in the monetary base resulting from QE. Data on the US money supply  $M2$  are drawn from the US Federal Reserve Bank. The literature suggests a negative coefficient on the  $M2$  variable.

In line with the literature (e.g. Burns *et al.*, 2014:6; Ahmed & Zlate, 2013:12; Bluedorn *et al.*, 2013:25), this study uses the Chicago Board of Options Exchange Volatility Index (VIX) of implied stock market volatility to capture the global perception of risk. Data on the VIX index are drawn from the Chicago Board Options Exchange. While data on the VIX are available at a higher frequency, this study uses the average of the VIX of the quarter. A lower VIX (lower global risk aversion) is likely to be accompanied by stronger flows, suggesting a negative coefficient a priori.

#### **3.6.3.1.2 Global Real-Side Conditions**

As with most studies (e.g. Burns *et al.*, 2014:35; Ahmed & Zlate, 2013), the weighted average of the real GDP growth rates of advanced economies is used to capture the effects of global real-side conditions ( $GRC_t$ ). Quarterly data on the weighted average real GDP growth for advanced economies are obtained from the IMF's IFS database. Global growth represents the real incentives for investing

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<sup>9</sup>  $M2$  is a broader definition of money supply which includes cash in circulation, demand deposits and ‘near money’. Near money refers to assets that are highly liquid but are not cash. These include short-term and medium-term deposits.

in EMEs' assets. However, the effect of high-income growth on capital flows to EMEs is ambiguous, as was discussed in Chapter 2. This implies that the coefficient on this variable could be either positive or negative.

### **3.6.3.2 Pull Factors**

#### **3.6.3.2.1 Interest Rate Differential**

The interest rate differential captures differences in short-term returns between EMEs and developed economies. The interest rate differential is determined by the monetary policy stance in all the countries. The differential is computed by subtracting the US federal funds rate from the nominal policy rate of each BRICS country (Ahmed & Zlate, 2013:12). A higher BRICS policy rate implies a positive interest rate differential. Chapter 2 showed that interest rates in the BRICS economies have historically been higher than interest rates in the USA. Quarterly data on monetary policy rates in the BRICS and the USA are obtained from the IMF IFS and individual country central banks. The discussion in Chapter 2 on the interest rate differential suggests a positive coefficient on this variable.

#### **3.6.3.2.2 Economic Growth Differentials**

The model described in Chapter 4 includes the growth rates of real GDP and growth differentials between each country in the BRICS relative to the weighted average GDP in advanced economies. This is consistent with Ahmed and Zlate (2013:11). Real GDP growth rates and growth differentials (quarterly BRICS real GDP growth rates minus quarterly US GDP growth rate) are used to estimate the effect of real economic variables on capital inflows to the BRICS economies (Ahmed & Zlate, 2013:11). Similar to interest rate differentials, a higher growth rate in the BRICS relative to growth in advanced economies implies a positive growth differential. Data on real quarterly GDP growth for the BRICS and the US are compiled from the IMF IFS and national sources. Existing literature suggests that there is a positive relationship between the growth differential and capital inflows.

### 3.6.3.2.3 Sovereign Credit Ratings

Sovereign credit ratings reflect several fundamental aspects of a country such as economic growth, debt, inflation and the ability of individual countries to repay their debt (Kim & Wu, 2008:17). This study considers only the long-term institutional credit ratings derived by Standard and Poor's (S&P). The rationale for using only S&P ratings is that they produce credit ratings more frequently and for a larger group of countries than Moody's and Fitch do. Moreover, the literature (e.g. Kim & Wu, 2008:8) indicates that ratings produced by S&P tend to lead those produced by the other institutions. The choice to focus on only long-term credit ratings stems from the fact most EMEs' foreign debt is long-term. However, credit rating announcements are not made regularly. They are only made when there are changes in the factors underpinning the credit quality of countries.

In order to aid statistical analyses, these ratings are converted into a time series by assigning a value to each of the rating categories ranging from 0 for default to 20 for AAA. This approach is borrowed from Kim and Wu (2008:8). These categories are shown in Table A2 in the Appendix. The ratings are also adjusted to include the outlook associated with each credit rating. For example, if the average credit rating for a country is AAA (20) and the outlook is positive (0.50), the overall long-term credit rating for that country is 20.50. This is consistent with the approach employed in Kim and Wu (2008:8). Because credit rating announcements are not made regularly, each quarter is assigned the combined value of the rating and outlook preceding the announcement of the next rating. Empirical evidence suggests a positive correlation between credit ratings and capital flows to EMEs.

## 3.7 Conclusion

Studies examining the spillover effects of QE can be grouped into three. The first includes studies that use event study methods to examine the effect of QE around the Fed's announcements of unconventional monetary policies. The second group of studies includes those that use panel data models to identify the long-term effects of QE on capital flows. The third group makes use of VAR models to study the effects of policy normalization in advanced economies on capital inflows to EMEs.

This study uses the dynamic fixed effects, as it has been widely applied in the QE literature. While event study methods offer insight into the behaviour of assets around the time that QE was implemented, they are unable to give a long-term perspective on the spillover effects of QE. Moreover, while VARs are ideal for analysing the effects of tapering in the USA on capital flows to EMEs, this study's aim is to identify whether there were any unobservable effects of QE over and above those channelled through the observables, and whether these effects were different for different types of capital flows.

In addition to identifying the appropriate approach for estimating the impact of QE on capital inflows to the BRICS countries, this chapter also established that most studies in the capital flows literature often face the difficulty of deciding whether to model gross or net capital inflows. This study models the behaviour of gross private capital inflows and not net inflows. This decision is guided by the empirical literature, which reveals that gross capital inflows are more important than net inflows for EMEs. Gross capital inflows and net capital inflows usually move in tandem in EMEs, because gross outflows are usually too small to offset gross inflows. This is different from developed countries, where gross outflows are often sufficient to offset gross inflows.

This chapter also outlined the model adopted for examining the effect of QE on gross capital inflows to the BRICS economies. Consistent with recent literature on QE, this study adopted the dynamic panel model for this purpose. The use of dynamic panel models allows for modelling fixed effects – unobserved factors that are time invariant and may influence the pattern of capital flows. However, the presence of the lagged dependent variable introduces complications in the estimation of the model. Several econometric techniques exist that can produce unbiased estimates, despite the introduction of a lagged dependent variable. This research adopted a technique that fits dynamic panel models using the AB and BB GMM estimators.

# Chapter 4

## Empirical Analysis and Results

### **4.1 Introduction**

The preceding chapter outlined and described the baseline model used to estimate the impact of QE on capital inflows to the BRICS economies. This chapter presents the key econometric findings as shown in Section 4.2. The output of the baseline regression generally suggests that QE increased the amount of capital inflows to the BRICS, and in particular portfolio inflows. This finding compares very well with those of similar studies (e.g. Burns *et al.*, 2014:38). In addition to presenting the main econometric findings, Section 4.2 tests the sensitivity of the baseline model through the introduction of additional controls. The results of these robustness checks indicate a noticeable drop in capital inflows to the BRICS during tapering expectations. Finally Section 4.3 provides the concluding remarks for the chapter.

### **4.2 Econometric Results and Main Findings**

#### **4.2.1 Panel Unit Root Tests**

Table 4.1 displays the results of the IPS and Fisher-type tests, discussed at length in Chapter 3. Both tests test the  $H_0$  that each time series has a unit root, but they differ slightly with respect to the  $H_1$ . The IPS test tests the  $H_1$  that some individual series are stationary, while the Fisher-type test tests the  $H_1$  that at least one series is stationary. The ADF regressions for both the IPS and the Fisher-type tests included a time trend and fixed effects, as is standard practice in many panel data studies (see, for example, Baltagi, 2008:241). The ADF regressions were demeaned – that is the cross-sectional means were removed – to lessen the effects of cross-sectional dependence.<sup>10</sup> The default of one lag was used for both tests.

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<sup>10</sup> This requires that the means of each panel are subtracted from the individual series.

**Table 4.1: Panel Unit Root Test Results for BRICS Countries**

Variables	Im-Pesaran-Shin test		Fisher-type test	
	Level	First Difference	Level	First Difference
gci	-11.2435***	-17.1791***	114.3506***	250.0116***
fdi	-9.7241***	-18.1633***	41.1455***	268.8765***
pi	-4.1384***	-23.5815***	37.1302***	259.8040***
pe	-5.2980***	-19.9954***	46.6801***	303.1357***
pd	-5.2228***	-20.3689***	21.5328***	189.2554***
bk	-13.3377***	-18.3647***	177.2386***	272.3696***
brics_rgdp	-4.2555***	-12.3896***	40.0387***	111.3429***
i_dif	-0.6374	-11.5292***	14.7747	104.8141***
g_dif	-4.2555***	-12.3896***	40.0387***	111.3429***
brics_cr	-2.7097***	-15.4278***	32.4793***	179.3110***

*Note:* \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels, respectively. Probability values are computed assuming asymptotic normality. The lag order was determined by the Akaike Information Criterion (AIC) for the IPS test. Only the rho-statistic is reported for the Fisher-type test.

The test statistics were evaluated based on the standard 1 percent, 5 percent and 10 percent levels of significance. If the  $\rho$ -value of the relevant test statistic is less than the 10 percent level of significance,  $H_0$  is rejected. However, when they are greater than 10 percent,  $H_0$  is not rejected. In the context of the IPS and Fisher-type tests, this implies that some series are stationary, while others are not.

Table 4.1 demonstrates that all the variables excluding the i\_dif (interest rate differential) variable are stationary both in levels and first difference. This is true for both tests. The gci, fdi, pi, pe, pd, bk, brics\_rgdp, g\_dif and the brics\_cr variables are integrated to the order of 0 or  $I(0)$ , as they do not have to be differenced to induce stationarity. The  $\rho$ -values for the test statistics are less than 5 percent, resulting in the rejection of the  $H_0$  that all the panels have unit roots. The i\_dif variable contains unit roots in levels, but becomes stationary after first differencing – it is  $I(1)$ . This is true for both tests.

Panel unit roots tests on the remaining variables fed\_qe, us\_3mth, yield\_curve, m2\_us, vix and us\_rgdp were not significant. A probable explanation for this is that these variables are only reported for one country, the USA, and therefore have insufficient time periods. Standard time series unit root

tests – the ADF and Phillips-Perron (PP) tests – were used to detect stationarity in these variables. Both tests test the  $H_0$  that each series has a unit root, against the  $H_1$  that the series is stationary. When the absolute value of the test statistic is greater than the absolute value of the critical values at all the levels of significance,  $H_0$  is rejected. Table 4.2 displays the results of the two tests.

**Table 4.2: Time Series Unit Root Test Results**

Variables	Augmented Dickey-Fuller Test		Phillips-Perron Test	
	Level	First Difference	Level	First Difference
fed_qe	-2.017	-5.065***	-2.241	-4.877***
us_3mth	-1.386	-3.961**	-1.960	-3.987**
yield_curve	-1.650	-5.524***	-2.161	-5.549***
m2_us	-4.000**	-8.722***	-3.961**	-9.027***
vix	-3.335*	-8.506***	-3.294*	-8.817***
ae_rgdp	-2.073	-5.138***	-2.649	-5.299***

*Note:* \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels, respectively. Probability values are computed assuming asymptotic normality. The lag order was determined by the Schwarz Information Criterion (SIC) and Bartlett Kernel. Only the Z(t) statistic is reported for the Phillips-Perron test.

The results indicate that only m2\_us and vix are stationary in levels. The fed\_qe, us\_3mth, yield\_curve and us\_rgdp variables become stationary in first differences, they are  $I(1)$ . While these results suggest that the i\_dif, fed\_qe, us\_3mth, yield\_curve and us\_rgdp should be used in their first difference in the regression, Enders (2015:291) warns against inducing stationarity through differencing, as this may result in the loss of valuable information. Engel and Granger (1987:251) argue, for example, that while the relationship existing between two variables may deviate in the short-run, they will always converge to their equilibrium in the long-run. Therefore this study will use all the variables in levels to preserve any valuable information contained in the data. Moreover, using transformed variables does not alter the main message of the findings.<sup>11</sup>

#### 4.2.2 Fixed Effects or Random Effects

As indicated in the preceding chapter, researchers are often faced with the challenge of deciding whether to fit their models with FE or RE. The Hausman specification test was devised to test whether an FE or RE model is appropriate for estimating panel data. It tests the  $H_0$  that the RE model

<sup>11</sup> See Table A3 in the Appendix.

is appropriate and the  $H_1$  that the FE model is appropriate. In practice, as described in Baltagi (2008:271), the RE estimator ( $\hat{\beta}_{RE}$ ) is assumed to be a consistent and efficient estimator under the  $H_0$ , but inconsistent under the  $H_1$ . The FE estimator ( $\hat{\beta}_{FE}$ ), on the other hand, is always consistent both under  $H_0$  and  $H_1$ , but is inefficient under  $H_0$ .

The Hausman specification test is conducted in Stata and proceeds by first running the FE model. The next step involves fitting the RE model. The estimates of the RE model are then compared to those of the FE model by using the Hausman command. A significant difference between the RE and FE estimators results in the rejection of the  $H_0$ . When the  $p$ -value of the Hausman statistic is less than 5 percent, the  $H_0$  that the RE model is suitable is rejected, meaning that the FE model is the correct model. However, when it is greater than 5 percent, the  $H_0$  cannot be rejected, implying that the RE model is the correct model.

Table 4.3 shows the findings of the Hausman specification test. The  $p$ -value for the test statistic is less than the 5 percent. Because of this, the  $H_0$  that the RE model is suitable is rejected. This suggests that the FE model is the correct model. This outcome is consistent with recent literature on QE, for example (Burns *et al.*, 2014), that have modelled the spillover effects of QE on EME's financial assets.

**Table 4.3: Hausman Specification Test Results**

	Chi-Square Statistic	Chi-Square Degrees of Freedom	$p$ -value
Test Summary	45.86	11	0.000***

*Note:* \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels, respectively. Probability values are computed assuming asymptotic normality.

The Breusch and Pagan Lagrangian Multiplier (LM) test is run as a complementary test to rule out completely the RE model. The LM test is a test for the RE model. It tests the  $H_0$  that the pooled OLS model is the appropriate model against the  $H_1$  that the RE model is the applicable one. The results for the Breusch and Pagan LM test are presented in Table 4.4. The findings indicate that the  $p$ -value is greater than all the recommended levels of significance. Therefore the  $H_0$  that the pooled OLS regression is the appropriate model is not rejected. The results of the LM test rule out the RE model.

**Table 4.4: Breusch & Pagan Lagrangian Multiplier Test for Random Effects**

	Chibar-Square Statistic	Chi-Square Degrees of Freedom	p-value
Test Summary	0.00	1	1.0000

*Note:* \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels, respectively. Probability values are computed assuming asymptotic normality.

The results of both tests suggest that the RE model is unsuitable. This study will therefore fit the dynamic panel model with FE. The decision to fit the FE model is also guided by empirical evidence. As already alluded to, several studies similar to this one – for example, Lim *et al.* (2014) – have used the FE model. They argue that the model investigating the effect of QE on EMEs should include FE to account for unobserved differences among countries, which may influence the pattern of capital flows.

#### 4.2.3 Model Adequacy Tests

In addition to choosing between the RE and FE model, this study ran diagnostic tests to ascertain the adequacy of the model described in Equation 4.7. As argued in Section 3.4.5, the purpose of these tests is not to ascertain whether the model is wrong, but rather to determine the gravity of any irregularities. Section 3.4.5 also showed that model adequacy tests often involve checking the behaviour of residuals of the estimated model. A model is argued to be a good model when it has well-behaved residuals which are normally distributed, homoscedastic and serially uncorrelated. This study employs the Wald Statistic for groupwise heteroscedasticity and Wooldridge's test to test for heteroscedasticity and serial correlation, respectively.

The Wald Statistic for groupwise heteroscedasticity tests the  $H_0$  that the residuals are homoscedastic across individuals, against the alternative hypothesis that they are heteroscedastic. The results of the Wald Statistic for groupwise heteroscedasticity are presented in Table 4.5 below. The  $p$ -value is less than 5 percent, resulting in the rejection of the  $H_0$  that the residuals are homoscedastic. This implies that the variance of the residuals is not the same across individuals in the panel. Heteroscedasticity can be corrected by deriving robust standard errors.

Section 3.4.5.2 established that serial correlation can result in extremely biased estimates. The Wooldridge test is one of the most attractive and flexible tests for detecting serial correlation. It tests the  $H_0$  of no serial correlation against the  $H_1$  of serial correlation. The Pesaran test for cross-sectional

dependence is used as a complementary test. Like the Wooldridge test, the Pesaran test also tests the  $H_0$  of no serial correlation against the  $H_1$  of serial correlation. The results of both tests are shown in Table 4.5 below. The probability values of the test statistics on both the Wooldridge and Pesaran tests are more than 1 percent. Therefore the  $H_0$  that there is no serial correlation cannot be rejected in both cases. This implies that serial correlation is not present in the data.

**Table 4.5: Test for Autocorrelation and Heteroscedasticity**

	Tests for Autocorrelation		Test for Heteroscedasticity
	Wooldridge Test	Pesaran Test	Wald Test
<b>Test Statistic</b>	0.643	-0.699	357.74
<b><math>\rho</math>-value</b>	(0.4674)	(1.5156)	(0.0000)***

*Note:* \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels, respectively

#### 4.2.4 Baseline Regression Results

The baseline regression estimates are displayed in Table 4.6. The baseline regression estimates are obtained through two specifications: one that only includes the 3-month US T-bill rate, yield curve, interest rate differential and the VIX, and an extended specification that includes the money supply (M2) and the growth differential. The first specification includes what Lim *et al.* (2014:13) term primary indicators, while the second includes secondary indicators. The inclusion of other controls, including each country's institutional credit rating and GDP growth, are varied in each specification. The QE dummy variables are also altered in the two specifications. Columns I-III represents results from the reduced specification, while columns the remaining columns correspond to the extended specification.

##### 4.2.4.1 The Persistence of Capital Flows

The extent to which capital flows persist over time is something of interest in discussions regarding the volatility of capital flows. A distinction is often made between *cold* flows, perceived to be relatively stable, and *hot* flows, seen to be more volatile. The persistence of gross capital flows is measured by calculating correlations of the dependent variable with its own past values. In this case it is the coefficient on lagged inflows ( $gci_{it-1}$ ) in Table 4.6. According to Becker and Noone

(2008:167), *cold* flows present a strong positive relationship with their past values, while *hot* flows have a weaker positive correlation.

The coefficient on lagged inflows is positive and significant across the various regressions, indicating some degree of persistence in the dependent variable. This is characteristic of most emerging economies, which tend to exhibit a lower degree of persistence than high-income countries. However, when compared to other EMEs, the persistence of gross flows is generally lower in the BRICS countries. The coefficient of lagged gross capital inflows ranges between 0.15-0.19 (Table 4.6). This is less pronounced than what has been reported in other comparable studies. This could be an indication that capital flows to the BRICS are more unpredictable, compared to other EMEs. The degree of persistence in the various components of capital flows is considered in another section below.

**Table 4.6: Baseline Regression Results Unbalanced Quarterly Panel 2001Q1-2015Q4**

	I	II	III	IV	V	VI
Dependent variable:	Gross Inflows	Gross Inflows	Gross Inflows	Gross Inflows	Gross Inflows	Gross Inflows
<b>Lagged inflows</b>	0.1892 (0.000)***	0.1949 (0.000)***	0.1681 (0.000)***	0.1880 (0.000)***	0.1944 (0.000)***	0.1463 (0.002)***
<b>All QE Episodes</b>	0.0453 (0.011)**			0.0551 (0.003)***		
<b>QE1 episode</b>		0.0607 (0.013)**			0.0667 (0.007)***	
<b>QE2 episode</b>		0.0476 (0.079)*			0.0605 (0.032)**	
<b>QE3 episode</b>		0.0161 (0.616)			0.0223 (0.516)	
<b>QE-related expansion</b>			-0.0061 (0.812)			0.2455 (0.000)***
<i>Global Financial-side Conditions</i>						
<b>3-month T-bill rate</b>	-0.0028 (0.734)	-0.0066 (0.461)	-0.0039 (0.781)	0.0015 (0.926)	-0.0067 (0.704)	-0.0068 (0.694)
<b>Yield Curve</b>	0.0164 (0.159)	0.0224 (0.079)*	0.0003 (0.982)	0.0159 (0.355)	0.0261 (0.180)	0.0304 (0.103)
<b>VIX</b>	-0.0028 (0.003)***	-0.0030 (0.0002)***	-0.0036 (0.001)***	-0.0023 (0.039)**	-0.0027 (0.021)**	-0.0043 (0.001)***
<b>Money supply (M2)</b>				-0.0268 (0.710)	-0.0496 (0.511)	-0.7699 (0.000)***
<i>Global Real-side Conditions</i>						
<b>BRICS GDP Growth</b>	0.0039 (0.151)	0.0039 (0.162)	0.0056 (0.076)*	0.0325 (0.027)**	0.0295 (0.051)*	0.0169 (0.301)
<b>Advanced Economy GDP Growth</b>	0.0041 (0.436)	0.0044 (0.430)	-0.0011 (0.840)	-0.0210 (0.115)	-0.0189 (0.176)	-0.0105 (0.469)

	<i>Country-specific Controls</i>					
<b>Interest Rate Differential</b>	0.0085 (0.000)***	0.0084 (0.000)***	0.0068 (0.007)***	0.0088 (0.000)***	0.0086 (0.000)***	0.0063 (0.011)**
<b>Growth Differential</b>				-0.0282 (0.047)**	-0.0255 (0.081)*	-0.0117 (0.452)
<b>BRICS GDP</b>	-0.0074 (0.393)	-0.0092 (0.301)	0.0046 (0.644)	-0.0022 (0.819)	-0.0032 (0.738)	0.0130 (0.196)
<b>BRICS Country Institutional Rating</b>	0.0382 (0.000)***	0.0369 (0.000)***	0.0456 (0.000)***	0.0418 (0.000)***	0.0407 (0.000)***	0.0518 (0.000)***
<b>Constant</b>	21.703 (0.000)***	20.6372 (0.000)***	21.0278 (0.000)***	21.3209 (0.000)***	21.9139 (0.000)***	37.1943 (0.000)***

Note: All level variables are in logarithmic form, but rates and indicator variables are untransformed. P-values are reported in the parentheses. \*\*\*, \*\*, \* represent significance at 1%, 5% and 10%, respectively

#### 4.2.4.2 Accounting for Push and Pull Factors

The push versus pull factors debate is not new in the literature. This is discussed at length in Chapters 2 and 3. To provide more understanding into the factors driving capital flows to the BRICS countries, the model outlined in Section 4.2.2 controls for the impact of observable global financial and real conditions (push) as well as country-specific factors (pull) on capital flows. The findings reported in Table 4.6 reveal differences in the way these factors influence capital flows to the BRICS.

Lower interest rates in high-income countries have historically been associated with a rise in capital flows to emerging economies, suggesting a negative relationship. However, this was difficult to establish in this study. The results in Table 4.6 suggest that US interest rates were not particularly responsible for the behaviour of capital flows to the BRICS in the period under review. The coefficients on the US T-bill rate and yield curve are indistinguishable from zero. This result is different from the findings of recent empirical work. For example, Lim *et al.* (2014:15) show that there is a negative relationship between the US 3-month T-bill rate and financial flows to emerging. This supports the argument that reductions in interest rates due to QE raised the return on short-term treasury bills, leading investors to rebalance their portfolios away from developing country assets, resulting in a decline in EMEs' capital flows.

Consistent with theory, the coefficient on money supply (M2) is negative in all the specifications. However, it is difficult to determine the importance of global liquidity in driving capital flows to the BRICS economies, because the effect of this is indistinguishable from zero, except in specification VI. This may have something to do with the way that the money supply variable correlates with the different measures of QE, as this is the only variable that is altered across all three specifications.

Table 4.7 reveals that money supply (M2) correlates very strongly with the QE-related expansion measure compared to the other QE indicators. This is not surprising, as the Fed's QE operations affect the monetary base. In any case, comparable studies (e.g. Burns *et al.*, 2014:38) similarly fail to establish the importance of global liquidity also proxied by money supply M2, for capital flows to EMEs.

**Table 4.7: Pairwise Correlations**

	Money Supply (M2)
All QE Episodes	0.3250
QE1 Episode	0.1351
QE2 Episode	0.1585
QE3 Episode	0.2546
QE-related Expansion	0.9692

Consistent with a priori expectations, Table 4.6 indicates that investors' perception of risk is an important predictor of gross capital inflows to the BRICS countries. The VIX reports a negative and significant coefficient in all the regressions, implying that an increase in investors' perception of risk is accompanied by a reduction in gross inflows. Burns *et al.* (2014:38), Lim *et al.* (2014) and Park *et al.* (2014:5), among others, find similar results. An IMF study reveals that the way in which the VIX influences gross inflows is contingent on its level (IMF, 2014b:12). That is, when the VIX is very low, small changes do not affect the level of capital inflows to a group of EMEs. However, when it is very high, marginal changes in the VIX became important drivers of capital flows. Investigating whether this is true for the BRICS countries is beyond the scope of this thesis.

The coefficients on the variables representing global real-side conditions show conflicting results. For example, the coefficient on the BRICS GDP growth enters the model positive but is insignificant in all the regressions. This finding is contrary to what much of the literature on capital flows (e.g. Burns *et al.*, 2014:37; Lim *et al.*, 2014:14; Park *et al.*, 2014; Suttle, Huefner & Koepke 2013:6) has found – that EMEs' real GDP growth is an important predictor of capital inflows. The expectation is that higher growth rates generally improve the relative attractiveness of developing countries for international investors. However, the findings of Park *et al.* (2014:6) are similar to those found in this study – they also fail to prove that EMEs' growth rates have an effect on gross inflows.

Similarly, the outcomes presented in Table 4.6 fail to support the notion that high-income country growth rates impact positively on capital flows to EMEs. Stronger real-side activity in high-income countries is likely to increase investment opportunities overall and increase flows to EMEs, hence one would expect a positive coefficient. However, the influence of world growth on capital flows is somewhat ambiguous; while it has been found to positively affect capital flows in some studies, others have found a negative correlation (Burns *et al.*, 2014:36), as was discussed in Chapter 2.

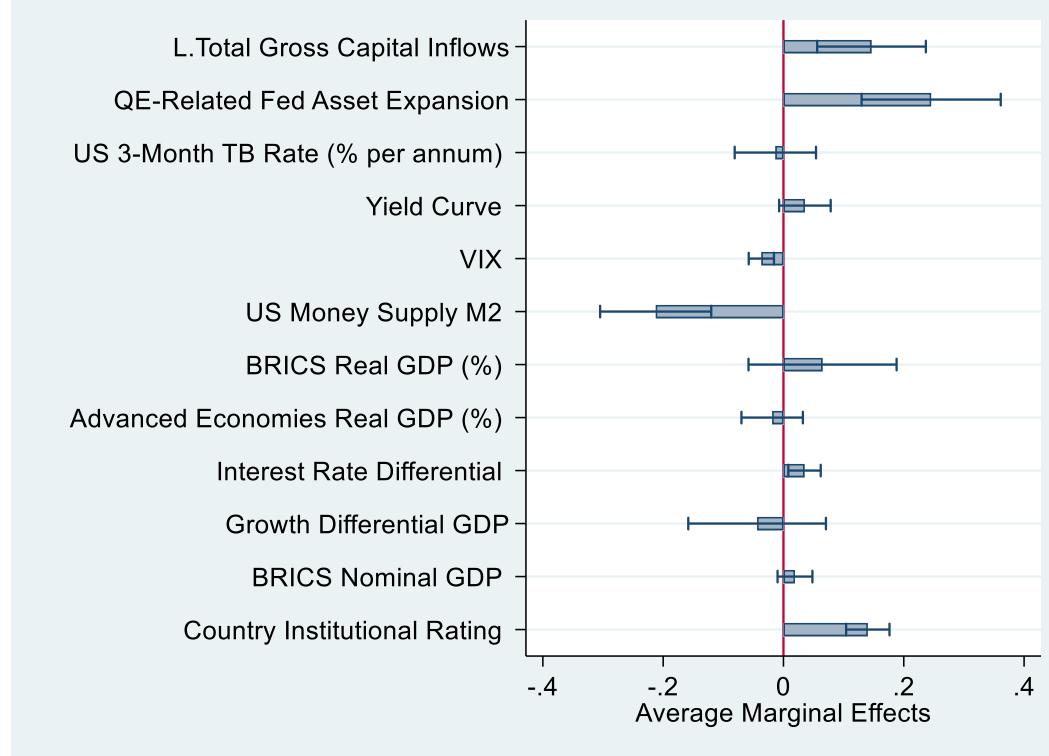
The results presented in Table 4.6 confirm that capital inflows to the BRICS are strongly affected by domestic factors. The interest rate differential enters the model with positive and significant coefficients. Higher interest rates in the BRICS economies relative to the US interest rates are accompanied by growth in capital inflows into the BRICS economies. These findings speak to the theoretical arguments presented in Chapter 2 and support the notion that investors went in search of higher yields in emerging market assets. However, Burns *et al.* (2014:39) and Lim *et al.* (2014:15) fail to prove that interest rate differentials impact EMEs' capital inflows.

The coefficient on the growth differential suggests effects that are contrary to literature and theory. For example, the findings of Suttle (2013:9) support what theory says about the effect of growth differentials on capital inflows, i.e. that a positive growth differential increases capital inflows to emerging economies. The coefficient on the growth differential is significant, but negative across all specifications, suggesting that an increase in the BRICS countries' growth rates relative to that of high-income countries results in a decline in capital flows to EMEs (Table 4.6). While this outcome is not in line with recent literature, it may suggest that other factors were more important in driving capital flows after the GFC. For example, it is possible that the reduction in investors' tolerance of risk countered the effect of the positive growth differential. The IMF (2014:4) shows, for example, that when VIX is high, signalling high risk aversion, its impact on capital flows is large, compared to when it is low, when country-specific factors become more important drivers.

The country investor ratings variable enters the model with positive and highly significant coefficients. This is in accordance with recent literature (e.g. Burns *et al.*, 2014:38; Lim *et al.*, 2014:15; Park *et al.*, 2014:5) that show evidence of a strong correlation between country ratings and capital flows.

Overall, the results presented above suggest that global and domestic economic and financial fundamentals are essential drivers of capital inflows to the BRICS economies. However, the results suggest that global factors tend to dominate domestic factors, with global conditions accounting for about three-fifths of the increase in capital inflows and domestic conditions for the remaining two-fifths. The various effects are summarised in Figure 4.1 below, which illustrates how capital inflows respond to a one standard deviation change in each of the push and pull factors.

**Figure 4.1: Impact of Push and Pull Factors on Gross Capital Inflows to the BRICS**



Source: Author's Own Construction

#### 4.2.4.3 Understanding the Effects of QE

The coefficients on the QE episode indicators are statistically significant as shown in Table 4.6. This suggests that QE induced additional gross capital inflows over and above the channels modelled in the baseline model. The coefficient on the QE indicator (all QE episodes) suggests that QE resulted in growth in capital inflows of approximately  $0.05 / (1 - 0.19) \approx 6$  percent, over and above the effect QE may have had on the traditional determinants of capital inflows.

When the QE variable is broken down into three separator indicator variables, the point estimates suggest a diminishing effect of QE from QE1 to QE3. The coefficient on the QE1 variable is than that on QE2, and is actually insignificant for QE3. This finding is comparable to the results of other empirical works (e.g. Fratzcher *et al.*, 2013:17; Burns *et al.*, 2014:38) and indeed supports the argument that the first round of QE was more effective than the later rounds of QE.

However, Lim *et al.* (2014:12) warn that care should be taken when interpreting these results. They argue that coefficients on the QE variables do not represent the full effects of QE and that the interpretation of the coefficients should be restricted to establishing whether or not QE had any additional unobservable effects on gross capital inflows. Therefore the estimated effect of the unobserved component should be treated as the minimum potential effect of QE. This implies that the minimum effect of QE on gross capital inflows to each country would probably be around 6 percent (see Table 4.6).

#### 4.2.4.4 Decomposition of Gross Capital Inflows

Gross capital inflows are by definition the sum of FDI, portfolio debt and equity, and bank flows. It can be expected that not all forms of capital flows will be affected in the same way by QE. Economic theory shows that portfolio and FDI flows respond to fundamentally different factors. Empirical literature reveals that while push factors may be more important for portfolio flows, FDI is more concerned with pull factors. This section breaks down the dependent variable – gross capital inflows – so as to better understand whether the spillover effects of QE are different for different components of capital inflows.

Table 4.8 reports the estimates based on the extended model for each component of  $gci_{it}$ . The results suggest differences in the behaviour of each component of capital inflows. To start with, the results reveal that there is a positive relationship between FDI inflows and their past values, suggesting a high degree of persistence. This speaks to the empirical literature, which suggests that gross FDI flows are less volatile and destabilising than portfolio and bank loans. The reason, as explained in Becker and Noone (2008:160), is that FDI inflows require a longer-term commitment and are therefore seen to be more stable and unlikely to reverse. This is in contrast to portfolio or bank flows, which are usually seen as conduits of speculation by investors seeking short-term gains.

**Table 4.8: Decomposition of Gross Capital Inflows (2001Q1-2015Q4)**

Dependent Variable:	FDI Inflows	Portfolio Inflows	Portfolio Equity Inflows	Portfolio Debt Inflows	Bank Loan Inflows
<b>Lagged inflows</b>	0.5175 (0.000)***	-0.0243 (0.618)	-0.0297 (0.542)	-0.0693 (0.127)	0.1531 (0.016)**
<b>All QE Episodes</b>	0.0172 (0.752)	0.3981 (0.008)***	0.5563 (0.000)***	-0.2219 (0.194)	-0.0544 (0.684)
<i>Global Financial Conditions</i>					
<b>3-month T-bill rate</b>	-0.0284 (0.542)	-0.1799 (0.166)	-0.0560 (0.674)	-0.3246 (0.028)**	-0.0525 (0.635)
<b>Yield Curve</b>	0.0492 (0.330)	0.2069 (0.142)	0.1241 (0.392)	0.1626 (0.311)	0.0745 (0.513)
<b>VIX</b>	-0.0029 (0.360)	-0.0469 (0.000)***	-0.0542 (0.000)***	-0.0250 (0.013)**	-0.0133 (0.071)*
<b>Money supply (M2)</b>	0.0257 (0.907)	-1.1420 (0.054)*	-0.6411 (0.292)	-2.7597 (0.000)***	0.4255 (0.495)
<i>Global Real-side Conditions</i>					
<b>BRICS GDP Growth</b>	-0.0657 (0.131)	0.0095 (0.938)	0.0480 (0.703)	-0.1871 (0.171)	0.0081 (0.936)
<b>Advanced Economy GDP Growth</b>	0.0645 (0.101)	-0.0442 (0.695)	-0.0822 (0.481)	0.1266 (0.307)	0.0165 (0.855)
<i>Country-specific Factors</i>					
<b>Interest Rate Differential</b>	0.0055 (0.427)	0.0068 (0.699)	0.0307 (0.091)*	-0.0183 (0.365)	0.0460 (0.011)**
<b>Growth Differential</b>	0.0703 (0.092)	0.0060 (0.959)	-0.0379 (0.757)	0.1525 (0.247)	-0.0030 (0.975)
<b>BRICS GDP</b>	-0.0235 (0.419)	-0.0528 (0.496)	-0.1494 (0.060)*	0.2312 (0.009)***	0.0531 (0.454)
<b>BRICS Country Institutional Rating</b>	0.1041 (0.000)***	0.0338 (0.436)	0.0467 (0.297)	0.2363 (0.000)***	0.1292 (0.004)***
<b>Constant</b>	12.2021 (0.050)**	60.6094 (0.001)***	51.7921 (0.004)***	104.8301 (0.000)***	6.8111 (0.699)

Note: All level variables are in logarithmic form, but rates and indicator variables are untransformed. P-values are reported in the parentheses. \*\*\*, \*\*, \* represent significance at 1%, 5% and 10%, respectively

Looking specifically at FDI flows, apart from lagged inflows, only the country rating is statistically significant. This emphasises the significance of the regulatory environment for FDI flows (Lim *et al.*, 2014:24). FDI inflows are mostly unresponsive to the global drivers of capital flows. Portfolio inflows, on the other hand, tend to be more responsive to push factors than to pull factors. Lim *et al.* (2014:24) note that this is because portfolio flows react mainly to economic conditions in high-income countries. However, when broken down into equity and debt flows, the results suggest a fair balance between their responsiveness to both push and pull factors. The results in Table 4.8 reveal fairly strong sensitivity of bank flows to the interest rate differential and country ratings.

Comparing the responsiveness of the various components of gross capital inflows to QE, the results suggest that portfolio flows, and in particular equity flows, are the most sensitive to the unobservable effects of QE. While Lim *et al.* (2014:24) also show that portfolio flows are the most sensitive to QE, they note that it is bond flows that are most responsive. Portfolio flows are more sensitive to QE than overall capital flows; the coefficient on the QE indicator for portfolio flows is 0.3981 compared to 0.0551 for overall capital flows. This is not surprising, given the understanding that portfolio flows are more responsive to conventional monetary policy and are easier to reallocate than the other components of capital flows (Lim *et al.* (2014:26). The other flows indicate no significant relationship with the QE indicator, suggesting that they are not responsive to the unobservable effects of QE.

#### **4.2.5 Robustness of the Baseline Regression**

This segment of the study examines the sensitivity of the baseline model through the introduction of additional controls to the baseline model. First, two dummies – crisis and post-crisis – are introduced into the model. Recent literature on the spillover effects of QE (e.g. Park *et al.*, 2014:4) on capital flows to developing countries include a crisis variable so as to capture the effects of the sharp drop in capital flows during the GFC. In the same vein, a post-crisis indicator to account for the influence of the recovery and stagnation of capital flows after the GFC. These dummies take the value of one for quarters ranging from 2008Q3 to 2009Q2, and 2009Q3 to 2013Q2, respectively. Studies have found the crisis dummy to be statistically significant.

The second and final set of tests attempts to estimate the influence of QE tapering on gross capital inflows to the BRICS economies. This is done by introducing two indicators to the baseline model, one accounting for the effects of tapering expectations and the other for the actual tapering. Anticipation of the tapering of QE began in the third quarter of 2013, while the actual tapering began on 18 December 2013 and ended on 29 October 2014. Tapering expectations are captured through an indicator that takes the value of one in 2013Q2 and zero in other periods. Similarly, the variable representing actual QE tapering takes the value of one in 2014Q1, 2014Q2 and 2014Q3.

Table 4.9 shows the results of these tests. Interestingly, while the crisis indicator reports a negative value, implying that capital inflows fell during the GFC, this is not significant (R1). The post-crisis

dummy on the other hand reports a positive and significant coefficient (R2). This outcome speaks to the literature that reveals that capital inflows normalised after the GFC.

**Table 4.9: Robustness Regressions for Gross Capital Inflows (2001Q1-2015Q4)**

	R1	R2	R3	R4
Dependent variable:	Gross Inflows	Gross Inflows	Gross Inflows	Gross Inflows
<b>Lagged inflows</b>	0.1876 (0.000)***	0.1757 (0.000)***	0.2032 (0.000)***	0.1802 (0.000)***
<b>All QE Episodes</b>	0.0551 (0.003)***	0.0101 (0.681)	0.0635 (0.001)***	0.0600 (0.002)***
<b>QE tapering expectations</b>			-0.1179 (0.015)**	
<b>Actual QE Tapering</b>				0.0425 (0.184)
<i>Global Financial-side Conditions</i>				
<b>3-month T-bill rate</b>	0.0024 (0.886)	0.0300 (0.110)	-0.0081 (0.621)	-0.0037 (0.819)
<b>Yield Curve</b>	0.0151 (0.401)	-0.0136 (0.497)	0.0266 (0.132)	0.0225 (0.209)
<b>VIX</b>	-0.0022 (0.086)*	-0.0021 (0.062)*	-0.0028 (0.013)**	-0.0022 (0.044)**
<b>Money supply (M2)</b>	-0.0235 (0.756)	0.0678 (0.392)	-0.0527 (0.469)	-0.0588 (0.440)
<i>Global Real-side Conditions</i>				
<b>BRICS GDP Growth</b>	0.0333 (0.032)**	0.0348 (0.017)**	0.0258 (0.083)*	0.0306 (0.039)**
<b>Advanced Economy GDP Growth</b>	-0.0222 (0.147)	-0.0277 (0.039)**	-0.0162 (0.227)	-0.0189 (0.159)
<i>Country-specific Controls</i>				
<b>Interest Rate Differential</b>	0.0088 (0.000)***	0.0091 (0.000)***	0.0084 (0.000)***	0.0088 (0.000)***
<b>Growth Differential</b>	-0.0289 (0.053)*	-0.0317 (0.025)**	-0.0220 (0.126)	-0.0262 (0.066)*
<b>BRICS GDP</b>	-0.0020 (0.838)	-0.0083 (0.386)	-0.0029 (0.757)	0.0016 (0.867)
<b>BRICS Country Institutional Rating</b>	0.0419 (0.000)***	0.0712 (0.000)***	0.0398 (0.000)***	0.0426 (0.000)***
<i>Additional Controls</i>				
<b>Crisis period</b>	-0.0068 (0.873)			
<b>Post-crisis period</b>		0.0712 (0.005)***		
<b>Constant</b>	21.2173 (0.000)***	18.8892 (0.000)***	21.7924 (0.000)***	22.4647 (0.000)***

Note: All level variables are in logarithmic form, but rates and indicator variables are untransformed. P-values are reported in the parentheses. \*\*\*, \*\*, \* represent significance at 1%, 5% and 10%, respectively

QE tapering expectations are associated with a noteworthy decline in gross capital inflows as shown by the negative significant coefficient on the QE tapering indicator (R3). The coefficient on this variable is more than twice the average effects of QE over all previous episodes. The period of actual QE tapering recorded an increase in gross capital inflows (R4). However, this increase is not as much as the increase witnessed in previous QE episodes. This is contrary to the views expressed in much of the literature which suggest that a reversal of QE would have led to weaker capital inflows to developing countries (e.g. Burns *et al.*, 2014:2).

### 4.3 Conclusion

The Hausman specification test confirms that the FE model is the preferred choice. Unit root tests reveal that the BRICS-related variables, with the exception of the interest rate differential, are stationary. The interest rate differential once transformed to first difference becomes stationary. A number of the US-related variables are stationary only in first difference. Model adequacy tests, in particular the tests for serial correlation, reveal that autocorrelation is not a problem in the data. However, the tests for heteroscedasticity show that the residuals are heteroscedastic, implying that the variance of the residuals is not the same across individual countries in the panel. Heteroscedasticity is corrected by deriving robust standard errors.

The regression output reveals that QE had a positive effect on gross capital inflows to the BRICS economies, over and above the effect that is modelled through the traditional drivers of capital inflows. The results further reveal a diminishing impact of the QE episodes on capital flows, with QE1 having the largest impact and the effect of QE3 being indistinguishable from zero. Further, gross capital inflows responded positively to a number of pull factors, for example, the interest rates differential and the individual country ratings. The response of gross capital inflows to push factors is less obvious. While capital inflows respond positively to the perceived global risk, their response to US interest rates is contrary to a priori expectations. When decomposed into their distinct components, the results show that portfolio flows, and in particular equity, are the most sensitive to the unobservable effects of QE.

Finally the baseline model is robust to different specifications. The addition of extra variables does not change the main message – QE worked through unobservable channels to increase gross capital inflows to the BRICS economies. Interestingly, the robustness checks also reveal a substantial decline in gross inflows to the BRICS during the anticipations of the tapering of QE.

## **Chapter 5**

### **General Conclusion**

#### **5.1 Introduction**

This study investigated the impact of QE on gross private capital inflows to the BRICS economies. In keeping with this objective, the study employed a dynamic panel data model with FE. Chapter 1 set out the background and explained the significance of the study. Chapter 2 reviewed both the theoretical and empirical literature on QE. Chapter 3 provided a discussion of the methods commonly used to assess the spillover effects of QE on capital flows, the methodological debates in the capital flows literature and the variables used in the study. Chapter 4 outlined the baseline model for estimating the impact of QE on capital inflows and presented the main econometric results.

Chapter 1 summarised how what seemed to be a manageable crisis in the US real estate market spread to other countries, throwing the global economy into recession. Chapter 2 demonstrated that central banks, especially those in high-income countries, responded by cutting policy rates even to levels constrained by the ZLB. However, the global recession created an environment in which successive policy rate cuts were ineffective in stimulating economic activity. Realising this, policy makers in high-income countries turned to unconventional monetary policies which came to be called ‘QE. Central banks in developed countries conducted LSAPs with the aim of lowering long-term interest rates.

The US Federal Reserve Bank emerged as the most active in these asset purchases. Consequently, the Fed engaged in three rounds of QE between 2008 and 2013. While these rounds of QE may have been effective in encouraging growth in the USA and other countries, the review of empirical literature reveals that QE may have increased capital inflows to EMEs. Several studies have found evidence in support of this. The empirical literature shows significant volatility in capital inflows to EMEs, especially in the years following the GFC. Empirical analyses reveal that QE increased capital inflows to EMEs, suggesting that QE had an impact on

capital inflows in addition to the effect occurring through traditional observable push and pull factors.

Chapter 3 shows that the studies investigating the spillover effects of QE on capital inflows can be grouped into three categories – those that use event study methods, panel data models or VAR models. Event studies have been criticised for failing to account for actual QE operations, with most studies stating that QE announcements alone are not sufficient to explain the spillover effects of QE. VAR models have been criticised for the difficulties associated with choosing the appropriate lag length and for using very little economic theory when choosing the appropriate specification. Dynamic panel data models have therefore emerged as the popular method for estimating the spillover effects of QE and have consequently been adopted in this thesis.

## 5.2 Main Findings

The first part of Chapter 4 outlined the dynamic panel model employed in this study. It described the bias arising from the correlation between the lagged dependent variable and the individual FE. This renders standard panel data methods useless. Several IV and GMM estimators have been devised to correct for this bias. This study used the dynamic panel data estimation technique that fits dynamic panel models using the AB and BB GMM estimators. The results of this estimator were presented in the latter part of Chapter 4.

The Hausman Specification test confirms what most of the recent literature on QE suggests, namely that the fixed effects model is the preferred choice. Unit root test reveal that all the BRICS-related variables, except for the interest differential, are stationary in levels. Most of the US-related variables are  $I(1)$ . The use of differenced variables does not generate any different results; therefore the study maintains the variables in levels. Model adequacy tests reveal the presence of heteroscedasticity but no serial correlation. While the literature suggests the use of robust standard errors to take care of heteroscedasticity, the regression results did not generate robust standard errors due to the sample size.

### **5.2.1 Push Factors Dominate Pull Factors**

The findings on the relative importance of push and pull factors are consistent with recent literature. The results suggest that global factors were more important in influencing the pattern of capital flows to the BRICS economies – global factors accounted for approximately three-fifths of the increase in capital inflows while domestic factors accounted for the remaining two-fifths. Capital inflows to the BRICS economies correlated in particular with the VIX, the interest rate differential and the sovereign credit ratings.

### **5.2.2 Quantitative Easing Increased Capital Inflows to the BRICS**

QE had a positive and significant effect on gross capital inflows to the BRICS economies. This implies that QE worked through unobservable channels to increase capital inflows to the BRICS economies. The estimates of the baseline model further reveal that QE had a diminishing effect on capital flows – QE1 having the largest impact on gross capital inflows. The impact of QE2 was smaller, while that of QE3 was negative.

### **5.2.3 The Impact of QE was Greater on Portfolio Flows**

When decomposed into different components, the results reveal differences in the impact of QE for different types of capital flows. The results suggest that portfolio flows, and in particular equity flows, are the most sensitive to the effects of QE. Other studies find bond flows to be more responsive to the effects of QE. The sensitivity of portfolio flows to QE is greater than that of overall capital flows.

### **5.2.4 Robustness Checks**

Finally, the results are also robust to various specifications. The inclusion of additional variables does not change the main result – QE worked through unobservable channels to increase gross capital inflows to the BRICS economies. Interestingly, the robustness checks reveal that the

anticipations of QE tapering were associated with a substantial decline in gross inflows to the BRICS economies.

### **5.3 Limitations of the Study**

The size of the panel used in this study posed a major challenge, as it was difficult to apply alternative estimation techniques that require a larger cross-section dimension relative to the time dimension. This also made it difficult to control for heteroscedasticity by deriving robust standard errors. Another limitation the study faced was the difficulty in assigning a direct effect of QE to the increase in capital inflows to the BRICS economies. As argued by studies such as Burns *et al.* (2014) and Lim *et al.* (2014), doing so would require first measuring the impact of QE on the traditional drives of capital inflows.

### **5.4 Areas for Further Research**

The argument that monetary policies of developed countries have large spillover effects on emerging countries is not new. Sudden surges in capital inflows, often reflecting changes in advanced economy monetary policies have been linked to financial instability in a number of EMEs. For example, a sudden reversal of capital inflows has been shown to result in significant exchange rate depreciation in a number of EMEs, creating a number of macroeconomic challenges in these countries. This study adds to the body of literature investigating the spillover effects of QE to EMEs. Therefore, the findings of this study offer more insight into how capital inflows to the BRICS were influenced by QE.

Past experience has shown that central banks in developed countries do not consider the possible impact of their monetary policies on developing and emerging countries such as the BRICS. This study focused on the specific set of developed country monetary policies referred to as 'QE' – policies that were deemed appropriate for the very unique circumstances that prevailed after the GFC. It is difficult to say if these circumstances will ever occur again or if they do, if it will be in a similar manner. Therefore it is possible that QE might not be implemented again for a long time. It will therefore be presumptuous to draw policy implications for emerging economies from the findings of this study.

The closest that the empirical results of this study can come to allowing any policy implications to be drawn from them, is that this study confirmed the finding of many other studies that monetary policies of developed countries have some impact on capital flows to developing countries. This may suggest that developing countries should factor in developed country monetary policies in their policy-making processes. Moreover, as with other similar studies, this study does not necessarily capture the full effects of QE; doing so would require estimating the impact of QE on the drivers of capital flows. For example, this would entail estimating the impact of QE on short-term nominal interest rates. Therefore further research to investigate for example how QE influenced other drivers of capital inflows is necessary to get a more comprehensive understanding of the impact of QE on capital inflows.

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# **Appendix**

## **A1: Event Study**

Event studies are popular in finance research, where they have been used to examine the behaviour of equity and bond prices around corporate events for instance mergers, stock splits and earnings announcements (Mackinlay, 1997:13). However, their use is also abundant in other fields of research, for example, in economics, where they have been used to examine the influence of changes in the regulatory environment on the behaviour of asset prices. Overall event studies aim to ascertain any abnormal (or beyond expected) behaviour of asset prices following an occurrence.

Event study methods are premised on the assumption that markets are efficient. Simons and Laryea (2005:7) define market efficiency as the ability of the market to fully absorb new information and instantaneously reflect this in prices. Given an efficient market, Mackinlay (1997:13) argues that prices will instantly reflect the impact of an event. Therefore, any abnormal performance in the value of an asset can be attributed to the event (Kothari & Warner, 2006:5). In other words, the magnitude of any unusual performance in prices is the measure of an event's influence on the value of an asset.

Event studies date back as far as the pioneering work of James Dolley (1933), who used them to examine changes in prices of assets at the time of stock splits. Nageswara Rao and Sreejith (2014:41) observe that event studies have evolved in sophistication with several modifications to accommodate new developments in research. Mackinlay (1997:13) notes that perhaps the version of the event study methodology closest to the one used today is the one introduced by Eugene Fama (1969), who analyses the effects of stock splits, controlling for other confounding factors. Following this work, Kothari and Warner (2006:8) observe that the general statistical format of event studies has remained the same over time.

The steps taken when implementing an event study are outlined in Mackinlay (1997:14). The initial step requires the researcher to identify the event of interest and to specify the event date defined as the exact date of the event (Nageswara Rao & Sreejith, 2014:42). Next the researcher has to identify the event window and estimation period. An event window is the period in which the impact of an

event is examined; it includes some days before and after the event as well as the event date itself. According to Mackinlay (1997:15), defining the event window in this way allows researchers to also study the periods around the event.

The estimation period, on the other hand, includes the periods preceding the event window. The event window is generally excluded from the estimation window to avoid any influence of the event on expected normal returns. The purpose of defining an estimation period is to calculate the normal (or expected) return on the variable being examined. The expected return represents what would normally occur in the absence of the event. It is this value that is compared with the actual return recorded in the event window in order to measure the unusual performance.

The abnormal yield is then derived by subtracting the actual from the expected return, over the event window. Once the returns are calculated, the econometric design for testing the significance of the abnormal returns is then selected. A number of researchers conducting event studies make use of parametric t-statistics to establish whether the abnormal return is indistinguishable from zero. The empirical results provide insights as to whether the event being studied had any impact on the behaviour of assets.

Proponents of event studies base their arguments on ability to isolate the impact of the events considered even for shorter windows (Moore *et al.*, 2013:6). While event studies have been found to be very useful in explaining the impact of events, they have some major limitations worth noting.

First, the assumption that markets are efficient may not hold in some instances.<sup>12</sup> When market efficiency is not observed, prices may not fully and instantaneously reflect all information, including the event. Moreover, market participants may anticipate the incidence of an event while other confounding events could also impact on the variable being investigated (Nageswara Rao & Sreejith, 2014:42). For example, because most of the QE announcements were made weeks and sometimes months prior to the actual operations, Fratzscher *et al.* (2013:12) argue that it is likely that asset markets may have to a certain degree adjusted, prior to the actual event. Therefore, it is likely that any abnormal behaviour in the asset markets may not necessarily be the result of market reaction to the specific event being investigated.

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<sup>12</sup> This is not necessarily a shortcoming of the event study methodology, but of the efficient market hypothesis.

Second, failure to correctly identify event and estimation windows may reduce the statistical power of event studies. Event dates are not easy to identify, especially when the information is being retrieved from metadata. Mackinlay (1997:37) notes that instances when it is difficult to identify the event date or where it is partially anticipated may result in biased estimates. Nageswara Rao and Sreejith (2014:42) argue that narrow event windows are more efficient than larger windows.

Like event windows, estimation windows are also difficult to determine and even when correctly identified may be subject to confounding effects, especially when the period is too long. Moore *et al.* (2013:6) point to the difficulty faced in selecting event windows that are wide enough to include the complete market reaction, but narrow enough to exclude the influence of other factors.

Commenting on the use of event methods, Ahmed and Zlate (2013:9) argue that focusing only on periods of sudden stops and surges makes it difficult to identify how much of the abnormal behaviour of capital flows is due to oversized movements in the factors that influence these flows when markets normalise. Moreover, they argue that examining capital flows during periods of abnormal behaviour may make it hard to understand how the drivers of capital flows may have evolved.

Because of the difficulties associated with event studies, some have opted for other methods to estimate the spillover effects of QE on EMEs' assets, most notably dynamic panel data models. Moreover, most of these studies have focused on the effect of actual operations of the Fed and not on the announcements.

## A2: Vector Autoregressive Models

VAR models have been identified as an easy tool for studying the transmission of shocks across countries. VAR models were developed by Sims (1980) as an alternative to multivariate simultaneous equations models that distinguish between endogenous and exogenous variables (Abrigo & Love, 2016:1). According to Lutkepohl (2005:66), Sims's main critique of simultaneous equations was centred on the exogeneity assumptions of the variables in the model, which he argued were ad hoc and often not supported by fully developed theories. Sims argued that if indeed real simultaneity exists among variables, there should be no difference between endogenous and exogenous variables (Gujarati, 2004:848).

Canova and Ciccarelli (2013:6) argued that Sims overcame the weakness of simultaneous equations models by creating a model in which all the variables are *a priori* endogenous. Although VAR models have traditionally been applied to pure time series data, they are increasingly being applied to panel data. While panel VARs are built on the basis of similar principles as standard VARs, Canova and Ciccarelli (2013:2) argue that they are a much more powerful tool for analysing the transmission of shocks across countries. Despite this, studies investigating the impact of QE tapering on capital flows have limited their analyses to standard VARs.

VARs are typically used for forecasting, structural inference and policy analysis. Forecasts obtained using VAR models are argued to be better than those derived from more complex simultaneous equations models (Gujarati, 2004:53). Moreover, they are easy to estimate given that OLS can be applied to each equation separately. VAR models make it possible to identify structural shocks in data using variance decompositions, notably the Cholesky decomposition (Kilian, 2011:5). By doing this, VARs make it possible to study causal impacts of unexpected shocks in one variable on other variables (Lutkepohl, 2001:16). The impacts of such variables are usually examined throughout the system using what are known as impulse response functions (Lutkepohl, 2001:16). This aspect of VARs makes them suitable for modelling QE tapering on capital flows to EMEs.

Despite having several advantages over their counterpart simultaneous equations, VARs are also fraught with significant drawbacks. VARs have been criticised for the difficulties faced in choosing the appropriate lag length in the specification of the model. Despite the existence of several approaches to identify lag lengths, they often derive different results. This is evident in Burns *et al.* (2014:42), where the Hannan and Quinn information and Schwartz Bayesian information criteria suggested one lag, while the Final Prediction Error and the Akaike Information Criterion recommended two and four, respectively.

A final point of contention is related to whether the variables in a VAR should be stationary. Opponents of VARs argue that all variables should be stationary if any meaningful hypothesis tests and tests of significance are to be conducted (Brooks, 2008:292). However, proponents of VARs argue that applying transformation techniques such as differencing, could result in the loss of valuable information (Gujarati, 2002:853). Brooks (2008:293) argues that doing so would go against the sole purpose of VAR estimation, which is to examine the relationships between variables. It is for

this reason that VARs are argued to perform better when the aim is to describe the data rather than when it is used for policy analysis.

**Table A1: Variable List for Panel Data Model of Capital Flows**

Variable	Source
Gross Private Capital Inflows	IMF Balance of Payments Statistics
Gross Portfolio Capital Inflows	IMF Balance of Payments Statistics
Gross Foreign Direct Investment Inflows	IMF Balance of Payments Statistics
Gross Bank Inflows	Bank for International Settlements Locational Banking Statistics
US Federal Funds Rate	US Federal Reserve
US 3-month T-bill Rate	US Federal Reserve
US 10-year Government Bond Yield	US Federal Reserve
US Money Supply (M2)	US Federal Reserve
Nominal GDP	IMF IFS World Development Indicators
Real GDP Growth	IMF IFS World Development Indicators
Central Bank Balance Sheet Expansion (QE)	US Federal Reserve Bank and IMF IFS
Country Credit Ratings	Institutional Investor Ratings
BRICS Monetary Policy Rates	IMF IFS and National Central Banks
Chicago Board of Options Exchange Volatility Index (VIX)	Chicago Board of Options Exchange

**Table A2: Linear Transformation of S&P's Sovereign Credit Ratings**

Long-term Ratings		Short-term Ratings	
Rating	Conversion	Rating	Conversion
<i>Investment Grades</i>			
AAA	20	A-1+	6
AA+	19	A-1	5
AA	18	A-2	4
AA-	17	A-3	3
A+	16		
A	15		
A-	14		
BBB+	13		
BBB	12		
BBB-	11		
<i>Speculative Grades</i>			
BB+	10	B	2
BB	9	C	1
BB-	8	D/SD	0
B+	7		
B	6		
B-	5		
CCC+	4		
CCC	3		
CCC-	2		
CC	1		
D/SD	0		
<i>Outlook for Long-term Ratings</i>			
Outlook		Conversion	
Credit Watch-Positive		0.5	
Positive		0.25	
Stable		0	
Negative		-0.25	
Credit Watch-Negative		-0.5	

Source: Bhatia (2002)

Note: -- Not applicable

**Table A3: Regressions for Gross Capital Inflows (2001Q1-2015Q4)**

Variable Name	Coefficient
Lagged inflows	0.2108 (0.000)***
All QE Episodes	0.0441 (0.016)
3-month T-bill rate	-0.0378 (0.208)
Yield Curve	0.0335 (0.130)
VIX	-0.0032 (0.014)**
Money supply (M2)	-0.0239 (0.571)
BRICS GDP Growth	0.0279 (0.043)**
Advanced Economy GDP Growth	-0.0241(0.090)*
Interest Rate Differential	0.0009 (0.870)
Growth Differential	-0.0248(0.058)*
BRICS GDP	0.0032 (0.732)
BRICS Country Institutional Rating	0.0300 (0.000)***
Constant	20.7056 (0.000)***

Note 1: 3-month T-bill rate, yield curve and interest rate differential are differenced once. Note: All level variables are in logarithmic form, but rates and indicator variables are untransformed. P-values are reported in the parentheses. \*\*\*, \*\*, \* represent significance at 1%, 5% and 10%, respectively