**DOCTOR OF ECONOMICS AND BUSINESS MANAGEMENT**

# Government Finances and financial shocks in developing economies

Megersa, Kelbesa

*Award date:*
2017

*Awarding institution:*
University of Namur

University of Antwerp
Faculty of Applied Economics

University of Namur
Faculty of Economics, Social Sciences
and Business Administration

# Government Finances and Financial Shocks in Developing Economies

Kelbesa MEGERSA

Thesis Submitted in Fulfillment of the Requirements for the Joint Degree of

Doctor in Applied Economics

University of Antwerp

&

Doctor in Economics and Management

University of Namur

June 2017

Supervisors:
Prof. dr. Danny Cassimon (University of Antwerp)
Prof. dr. Romain Houssa (University of Namur)

Jury:
Dr. Janvier Nkurunziza (UNCTAD)
Prof. dr. Paul Reding (University of Namur)
Prof. dr. Jean-Marie Baland (University of Namur)
Prof. dr. Jan Annaert (University of Antwerp)
Prof. dr. Guido Erreygers (University of Antwerp)

Kelbesa Megersa

Doctoral Essay

ISBN: 978-90-8994-164-0

To my father, Abdisa.

# Contents

# Acknowledgements

Before I first came here, a little over eight years ago, I didn't know much about Belgium. I was a young fellow (24 or so years old) who was actively looking for further education. In a way, the journey that brought me here was random. I was applying to different universities that offered courses in economics and development. I just happened to be first selected for the master's program in Globalization and Development at the Institute of Development policy and Management (IOB), University of Antwerp. I greatly thank the institute and its staff for giving me that opportunity and VLIR-UOS for funding my study. As I hoped, the program gave me the possibility to advance my understanding of the economic and institutional challenges of developing countries. Even more so, I got the chance to meet people from all over the world, most of whom remain my cherished friends to this day.

Yet, little did I know that my life would change forever in Antwerp, perhaps in ways I never imagined. I met my then classmate, my best friend, and future wife: Klara! However, the three years following our masters (2010-12) were not the easiest. As one of us worked-studied-travelled somewhere (Belgium, Ethiopia, China, Rwanda, Congo, …) in the absence of the other, it seemed 'impossible' to be together. To add to the anxiety, my efforts to find PhD funding in Antwerp didn't immediately bear fruit. That was when (end of 2012) I, nonetheless, decided to come back to the city and join Klara - she was by then also doing her PhD. Indeed, Klara became the reason why I kept coming back to Belgium. We got back together and went on to have an adorable little boy: Abel! … I owe my happiness and dreams to the two of you!

The commencement of my PhD in Antwerp would certainly be credited to my supervisor, Danny Cassimon. I am immensely thankful to him for believing in me and for introducing me to the world of research and development finance. He was always there to guide me with a range of ideas and literature. His support has always followed me from the beginning of my master's at IOB and pre-doctoral study at TEW - till the end; but even more so, when I was primarily based at IOB, over the 2013-15 period. My academic journey took another positive turn when I joined the Belgian policy research group on Financing for Development (BeFinD) as a researcher, around end of 2015.

The work for BeFinD took me to the Centre of Research in the Economics of Development (CRED), University of Namur. During this time, I have been working closely with the academic coordinator, Romain Houssa, and also other researchers at CRED. Given this, it became convenient for me to pursue a joint PhD, between University of Namur and University of Antwerp. Romain became the supervisor of my PhD on the side of Namur. Ever since, he has enormously enriched my work. The writing of my last chapter has especially benefitted from his clear guidance and suggestions. I am deeply grateful to Romain for his devotion, diligence and for the many opportunities he provided me with. I am particularly indebted to BeFinD and

University of Namur for helping me fund my PhD and for giving me the chance to work in an excellent research environment.

I am also extremely thankful to all members of my doctoral commission and jury. I thank Paul Reding, Jan Annaert, Janvier Nkurunziza, Jean-Marie Baland and Guido Erreygers for taking the time to carefully read and comment on my draft essay. I believe that your constructive comments have improved the quality of my PhD. Any remaining errors are mine.

I am grateful to Esmeralda Aerts, Pierrette Noel, Katleen Van pellicom and Sandra Verheij for following up and guiding me through the various administrative hurdles of the PhD. I give a special thanks to Stefaan Marysse, for helping me with all my endeavors during my masters - and especially for facilitating my early PhD years. I would like to thank my wonderful IOB colleagues (professors, researchers, admin staff) for their kindness and support over the years. Thank you An, Bert, Catherine, Christian, Ciska, Dennis, Dimitri, Els, Filip, Gabi, German, Gert, Greet, Hans, Joachim, Joëlle, Johan, Karel, Katleen, Kristof, Line, Lisa, Loresel, Marie, Marijke, Marjan, Marleen, Mathias, Miet, Mollie, Monica, Nadia, Nathalie, Nicole, Robrecht, Sahawal, Sara D., Sara G., Sarah, Stef, Styllianos, Tobias, Tom, Vicky, and Wannes. I would also like to especially thank those with whom I shared the IOB attic: Allelie, Filip, Francine, Francis, Frederic, Janus, Janvier, Jolino, Katrien, Paterne, Patricia, Pierre, Stani, Tri, and Trine.

I sincerely thank my superb UNamur colleagues with whom I shared the 6$^{th}$ floor: thank you Albena (great officemate), François, Giulia, Hélène, Jérémie, Jolan, Ludovic, Marie-Sophie, Modeste, Nicolas, Olivier, Renate, Rinchan, and Wouter. I also thank my senior UNamur colleagues, Benoît, Catherine, Guilhem, Jean-Marie, Jean-Philippe, Stéphanie, Vincenzo, and Yuliya. I must also thank Pierre-Alexandre for taking care of my computer issues.

Next, I thank my magnificent friends Benyam and Daniel for their enduring support and encouragement, for all these years! I thank my friends from Bahir Dar and my (all-time favorite) Jimma buddies, with whom I shared some of the best years of my life. I thank my small Ethiopian network in Antwerp - for giving me a taste of home over here! Thank you John, Tati, Hilina, Blen, Kaleb, Semere, Eden, Dalina, Bruk, Yohannes, Miki, and Seble. I'm also grateful to my IOB ex-classmates for our exciting get-togethers. Thank you Koen, Annelies, Imke, Fiona, Jean, Kaat, Emilia, Hans, Hans W., Christina, and Vadim. I also thank Klara's long-time friends (who have become my friends) for helping us in our busy times - especially with Abel.

At Last, I deeply thank my Belgian family for their kindness, endless support, and for giving me a second home! Thank you Luc, Els, Lukas, Anne, Jeroen, Simon, Inge, Basiel, Flore, plus all the Denissen and Claessens family. I'm out of words to thank my family in Ethiopia. Thank you for raising me, getting me to where I am, and for always loving me! Thank you Abaye, Woin, Haile, Meti, Yordi, and Letera!

# Samenvatting

Het essay bevat drie analytische hoofdstukken (dat wil zeggen hoofdstukken 2, 3 en 4) die de problemen van de schuldhoudbaarheid, de financiële crisis en de rol van externe monetaire schokken op de stabiliteit van ontwikkelingslanden bespreken. Hier vat ik de sleuteloefeningen, bevindingen en bijdragen van deze drie hoofdstukken samen.

**Hoofdstuk 2** heeft zich gebaseerd op het argument dat 'onhoudbare' schuldenlast een negatieve rol speelt op de groeivooruitzichten van ontwikkelingslanden. In de literatuur wordt echter niet veel aandacht besteed aan de algehele heterogeniteit in ontwikkelingslanden, terwijl de benchmarks voor duurzaamheid van schulden worden vastgesteld. Met name de kloof tussen ontwikkelingslanden met betrekking tot institutionele kwaliteit wordt vaak over het hoofd gezien. Naast de focus op de niet-lineaire effecten van de overheidskuld op groei, levert dit hoofdstuk een bijdrage aan door de rol van instellingen te benadrukken (met name die van de kwaliteit van de overheidssector). Het hoofdstuk heeft zich vooral geconcentreerd op hoe regeringen met uiteenlopende beheerscapaciteit van de overheidssector een uiteenlopende samenhang tussen de overheidsschuld en de economische groei kunnen zien.

Hoewel een lineaire en rechtmatige kijk op de gegevens de hypothesized negatieve relatie tussen schuldenlast en economische groei ondersteunt, worden de gegevens niet meer in verband gebracht met de kwaliteit van de instellingen. Wat zou worden beschouwd als een duurzaam schuldenlast in één land (bijvoorbeeld een land met een efficiënte overheidssector, sterke inkomstenmobilisatiecapaciteit en een laag niveau van corruptie) kan niet duurzaam zijn voor een ander land (bijvoorbeeld een land met een zwakke institutionele kwaliteit).

De schuldgroei nexus toont ook een beetje gevoeligheid voor het schuldniveau. Een interessant resultaat van de non-linearity oefening (gebaseerd op schuldeniveau) is dat ontwikkelingslanden met een beter bestuur van de overheidssector de nadelige gevolgen van de overheidsschuld op relatief hogere niveaus ervaren - in vergelijking met andere ontwikkelingslanden met een zwakker bestuur van de overheidssector kwaliteit.

**Hoofdstuk 3** onderzoekt de voorspellende kracht van belangrijke macro-economische variabelen tegen incidenten van valuta crisis met behulp van 'signalen' benadering. Door valutakrisisafspraken te definiëren als extreme bewegingen in de valutamarktdrukindex, maakt de aanpak een niet-parametrische ex-post studie in het gedrag van belangrijke macro-economische variabelen, in de directe perioden voorafgaand aan geïdentificeerde crisisincidenten.

De analyse bepaalt drie belangrijke afleveringen van de valutakrisis in Ethiopië (1992-93, 1999 en 2008). De eerste crisis vertoonde relatief hogere crisis-waarschijnlijkheden buiten de steekproef, in vergelijking met de laatste twee crisis. Op basis van de regel van geluid-tot-signaalverhouding, M2-vermenigvuldiger, bankdeposito's, uitvoer, handelsvoorwaarden, afwijking van de echte ER van de trend- en leningsverhouding ratio waren goede indicatoren die aanzienlijke 'abnormale' bewegingen voor valuta vertoonden Crisis gebeurtenissen in Ethiopië.

**Hoofdstuk 4** draagt bij aan het onderzoek naar problemen die verband houden met externe financiële schokken. Het bestudeert de spillovers van recentelijk onconventioneel monetair beleid van de Fed en ECB. Het analyseert de impact van deze schokken op de rendementen (dynamiek) van diverse Zuid-Afrikaanse activa, b.v. Valuta, obligatie rendementen, credit default swap, interbancaire marktrente en aandelenmarkt. Aangezien de impact van beleidsaanbevelingen op de financiële markten vaak 'direct' is, gebruikt het hoofdstuk dagelijkse data met hoge frequentie.

De resultaten tonen significant bewijs van spillover-effecten. Bijvoorbeeld, de aankondigingen van het grootschalige activa aankoopprogramma (QE) van de Federal Reserve hebben doorgaans geleid tot de appreciatie van de Zuid-Afrikaanse valuta, vermindering van de rentes op de overheidsschulden (vooral tijdens QE1), credit default swaps, vermindering van de interbancaire rente en Winsten door de beurs. De aankondigingen betreffende de afnemende (geleidelijk stopzetting) van Fed's activa-aankoopprogramma's tonen in wezen de omgekeerde effecten van de activa-aankoopprogramma's. Het leidde tot de afschrijving van de rand, stijging in CDS, toename van de interbancaire koers en afname van belangrijke aandelenmarkten.

Net als het niet-standaard monetair beleid van de Fed, hadden de beleidsinstrumenten gevolgd door de ECB ook verspilling op diverse Zuid-Afrikaanse activa. Over het geheel genomen werden de aankondigingen van het beleid van de activa-inkopen van de ECB (bijv. 'Securities Markets Programme', 'Outright Monetary Transactions', 'Covered Bond Purchases Programs') gevolgd door de appreciatie van de rand, dalende opbrengsten van de soevereine obligaties en CDS, en Een stijging van aandelenmarkten. Daarnaast heeft het beleid inzake liquiditeitsverzekering (bijvoorbeeld 'Fixed Rate Tenders With Full Allotment', 'Long-Term Refinancing Operations', 'Foreign Currency Funding') en de 'Collateral easing'-programma's (voornamelijk bestaande uit 'Asset-Backed Securities' ) Had ook kwalitatief dezelfde gevolgen voor de activa-aankoopprogramma's van de ECB, hoewel de betekenis van de programma's (en hun specifieke instrumenten) niet op alle activa was gezien en ook afhankelijk was van de specificatie van de gebruikte regressies.

# Résumé

La présente thèse comporte trois chapitres analytiques dans les chapitres deux, trois et quatre qui traitent des problèmes de soutenabilité de la dette, de crise financière et du rôle des chocs monétaires extérieurs dans la stabilité des pays en développement. Je résume ici les principales méthodes, résultats et contributions de ces trois chapitres.

**Le chapitre deux** est fondé sur l'argument selon lequel le fardeau de la dette dite insoutenable joue un rôle négatif sur les perspectives de croissance des pays en développement. Cependant, la littérature ne parvient pas à prendre en compte l'hétérogénéité globale dans les pays en développement en fixant des critères de soutenabilité de la dette. En particulier, les écarts entre les pays en voie de développement pour ce qui concerne la qualité des institutions sont souvent occultés. En plus de l'accent mis sur les non-linéarités des impacts de la dette publique sur la croissance, ce chapitre contribue à la littérature en mettant en lumière le rôle des institutions (en particulier, celles ayant trait à la gestion du secteur public.) Le chapitre s'est particulièrement focalisé sur la manière dont les gouvernements dotés d'une capacité de gestion du secteur public différente peuvent avoir des interactions diverses entre la dette publique et la croissance économique.

Bien qu'un simple regard sur les données appuie l'hypothèse d'un lien négatif entre l'endettement et la croissance économique, une analyse plus approfondie des données révèle des non-linéarités liées à la qualité des institutions. Ce qui serait considéré comme un niveau de dette durable dans un pays (par exemple, un pays avec un secteur public efficace, une forte capacité de mobilisation des revenus et un faible niveau de corruption) peut ne pas être durable pour un autre pays (par exemple, un pays ayant une faible qualité institutionnelle).

L'interaction dette-croissance montre également une certaine sensibilité au niveau de la dette. Un résultat intéressant issu de cet exercice basé sur le niveau de dette est que les pays en développement avec une meilleure gestion du secteur public tendent à voir les effets néfastes de la dette publique à un niveau supérieur de dette, comparé à d'autres pays dont la qualité de la gestion du secteur public est moindre.

**Le chapitre trois** examine la puissance prédictive des variables macroéconomiques clés concernant l'apparition de crises monétaires en utilisant l'approche des signaux. En définissant les épisodes de crise monétaire en tant que mouvements extrêmes dans l'indice de pression du marché des changes, l'approche fait une étude non paramétrique ex-post sur le comportement de variables macroéconomiques clés, dans les périodes immédiates précédant les incidents de crise identifiés.

L'analyse détermine trois épisodes clés de crise monétaire en Éthiopie (1992-1993, 1999 et 2008). La première crise correspond à des probabilités de crise hors-échantillon bien supérieures aux deux autres. Sur base du ratio signal-bruit, le multiplicateur de M2, la quantité de dépôts bancaires, la valeur des exportations, les termes de l'échange et la déviation de l'ER réel de sa tendance et le ratio prêts-dépôts sont de bons indicateurs qui détectent les mouvements anormaux significatifs avant les cas de crises de change en Ethiopie.

**Le quatrième chapitre** supplémente la recherche sur les problèmes liés aux chocs financiers externes dans les pays en développement. Ce chapitre étudie les retombées des récentes politiques monétaires non-conventionnelles de la Réserve Fédérale et de la BCE. Dans ce chapitre, nous analysons l'impact de ces chocs sur les rendements (dynamiques) de divers actifs sud-africains : la devise, les rendements obligataires et boursiers, le swap de défaut de crédit, le taux en vigueur sur le marché interbancaire.

Dans la mesure où l'impact des annonces des institutions financières sur les marchés est souvent immédiat, le chapitre utilise des données journalières à haute fréquence.

Les résultats concluent à l'importance des répercussions des décisions de la Réserve Fédérale et de la BCE. Par exemple, les annonces du programme d'achat d'actifs à grande échelle (QE) de la Réserve fédérale ont généralement conduit à l'appréciation de la monnaie sud-africaine, à la réduction des rendements des obligations souveraines (en particulier au cours de la période de référence QE1) et des swaps de défaut de crédit, à la diminution du taux interbancaire et à une augmentation des gains sur les marchés boursiers. Les annonces successives quant à un ralentissement du programme de rachat d'actifs ont essentiellement eu l'effet inverse : dépréciation du Rand, augmentation des swaps de défaut de crédit, augmentation du taux interbancaire et baisse des principaux indices boursiers.

Tout comme les politiques non-conventionnelles de la Réserve Fédérale, les instruments de politique monétaire activés par la BCE ont également eu des répercussions sur la valeur de divers actifs sud-africains. Dans l'ensemble, les annonces par la BCE de ses décisions concernant l'achat d'actifs (par exemple, 'Securities Markets Program', 'Outright Monetary Transactions', 'Covered Bond Purchases Programs') ont été suivies par une appréciation du Rand, une baisse du rendement des obligations souveraines et des CDS et une hausse des indices boursiers. En outre, la politique de fourniture de liquidités (par exemple, 'Fixed Rate Tenders With Full Allotment', 'Long-Term Refinancing Operations', 'Foreign Currency Funding') ainsi que les programmes d'assouplissement des garanties de crédit (comprenant principalement les 'Asset-Backed Securities') ont également eu des impacts quantitativement similaires aux programmes de rachat d'actifs de la BCE, bien que la significativité de ceux-ci (et leurs instruments spécifiques) n'ont pas été observés pour toutes les classes d'actifs. Cette significativité dépend également de la spécification économétrique utilisée.

# Chapter 1

# Chapter 1: General Introduction

> "...in the past thirty years financial systems around the world have undergone revolutionary change. People can borrow greater amounts at cheaper rates, invest in a multitude of instruments catering to every possible profile of risk and return, and share risks with strangers across the globe..." Raghuram Rajan (Jackson Hole - Aug 27, 2005)

Among the biggest challenges faced by developing countries today is the management of government finances and various financial shocks emanating from their domestic economy and external sources. An increasing number of developing economies are witnessing the integration of their domestic financial markets with international capital markets. This has granted them access to international capital that has been the driving force of the fast pace of growth across many emerging economies in recent decades. Yet, it has also introduced them to equally daunting challenges. Developing countries have become particularly vulnerable to capital flow reversals - not only when the countries in question show weak macroeconomic fundamentals but also when policies in advanced economies change or symmetric shocks affect other emerging economies. In such circumstances, monetary policy authorities and central banks in developing countries are finding it hard to maintain financial stability and policy independence (Rey, 2015; Aizenman et al., 2015, Schaechter et al., 2004; IMF, 2015).

The gains and adverse impacts of financial globalization are being witnessed both in developing countries at an early stage of financial development that follow (managed) floating monetary regimes, e.g. Ethiopia, or those at advanced levels of financial development that follow a mature inflation targeting monetary system, e.g. South Africa. The growth in the demand and supply of external financial flows - in the era of increased global financial instability and repetitive crisis - underscores the need for public debt management by governments across the developing world. Maintaining sustainable public debt levels helps them to keep their overall financial stability and also makes them less vulnerable to the damage from unforeseen financial shocks - as they will have the fiscal space for necessary (e.g. expansionary) monetary policy instruments.

Given the foregoing motivational issues, this essay tries to answer the following questions. 1) How can developing countries balance 'public spending' with 'debt sustainability' — and does the quality of institutions and public sector management play a role? 2) How can developing countries 'foresee' financial crisis and better prepare themselves to minimize their vulnerability? 3) What is the nature and extent of developing countries' vulnerability to external financial shocks — particularly to recent monetary policy experiments in advanced countries? However, the answer to these questions is rather complex and depends on various domestic and external factors. The essay tries to address these issues by presenting its discussions through three (analytical) chapters.

In **chapter 2**, the problems of sovereign (public) debt, the impact of severe indebtedness on economic growth, the issues of debt sustainability, and the institutional settings (specifically relating to the public sector) that determine debt sustainability are discussed. The chapter

contributes to a topic that has been widely discussed in developed countries in the post crisis era — yet, here, we are refocusing the issue to developing countries. In fact, it was only recently that the issue of public debt sustainability in high income countries assumed the center stage of discussion in mainstream media, international financial institutions and markets. In developing countries, by contrast, problems of government debt sustainability have been central and represented one of the key areas of advice from global financial institutions such as the IMF and World Bank. Indeed, many of the so called 'heavily indebted poor countries' (HIPC) went through long periods of sovereign debt distress and got back to some fiscal prudence following substantial debt forgiveness and restructuring by their key bilateral and multilateral creditors (Cassimon et al., 2015; Freytag and Pehnelt, 2008).

However, while the recent attention on public debt sustainability shifted to advanced countries, many developing countries are, once again, facing increasing levels of indebtedness. The chapter delivers a timely and useful discussion on the issue by studying a group of developing countries. Specifically, it studies the impact of debt distress on economic growth and also if its impact is non-linear. That is, whether or not debt plays a constructive role (say by financing the development projects of poor countries) when its magnitude is manageable and plays a detrimental role when it becomes big and unstainable. The study also makes a further contribution by adding an institutional dimension, specifically, regarding the efficiency of the public sector. Two countries with comparable economic size but with different revenue mobilization capacities, degree of corruption, and property rights should not have similar debt sustainability targets. Ceteris paribus, countries with robust bureaucratic apparatus, domestic revenue mobilization capacities and low level of corruption should be able to better manage their sovereign debt compared to countries with weaker institutions.

The chapter studies the impact of public debt (with a non-linear model), while controlling for other standard determinants of economic growth and cross-country differences in public sector management (institutional) quality. A linear estimation of the baseline model (i.e. a comparator model to the literature) shows a negative impact of public debt on economic growth. However, accounting for non-linearity, reveals that public debt assumes a negative relationship with growth only at 'high' debt levels. Interestingly, countries with better managed public sectors see the negative impact of public debt at levels higher than those countries with weaker public sector bureaucratic quality.

**Chapter 3** discusses an aspect of a financial shock that developing countries often face. It specifically deals with 'currency crises' and how major shocks to key macroeconomic variables could be used as an 'early-warning' system, so that governments (and monetary authorities) in developing countries take timely measures. This procedure uses a non-parametric (signals) approach that makes an ex-post analysis of past crisis incidents and how well key macroeconomic variables signaled an ensuing crisis (Kaminsky et al., 1998; Kaminsky and Reinhart, 1999; El-Shagi et al., 2013). In this way, monetary authorities in developing countries could derive key lessons for future crisis and closely track the dynamics of key macroeconomic indicators.

The paper conducts a case study on Ethiopia and, in doing so, delivers the first such empirical exercise on the country. In poor developing economies like Ethiopia, financial early warning tools are not properly utilized by monetary authorities. Even if the early warning tools by themselves have no perfect foresights, they (at least) give some prior warnings - so that necessary precautions can be taken.

While both chapter 3 and 4 deal with the roles of financial shocks in developing countries, the countries up on which the case studies are conducted differ as much as the issues addressed. Ethiopia (the focus of chapter 3) is a low-income developing economy with very negligible links to international capital markets. In fact, the country has yet to adopt a formal stock market, liberalize its banking industry, and allow foreign capital investments to own domestic bank assets. South Africa (the focus of chapter 4), on the other hand, is an emerging (upper middle-income) economy with a highly developed financial sector. Nevertheless, it is also a country with significant levels of poverty (among a section of its population) and suffers from one of the world's highest rates of inequality. These problems partly stem from the country's unique history.

Given the difference in the structure of the two economies (level of economic development and degree of integration to world economy), the set of shocks affecting them also differ. For this reason, the chapter on Ethiopia focuses mainly on key domestic macroeconomic variables and their dynamics, while the chapter on South Africa focuses on issues that link the country to economic events largely happening outside its borders. However, even in the case of Ethiopia, there are signs that domestic shocks could coincide with key external events.

The key exercises in the chapter include: first, the use of extreme movements in 'exchange market pressure index' to detect currency crisis episodes.[1] Second, studying the periods before crisis events and, particularly, the behavior of key macroeconomic indicators for the current account (real exchange rate, imports, exports, and terms of trade) the capital account (international reserves, ratios of monetary base to reserves, real interest rate differentials) and the domestic financial sector (levels and growth rates of domestic credit, domestic real interest rates, lending-deposit rate, excess liquidity, bank deposits). Overall, indicators for 'abnormalities' (significant unusual movements) in the current account and domestic financial sector were found to be good crisis detectors, on the basis of the noise-to-signal ratio rule. This is less of the case for the indicators from the capital account sector - perhaps, characteristic of a developing economy with closed financial systems.

**Chapter 4** discusses the unintended consequences (spillovers) of the unconventional monetary policies adopted by the US Federal Reserve (Fed) and European Central Bank (ECB). These policies became operational largely as a response to (first) the global financial crisis and (later on) the liquidity and credit crisis in the banking industry and sovereign debt crisis, which followed the global financial crisis of 2008-09 (Bernanke, 2009; Joyce et al., 2012; Aizenman et

[1] The Exchange Market Pressure Index (EMPI) essentially tracks movements in a country's exchange rate and foreign reserves.

al., 2014). Yet, the key interest of the chapter centers on the spillovers on developing countries. For this purpose, the chapter conducts a case study on South Africa. As mentioned earlier, the impact of external shocks from such policies on the least-developed countries (with minimal integration to international financial markets) will be limited. However, the impact on the likes of South Africa (i.e. developing countries with reasonable degree of financial sophistication) will be considerable, since these countries have strong ties to international capital markets.

The chapter specifically studies how the announcements of major unconventional monetary policies by the Fed and ECB (such as sterilized and non-sterilized asset purchase programs, liquidity provisions, collateral easing operations, etc.) affect the South African currency, sovereign bond yields, Credit Default Swaps, Interbank market, and the stock market. The study employs high-frequency daily data. Apart from the non-standard monetary policies, the study also controls for standard monetary policy changes by the Fed, ECB and the South African Reserve Bank (SARB). It also accounts for underlying volatilities in international capital markets using appropriate indices. Important news items concerning SARB as well as the release of key macroeconomic variables that may affect market sentiment are also accounted for (e.g. trade balance, current account, GDP growth rate, industrial production, mining production, inflation rate, unemployment, retail sales, money supply, foreign exchange reserves, consumer confidence, business confidence, etc).

The results reveal that the unconventional monetary policies of the Fed and ECB have impacted various categories of South African assets investigated by the chapter. However, the size and significance differs from one policy instrument to another. Overall, the results were in line with expectations. The dynamics in the South African assets goes in line with how significant international capital inflows/outflows (tied to the 'international portfolio rebalancing', 'confidence', 'sovereign credit', etc. transmission channels) affects economies with open and developed capital markets. Specifically, the 'large scale asset purchases program' (QE) of the Fed (mainly the first wave) had the effect of reducing South African sovereign bond yields of different maturities, lowering credit default swaps, lowering interbank rate and rising stock market indices. Announcements of the tapering (gradual termination of QE) had the reverse effects. ECB's asset purchases programs also had similar impacts to Fed's QE policy. Further, ECB's liquidity provisions and collateral easing policies also had a qualitatively similar impact to the asset purchases programs - although they are not consistently significant across different South African assets.

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# Chapter 2

# Chapter 2: Public Debt, Economic Growth and Public Sector Management [†]


## Abstract

The paper investigates whether differences in public sector management quality affect the link between public debt and economic growth in developing countries. For this purpose, we primarily use World Bank's institutional indices of public sector management (PSM). Using PSM thresholds, we split our panel into country clusters and make comparisons. Our linear baseline regressions reveal a significant negative relationship between public debt and growth. The various robustness exercises that we perform also confirm these results. When we dissect our dataset into 'weak' and 'strong' county clusters using public sector management scores, however, we find different results. While public debt still displayed a negative relationship with growth in countries with 'weak' public sector management quality, it generally displayed a positive relationship in the latter group. The tests for non-linearity shows evidence of an 'inverse-U' shape relationship between public debt and economic growth. However, we fail to see a similar significant relationship on country clusters that account for PSM quality. Yet, countries with well managed public sectors demonstrate a higher public debt sustainability threshold.



Keywords: public debt, economic growth, public sector management, developing countries
JEL Classification: E62, F34, H63, H83, O11



[†] Published: Public Administration and Development. 35 (5), p. 329–346. A special appreciation goes to George Guess, Janvier Nkurunziza, Paul Reding, Jean-Marie Baland, Jan Annaert, Guido Erreygers and two anonymous referees for their helpful comments.

# 1 Introduction

Although there is an increasing focus on debt sustainability, one noticeable weakness of the current line of research is the failure to account for cross-country heterogeneity in the public debt vs. growth dynamics (Kourtellos et al., 2013).[3] In an effort to close this literature gap, and also supplement the existing empirical works that account for country heterogeneity, this paper will study the debt-growth relationship while focusing on a specific set of institutional measures of public sector management quality. In this regard, this work tries to complement existing studies of public debt sustainability that utilize aggregate institutional measures. As a further contribution, the paper will use robust tests of non-linearity and check if non-linearity prevails in a similar fashion between countries with different institutional scores for public sector management. The main interest of this paper will be to find out if differences in the quality of the public sector, other things remaining constant, bear differences in the debt-growth nexus in developing countries.

The quality of public sector management, e.g. property rights, budget management, transparency etc., has been shown to positively affect growth (Duvanova, 2014). However, the special interest of this paper is to analyze if country differences in public sector management result in differential outcome in the debt-growth relationship. There are different channels through which the quality of the public sector might have an impact on the debt-growth nexus. For instance, countries with lower public sector quality (say those with lower rate of revenue mobilization, poor budget management and low transparency) are more prone to higher public debt levels as they tend to borrow more (Heylen et al., 2013; Fernandez and Velasco, 2014). Shleifer and Vishny (1993) also state that inefficient and corrupt governments and public sectors have the tendency to redirect funds from high value investment areas such as education and health to less productive sectors like defense and superfluous infrastructure projects.

However, there might also be counterintuitive arguments. That is, even public sectors with good governance quality may sometimes behave in a less efficient manner. Jalles (2011), for instance, notes that a democratically elected government may not be very enthusiastic about budget sustainability or public debt levels since their primary concern is fulfilling the demands of their voters in the short term, i.e. while they are in office. Financing short run consumption with debt is argued to yield positive growth (Elmendorf and Mankiw, 1999). However, unrestrained and unsustainable consumption level will push sovereign debt levels higher and higher, which may on the longer term lead to a negative growth rates.

Furthermore, in countries with weaker public sector management, we would expect a lower level of investment compared to countries where good institutions exist. Weaker institutions bring uncertainties to the investment atmosphere. Public funds would also be redirected to inefficient

[3] For the issues behind rising concerns of debt-sustainability, see e.g. Michel and Von Thadden (2010), Helm (2011), Jogiste et al. (2012), Dell'Erba et al. (2013), Panizza and Presbitero (2013).

sectors that are more conducive to misappropriation rather than productivity. Scully (1988) argues that the presence of freer institutions, such as business freedom and personal liberties, yield higher economic growth rates.

With the foregoing brief introduction in to the importance of institutions in the analysis of public debt, and its relationship with growth, we will proceed to the discussion of a specific aspect of institutional quality (i.e. public sector management) and its possible effects up on the debt-growth nexus.

# 2 Public Sector Management Quality

The focus of most studies on public sector management and public spending has been examining the 'efficiency' of the public sector (Gupta and Verhoeven, 2001; Afonso et al., 2005; Hauner, 2008). In doing so, such studies often dwell on particular socio-economic projects and sectors towards which public spending flows. They measure 'efficiency' by linking public expenditure to specific socio-economic gains. For instance, school enrollment (relative to public expenditure) is often used to measure the efficiency in education sector while infant mortality is used for the health sector. Apart from the estimations of respective scientific papers, it is often difficult to find databases that are dedicated to measuring public sector efficiency or quality at the aggregate level, and even more so to compare multiple countries.

One reliable measure of public sector management quality for developing countries has been the Country Policy and Institutional Assessment (CPIA) database of the World Bank (WB). Various empirical papers dealing with cross-country institutional differences have been adopting this measure in their analysis (Knack et al., 2011; Dabla-Norris and Gunduz, 2014).[4] As its name implies, CPIA evaluates the quality of policy and institutional frameworks in developing countries. To make sure that there is consistency in the process of applying the criteria for various countries, the WB follows a rigorous internal review process (IDA, 2004; GTZ, 2008). CPIA is widely used to gauge the allocation of resources to developing countries. The International Development Association (IDA) of the WB and various other institutions (both private and public) are dependent on this rating for their operational decisions. The increasing attention given to the CPIA by WB and other development partners emanates from their belief that aid and concessional lending is effectively utilized in countries with a good policy and institutional environment.

The CPIA ranks countries on the scale of 1 to 6, where higher is better. The WB uses a median score of 3.5 as a threshold. Countries with policy scores above 3.5 will be treated as 'strong'

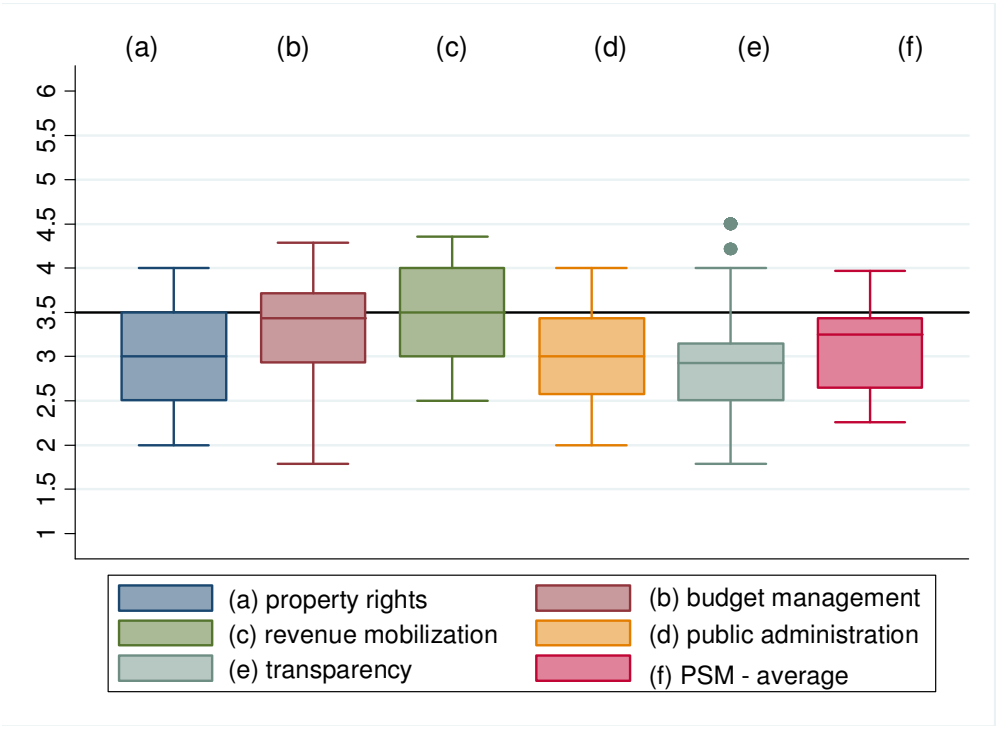
[4] The CPIA index is compiled by the WB annually (WB, 2011). In order to direct the IDA lending process, the WB kicked-off country assessment programs in the late 1970s (GTZ, 2008). The assessment criteria have evolved to assume its current version in 2004. The revisions have also been made with the intention of facilitating international comparability in performance across countries.

performers and countries scoring below that will be treated as 'weak' (see IDA, 2004; Eifert and Gelb, 2007). The index also has 16 specific indicators. The 16 individual criteria within the overall CPIA index are grouped in to four categories, namely: economic management, structural policies, policies of social inclusion and equity, and also public sector management and institutions (PSM). Our study focuses on the last category, i.e. PSM, and its 5 individual sub-components. The five indicators that constitute the PSM index are:

- Property Rights and Rule-based Governance,
- Quality of Budgetary and Financial Management,
- Efficiency of Revenue Mobilization,
- Quality of Public Administration, and
- Transparency, Accountability, and Corruption in the Public Sector

The detailed descriptions of the indices are given in table 3. The table additionally gives the basic statistical summaries of these indices, and also other variables used in our study. Looking at the means of the indices, see column-4, we notice that most developing countries receive below median score (i.e. below 3.5 on the scale of 1 to 6) for all indices, except for the index of revenue mobilization. However, to get a clearer view on the distribution of country scores, we may look at the box-plots in figure 1.

**Figure 1: Box-plots for the indices of public sector management quality**




As we can see from the plots, most countries indeed fall in the low institutional score category. We can observe from plot (f) that a little over three quarters of the countries score 'low' on the overall PSM index. Looking at the five specific indices separately, i.e. plots (a) to (e), we observe

some differences among the indices. Just like the overall PSM index; about three quarters of the observations for property rights (plot-a) and public administration (plot-d) fall in the 'low' score zone. The index where almost all countries score worst is on transparency. As could be seen from plot (e), only a portion of the top quartile for transparency index falls within the 'high' score range. However, the countries in our sample tend to be evenly spread on the quality of revenue mobilization (plot-c) and nearly so for budget management (plot-b). For these two indices, the two upper quartiles fall in the 'high' score zone while the two lower quartiles fall in the 'low' score range.

As an alternative, we consider The Heritage Foundation's (THF) Index of economic Freedom (IEF). This dataset is also commonly used by researchers who model economic growth, cross-country institutional differences and performances of the public sector (see Alonzo, 2002; Dawson, 2003; Altman, 2013). Out of ten specific indicators that constitute the IEF, this paper will be utilizing five indicators that match the WB's PSM. Specifically, our paper will use 'property rights', 'freedom from corruption', 'fiscal freedom', 'government spending', and 'business freedom' in an effort to calibrate an alternative index to the WB's PSM index. Each one of these indices is graded on a scale ranging from 0 to 100 (THF, 2014). To match the PSM, the IEF index has been converted to the scale of 1 to 6.

# 3 Methodology and Data

There is no unique way of testing debt sustainability. For instance, IMF's formal debt sustainability analysis sets thresholds of debt (often as % of GDP) that represent the benchmarks of sustainability. These thresholds are different, where poorer countries are generally given lower debt to GDP targets. See IMF and WB (2012) for more on the details of the joint IMF/WB debt sustainability framework (DSF) for developing countries. Further, the debt sustainability analysis undertaken by the empirical literature is even more diverse.

Debt dynamics is largely driven by three important components. These are; the primary budget balance (deficit or surplus constituted by revenue minus non-interest spending), interest payments, and GDP growth (Hasko, 2007; Apergis and Cooray, 2015). The traditional tests of debt sustainability have focused on the primary balance. In this regard, an exemplary important contribution has been that of Bohn (1998). Bohn's approach utilized long run (historical) time series regression of the primary fiscal surplus on public debt, and also other control variables.[5] The focus on primary balance makes sense in advanced countries since it is the main component deriving debt dynamics. Bohn (1988), in his analysis of U.S. debt dynamics, argues that the primary surplus is an increasing function of the debt to GDP ratio. A further analysis of fiscal

[5] So far, the application of Bohn's technique of assessing debt sustainability via the analysis of primary balances is largely limited to advanced and emerging countries due to requirements of longer time series for a reliable estimation. For further application, see also Mendoza and Ostry (2008); Mauro et al. (2013); and Eichengreen and Panizza (2014).

sustainability and primary surpluses in emerging markets by Celasum et al. (2006) and recently on EU countries by Eichengreen and Panizza (2014) also reveal that high debt to GDP ratio is positively associated with the primary balance. Another reason for the focus on primary balance is the fact that adjustments to high debt levels via the primary balance are more preferred over adjustments through defaults or inflation (IMF, 2002; Eichengreen and Panizza, 2014).

However, the analysis of longer term debt sustainability deserves to be more focused on the 'growth' component of debt dynamics, especially in developing countries. In rich countries, where there are low growth prospects, the face value of debt matters more. In developing countries, however, sustainability depends on how quickly they can grow, so that their debt (say as % of GDP) becomes smaller – even if the nominal or face value of debt is rising. Incidentally, recent research on public debt is delivering alternative measures and tests that anchor 'sustainability' in the 'growth' element of debt dynamics. A growing number of recent studies use some form of growth regression that augments debt variables among other controls. For instance, Eberhardt and Presbitero (2013) use a static neoclassical production function augmented with a debt stock term to analyze the debt-development nexus. Kourtellos et al. (2013) use the structural threshold regression model. Panizza and Presbitero (2012) use an augmented growth model (previously applied in Cecchetti et al., 2011) alongside threshold regression estimations. Presbitero (2008), Kumar and Woo (2010), Cecchetti et al. (2012), Checherita-Westphal and Rother (2012) and Megersa (2015) use augmented dynamic versions of Solow's growth model where public debt is included besides other explanatory variables.[6]

The debt sustainability analysis applied in our study also follows this fundamental debt-growth relationship that is widely used in current literature. The special contribution of our study is adding the institutional element of public sector management, along with a non-linear analysis of the debt-growth nexus. We particularly study how divergences among developing countries with regard to their public sector management quality bear different results on the debt-growth relationship (see section 1).

Further, the econometric modeling of the debt-growth nexus in the literature often utilizes linear models (Schclarek, 2004; Blavy, 2006; Greiner, 2012; Bal and Rath, 2014). However, there is a growing argument that this relationship could be non-linear (Kourtellos et al., 2013; Panizza and Presbitero, 2013). To address these issues we will commence with a linear estimation first and later on add a test for non-linearity.

[6] See Panizza and Presbitero (2013) for more account of the diverse debt sustainability modeling exercise used in the literature.

## 3.1 Linear Estimation

To estimate the relationship between public debt and economic growth we will consider an augmented version of Solow's growth model.[7] The model we are utilizing comprises of public debt and other control variables;

$$g_{it} = \alpha + \beta Debt_{it} + \mu X_{it} + \varepsilon_{it}, i = 1, \ldots, n \quad (1)$$

Here, $g_{it}$ represents economic growth and it is calibrated as the log difference of per-capita GDP. $Debt_{it}$ represents public debt and is calibrated as the log of general government gross debt as percent of GDP. In our analysis, we will specially focus on the sign, magnitude and significance of the coefficient of public debt ($\beta$) – in relation to our dependent variable, per-capita GDP growth. We will control for various standard determinants of economic growth that we find in growth literature ($X_{it}$). In addition, $\varepsilon_{it}$ represents random error.

The vector of standard control variables ($X_{it}$) includes; log of initial per-capita GDP (Init_income), log of investment as percentage of GDP (Investment), log difference of total population (Population), the log ratio of import plus exports to GDP (Openness), log difference of average CPI (Inflation), log of primary school enrollment (schooling), log difference of net barter terms of trade (TOT) and log of net Official Development Assistance receipts (ODA). These variables are routinely used by cross-country studies of economic growth (Alesina et al., 2003; Durlauf et al., 2005) and public debt (Cordella et al., 2010; Presbitero, 2012; Kourtellos et al., 2013). They also explain much of the variation in per-capita GDP growth across countries (Kathavate and Mallik, 2012).

Among the set of controls are also institutional measures of public sector management, towards which this paper will be paying a special attention to. These are the index of Public sector management (PSM) and its five subcomponents, namely: Property Rights and Rule-based Governance (Property_right); Quality of Budgetary and Financial Management (Budget_mgt); Efficiency of Revenue Mobilization (Revenue_mobil); Quality of Public Administration (Public_admin); and Transparency, Accountability, and Corruption in the Public Sector (Transparency).

As we are especially interested in finding out possible divergences in the debt-growth relationship across clusters of developing countries, we will split our sample in to country clusters based on the scores of public sector management indices. To determine our clusters, we use both exogenous and endogenous thresholds. The exogenous CPIA threshold (i.e a median value of 3.5, out of a scale of 1 to 6) are used as rough guides to categorize countries as 'strong' or 'weak'

[7] Apart from their use in the debt literature (see section 3 above), variants of Solow's model are also widely used in the literature of economic growth (Durlauf et al., 2001; Ding and Knight, 2009) and public sector (Bajo-Rubio, 2000; Silaghi et al., 2014).

performers, regarding the quality of their public sector management. To make our clustering robust, we will also internally determine the policy thresholds by using Hansen's novel technique of threshold regression (see Hansen, 1999 and 2000).

As a further tool of robustness, we will include an interaction term between public debt and the index of public sector management. This should enable us to capture the possible heterogeneous effect that public debt may have on economic growth due to cross-country differences in institutional quality. It is sensible to assume that countries with well-run public sectors suffer less from the negative impacts of debt compared to countries where the public sector is not functioning well, ceteris paribus. A negative coefficient for public debt ($\beta$ in equation-1) and a positive coefficient for an interaction term between a public sector management index and public debt (see table 1) would prove this to be true.

While examining the impact of public debt ($Debt_{it}$) on economic growth ($g_{it}$) in equation (1), we will rely on a System Generalized Method of Moments (SYS-GMM) regression as a base model. There is a growing popularity of GMM models in the growth literature, owing to their reliable estimation results for cross-country panels.[8] In the face of heteroscedasticity, for instance, the GMM estimator outperforms a normal IV regression (Baum et al., 2003).[9] Further, as Kathavate and Mallik (2012) note, customary techniques like pooled OLS do not consider the potential endogeneity of explanatory variables. In other words, these estimations do not reflect on the impacts of unobserved and unmodelled country specific differences. As Hansen and Tarp (2001) explain, results from OLS estimations will be inconsistent if unmodelled country specific elements are significantly correlated to explanatory variables. GMM estimation, on the other hand, tackles endogeneity problems among country-specific elements and right hand side variables.[10] Therefore, the use of SYS-GMM estimation in this study is justified.

[8] The SYS-GMM estimator was introduced by the seminal work of Blundell and Bond (1998). See Durlauf et al. (2005) for the applications of GMM models in growth regressions.

[9] As commonly done in panel growth regressions, we will be utilizing instrumental variables (see Raghuram and Subramanian, 2008; Kathavate and Mallik, 2012). Apart from the potentially endogenous explanatory variables themselves (i.e. the lagged and differenced macroeconomic and institutional variables listed in table 1), we will be using additional instruments for legal origin and religious composition, taken from La Porta et al. (2008), and ethnic and linguistic fractionalization, taken from Alesina et al. (2003). We will be testing the validity of our instruments by making use of Hansen's J statistic of over-identifying restrictions. Further, for the tests of first and second order serial autocorrelations, we will report the Arellano and Bond (1991) AR (1) & AR (2) tests.

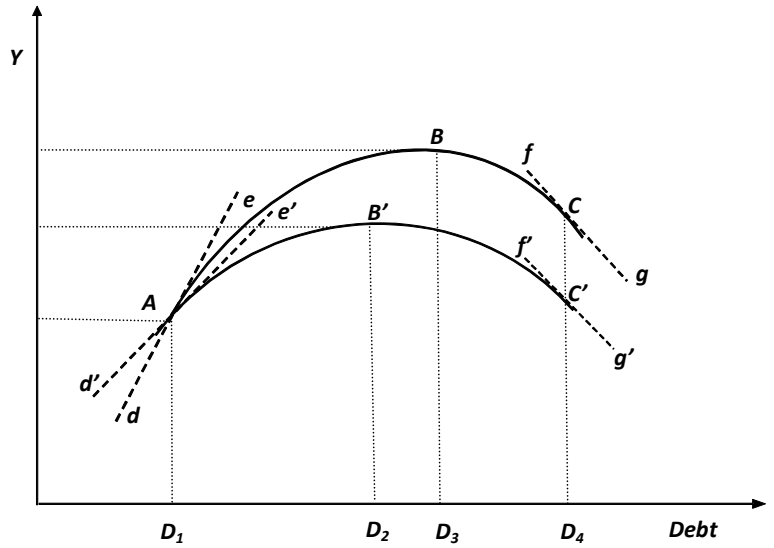
[10] GMM estimator uses first differencing and the lagged values of the endogenous variables as instruments (Raghuram and Subramanian, 2008; and Kathavate and Mallik, 2012).

## 3.2 Testing for Non-Linearity ('Inverse-U' Shape)

Some researchers (Pattillo et al., 2003; Adam and Bevan, 2005; Dogan and Bilgili, 2014) argue that the relationship between public debt and growth could be positive in lower debt levels and in the presence of well-functioning institutions. As Pattillo et al. (2003) explain, in the presence of good institutions where the borrowed funds are directed to productive investment areas, there will be economic growth, which will also repay or refinance the borrowed money in a timely manner. Yet, if debt becomes very high, i.e. exceeds the sustainability threshold or 'tipping point', then the relationship between growth and public debt becomes negative. As Clements et al. (2003) argue, the theories on 'debt overhang' and 'crowding-out' help explain the negative relationship seen in the debt-growth nexus at higher debt levels. In an effort to address such assertions of non-linearity in the debt-growth nexus, we will be making appropriate tests.[11]

The non-linearity tests in the debt literature are often conducted via spline regressions. However, Panizza and Presbitero (2013) argue that these are not robust due to the arbitrary setting of the cut-off points. Here, as in Megersa (2015), we will be using a robust technique of testing non-linearity proposed by Lind & Mehlum (2010). The presence of an 'inverse-U' shape relationship between public debt and economic growth would imply a relationship that can be depicted with the following graphical relationship.

**Figure 2: A non-linear ('inverse-U') relationship between public debt and growth**
(For 'strong' and 'weak' PSM country clusters)




Note: In this theoretical graph, (Y) represents economic growth. This is captured by annual growth in per-capita GDP. (Debt) represents the debt-to-GDP ratio (see 'Methodology and Data' section for more explanation). B and B' represent the debt sustainability thresholds for countries with 'strong' and 'weak' PSM, respectively (see 'Testing for non-linearity' section for more explanation on this).

[11] The presence of a 'Laffer-curve' or 'inverted-U' type relationship in the debt-growth nexus is often reported in public debt literature (see Krugman, 1989; Claessens, 1990; Megersa, 2015).

As the hypothesis of the 'debt-laffer curve' shows, the slopes of $\overline{ABC}$ & $\overline{AB'C'}$ will be positive at lower levels of public debt and will be negative at higher levels of public debt. That is, $\overline{de}$ & $\overline{d'e'}$ will be positively sloped while $\overline{fg}$ & $\overline{f'g'}$ will be negatively sloped. The additional hypothesis we make here is that, countries with better institutions (i.e. better public sector management), will have a higher curve ($\overline{ABC}$) compared to countries with bad public sector management ($\overline{AB'C'}$). This also gives them a higher debt sustainability threshold (B) compared to countries with weaker institutions (B'). However, in both cases - as the literature argues (e.g. Sachs, 1989; Claessens, 1990), we expect a non-linear - specifically an 'inverse-U' shaped relationship between public debt and economic growth.

Assuming the 'inverse-U' quadratic relationship between public debt and per-capita GDP growth depicted in Figure 2 holds true, we may state equation (1), i.e. the growth regression in section 3.1, as

$$g_{it} = \alpha + \beta Debt_{it} + \eta f(Debt_{it})^2 + \mu X_{it} + \varepsilon_{it}, i = 1, \dots, n \tag{2}$$

We can then test the presence of the 'inverse-U' relationship with the following joint conditions;

$$\beta + 2\eta\ f'(D1)\ >\ 0\ >\ \beta +\ 2\eta\ f'(D4) \tag{3}$$

This may also alternatively be specified as a composite hypothesis of the following null and alternative hypothesis; [12]

$$H0\text{: } \beta + 2\eta\ f'(D1) >\ 0\ and\ \beta + 2\eta\ f'(D4)\ <\ 0 \tag{4}$$

$$H1\text{: } \beta + 2\eta\ f'(D1)\ \leq\ 0\ and/or\ \beta + 2\eta\ f'(D4)\ \geq\ 0 \tag{5}$$

## 3.3 Data

The dataset is composed of an unbalanced panel of 57 developing countries over the period 1990 to 2011.[13] This list is dependent up on the availability of institutional data for PSM and we have taken developing countries for which there is a CPIA report. While classifying countries in to separate clusters on the basis of PSM scores, we use an average score over the 2005-2011 period. The detail list of the variables in our analysis and their summary statistics has been depicted in Table 3 (in annex). The macroeconomic variables come from the World Economic Outlook

[12] For more on this non-linearity ('inverse-U') test, please refer to Lind and Mehlum (2010).

[13] The countries included in the analysis are: Angola, Albania, Armenia, Azerbaijan, Burundi, Benin, Burkina Faso, Bosnia And Herzegovina, Bolivia, Bhutan, Central African Republic, Cote D'Ivoire, Cameroon, Congo, Rep., Comoros, Cape Verde, Djibouti, Eritrea, Ethiopia, Georgia, Ghana, Guinea, Gambia, Guinea-Bissau, Guyana, Honduras, Haiti, India, Kenya, Kyrgyz Republic, Cambodia, St. Lucia, Lesotho, Moldova, Madagascar, Mali, Mozambique, Mauritania, Malawi, Niger, Nigeria, Nicaragua, Nepal, Pakistan, Rwanda, Sudan, Senegal, Solomon Islands, Sierra Leone, Chad, Togo, Tajikistan, Tanzania, Uganda, St. Vincent and the Grenadines, Vietnam, Zambia.

(WEO) of the IMF and World Development Indicators (WDI) of the WB. The institutional measures of public sector management come from WB's CPIA dataset. However, we also construct and use an alternative measure of public sector management from THF's IEF dataset to control for the WB's CPIA data (see table 3).

# 4 Results and Discussion

## 4.1 Results from Linear Modeling

The linear baseline estimations of our growth model, given in equation (1), for different specifications (specifications with and without the debt-growth interaction term) and different PSM indices (indices of WB & THF) are displayed in Table 1. Column 1 displays the estimation of the growth model incorporating public debt and the other control variables but without our institutional variable, i.e. PSM. The rest of the columns, however, incorporate it. Columns 2&4 deliver estimations without the interaction term between PSM and public debt (i.e. Debt_PSM) while columns 3&5 include the term. Columns 2&3 are based on indices from the WB's CPIA index while Columns 4&5 are based on indices from THF's IEF.

Table 1: SYS-GMM baseline regressions

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Init_income | -0.00580* | -0.00656** | -0.00636** | -0.00789* | -0.00599 |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) |
| Investment | 0.0107 | 0.00724 | 0.00627 | 0.00709 | 0.00993 |
| | (0.012) | (0.015) | (0.015) | (0.015) | (0.014) |
| Population | -0.744*** | -0.715*** | -0.796*** | -0.720*** | -0.761*** |
| | (0.181) | (0.177) | (0.182) | (0.184) | (0.194) |
| Openness | 0.00181 | 0.00395 | 0.00221 | 0.00597 | 0.00286 |
| | (0.011) | (0.011) | (0.011) | (0.013) | (0.013) |
| Inflation | 0.105*** | 0.104** | 0.119*** | 0.124 | 0.134* |
| | (0.041) | (0.041) | (0.043) | (0.076) | (0.076) |
| Debt | -0.00786* | -0.00718* | -0.0643*** | -0.00840* | -0.0740** |
| | (0.004) | (0.004) | (0.025) | (0.004) | (0.030) |
| Schooling | 0.0101 | 0.00821 | 0.0065 | 0.0076 | 0.0103 |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) |
| TOT | -0.0661** | -0.0648* | -0.0625* | -0.0493 | -0.0478 |
| | (0.034) | (0.034) | (0.033) | (0.037) | (0.037) |
| ODA | -0.00181 | -0.00178 | -0.00114 | -0.00152 | -0.00145 |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) |
| PSM | | 0.00563 | -0.0726** | 0.00922 | -0.0745** |
| | | (0.008) | (0.031) | (0.010) | (0.037) |
| Debt_PSM§ | | | 0.0188** | | 0.0184** |
| | | | (0.008) | | (0.009) |
| _cons | 0.0336 | 0.0332 | 0.281** | 0.0292 | 0.301** |

| | | | | | |
|---|---|---|---|---|---|
| | (0.054) | (0.054) | (0.112) | (0.051) | (0.121) |
| N | 643 | 643 | 643 | 572 | 572 |
| AR (1) | 0.001 | 0.001 | 0.001 | 0.003 | 0.003 |
| AR (2) | 0.024 | 0.024 | 0.020 | 0.030 | 0.027 |
| Hansen OIR | 0.899 | 0.874 | 0.714 | 0.836 | 0.664 |

Notes: Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.010.
Dependent variable is the log difference of per-capita GDP.§Debt_PSM is an interaction term between public debt and PSM.
Column 1: regression without PSM; 2&3: with PSM from WB data; 4&5: with PSM from THF data.

The magnitude and sign of the coefficients as well as their significance is robust across the different specifications of the growth model, with respect to the public debt and public sector management variables. Going to the details, the coefficients of public debt are negative and significant in all cases (see columns 1 to 4). The coefficient of our policy variable, PSM, is positive but not significant (see columns-1&3). It, however, becomes negative and significant once we introduce the interaction term (see columns 2&4). This reaffirms the strong negative relationship between public debt and growth, even while controlling for the potential positive impacts of good policy on growth and public debt.[14] The coefficients of the control variables also mostly match the theoretical and empirical literature. The coefficients of investment, openness, inflation and schooling are positive.[15] On the other hand, the coefficients of initial GDP per-capita, population growth, terms of trade growth and official development assistance are negative.[16]

Based on the P-values at the foot of columns 1 to 5, we cannot reject the Arellano and Bond (1991) test for the presence of first and second order serial autocorrelation, i.e. AR(1) & AR(2). However, as can be seen from Tables 5&6 (in annex), the second order serial autocorrelation is mostly absent once we take disaggregates of the PSM index and account for the differences in quality of public sector management, i.e. running regressions on separate country clusters.[17] The validity of the instruments used is also confirmed by Hansen's J-statistic for over-identifying restrictions (OIR), as can be seen from the last row of table 1.

[14] Presbitero (2012), Cordella et al. (2010), and Kourtellos et al. (2013) also arrive at comparable findings from their analysis of public debt.

[15] Further estimations (not shown here) using alternative regressions (Differenced-GMM, Fixed Effects, Instrumental Variables) show comparable results to our baseline SYS-GMM. The Differenced-GMM yielded the closest results to the baseline regression. This is to be expected given that it is related to SYS-GMM estimation (see Arellano and Bond, 1991 and Blundell and Bond, 1998).

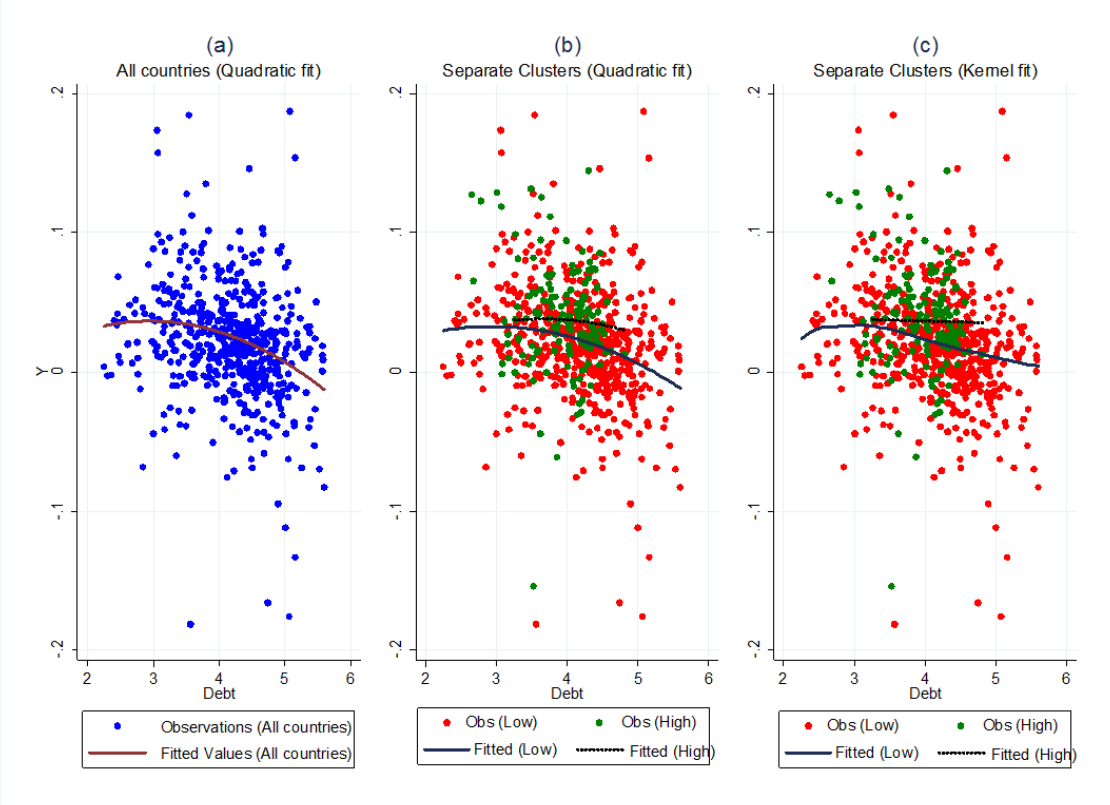
[16] It is interesting to see that the coefficient of initial GDP per-capita is negative and significant in most of the cases (see columns-1 to 3). This confirms the 'convergence-hypothesis' among countries in the literature of economic development.

[17] The robustness exercise that we run on lower frequency dataset, taking four year period averages to deal with possible business cycles, strongly confirms the absence of second order serial autocorrelation.

## 4.2 Results from Non-Linearity ('Inverse-U') Test

Before we make a formal statistical test for the presence of the hypothesized 'inverse-U' form of non-linear relationship between public debt and economic growth (i.e. table 3), we will first make quadratic and kernel fits in to the dataset, see figure 3 below. As we can see from the figure, there is an obvious evidence for downwards concave functional relationship in the overall sample, see plot (a). When we split our sample in to separate country clusters of strong and weak public sector management quality, we even get a more interesting result. Specifically, the data seems to back the hypothesis we made earlier (in section-3.2) that countries with better public institutions display a higher curve, see plots (a) and (b). As we can see from the basic graphical depiction in figure 2, this translates in to higher debt sustainability thresholds for the countries with good institutions.

**Figure 3: Fitting a non-linear ('inverse-U') relationship between public debt and growth**
(For 'strong/high' and 'weak/low' PSM country clusters)




We addresses the formal tests for the hypothesis of non-linearity in the debt-growth nexus, and also the differential thresholds for the set of countries having 'lower' and 'higher' PSM ratings, in Table 2.[18] As we can see from column-1 of the table, there is evidence of a non-linear ('inverse-U') relationship between public debt and economic growth when our whole set of developing countries is considered (also see figure 3a). The extreme value lies within the lower and upper

[18] The detail of the non-linearity test adopted in this paper is shown in Section 3.2.

bounds. Further, the slopes are positive and negative at the lower and upper bounds, respectively. The overall t-test for the presence of an 'inverse-U' shape is significant, though weakly at 10%.

**Table 2: Non-linearity test**

(Using the Lind-Mehlum test for 'inverse-U' shape)

| | (1)All countries | | (2)Countries with 'weak' public sector management (PSM <3.5) | | (3)Countries with 'strong' public sector management (PSM >3.5) | |
|---|---|---|---|---|---|---|
| Bounds | Lower | Upper | Lower | Upper | Lower | Upper |
| Interval | 1.26186 | 6.11999 | 1.26186 | 6.11999 | 1.26186 | 6.11999 |
| Slope | .02435 | -.03557 | .0116915 | -.031210 | .18468 | -.06554 |
| Test for slope : P>t | .07322 | .00663 | .282763 | .02851 | .27202 | .37559 |
| Extreme point: | 3.23628 | | 2.58581 | | 4.84755 | |
| Overall test of presence of a bell shape: P>t | .0732 | | .283 | | .376 | |

However, as we can see from columns 2&3, the significance tests failed once we split our sample in to 'strong' and 'weak' country clusters, based on the PSM scores. Yet, we can still trace a weak 'inverse-U' shape for both clusters as the slopes are negative at the lower bounds and positive at the upper bounds.[19] Furthermore, the extreme points lie within the lower and upper bounds in both cases. The extreme point for the strong scoring cluster (Debt/GDP in log. ≈ 4.85) is higher than the weak scoring cluster (Debt/GDP in log. ≈ 2.59). This is also graphically shown in Figure 2 (see B & B'). This result supports the argument that countries with better institutions, i.e. PSM, have (and deserve) higher public debt sustainability targets compared to those with weaker institutions (see Reinhart et al., 2003; Caner et al., 2010; Cordella et al., 2010).

## 4.3 Robustness Tests

We will run different robustness exercises to see the consistency of the results against different specifications. Roodman (2007) and Kathavate and Mallik (2012) show the importance of conducting robustness exercises that involve changes in specification, variable definition and datasets. On the basis of such recommendations, we will carry out the following list of robustness checks.[20]

i) we use an alternative dataset for the public sector management index (Table 1, columns 4&5);

[19] This 'inverse-U' shape is more clearly visible for the countries with low PSM score (see figure 2b&c).

[20] We also made robustness exercises where i) we used a dynamic specification involving the lagged values of debt ii) we filtered our data and control for trends iii) we also took consecutive four year period average to control for business cycles. In these exercises, public debt displays negative coefficients – as is the case in our foregoing analysis.

ii) we use a disaggregated measure of the index of public sector management (Table 4 in annex);

iii) we use WB's median CPIA threshold (i.e. a score of 3.5) and an alternative robust technique (Hansen's threshold regression) to create country clusters and then run regressions (Table 5 & Table 6 in annex);

In the following section, we will deal with the aforementioned robustness exercises in the same chronological order. The outputs of the growth regression for equation (1) using the alternative THF's IEF dataset are given in columns 3&4 of Table 1. As explained in the foregoing section (section 4.1), the results are quite stable and match the regressions conducted using the WB's CPIA data.

The results of the regressions run with the disaggregated indices of public sector management are given in table 4 (in annex). As noted in section 2, the PSM index is the average of five indices that measure different aspects of public sector management quality. Countries often tend to score high on some measures and low on others. Furthermore, the different aspects (subcomponents) of PSM may exert a different magnitude or direction of influence on economic growth or the debt-growth relationship. Therefore, it becomes useful to use disaggregates of the index, as a complement to the analysis made with the PSM index itself. As we can indeed see in table 4, there is no uniformity in the coefficients of the subcomponents of the PSM index. All sub-indices except one, i.e. revenue mobilization, have positive coefficients. Though, we find a significant positive effect only from one index, i.e. budget management.

The results shown in the table 4 enable us to see the direction and significance of the relationship between growth and the policy disaggregates that constitute the PSM index. We could see that four of the subcomponents of the index, namely: good property rights, budgetary and financial management, public administration, transparency, have a positive relationship with economic growth, as we might expect. Of these, good budgetary and financial management appears to have a very significant effect on growth, even at 1%. On the other hand, the coefficient for efficiency of revenue mobilization has a negative sign. It is also significant, though weakly, just at 10%.[21]

[21] To score good in the measure of '*Efficiency of Revenue Mobilization'*, a country is expected to have a broad tax base, less reliance on tax from international trade, low import tariffs, significant income tax, etc. However, even those developing countries that witness rapid growth rates (and have better scores in other institutional and policy measures) often have problems with tariffs and taxation. They often rely on their small formal sector and international trade as major source of taxation. This might, therefore, lead to the counterintuitive negative coefficient of the indicator.

As a further test of robustness, we will check if different country clusters (based on the quality of their institutions) witness similar pattern of relationship between economic growth and public debt. Towards achieving this objective, we will first use the CPIA median to create clusters (see section 3). Next, we will use a novel threshold regression technique pioneered by Bruce Hansen to create clusters that are statistically different from each other (Hansen, 1999). We will use the PSM index and its five subcomponents as threshold variables to create the country clusters. The threshold regression technique that we adopt has been widely applied by recent researches to optimally dissect databases and see how one cluster compares with another (see Van Campenhout and Cassimon, 2012; Kuo et al., 2013).

Table 5 shows the results of the regression that we run on the clusters of countries with 'strong' and 'weak' public sector management. The first two columns use the PSM index itself while the rest of the columns use the five subcomponents of PSM to create the clusters. As explained in section 2, each of these policy and institutional variables are measure on a scale of 1 to 6, where scores below 3.5 are treated as 'weak/low'. Irrespective of the policy variables that are used, public debt appeared to have a negative relationship with economic growth, especially for the country clusters with 'weak' score. Further, in most of these cases the coefficient of public debt was not only negative but also significant. For the clusters with 'strong' score, the coefficient of public debt was positive and even significant in half of the cases. We have only one instance, i.e. the cluster formed by revenue mobilization, where the coefficient is negative out of the six clusters of countries with 'strong' policy score.

Table 6 basically delivers the same information as table 5. The difference here is that we internally determine the thresholds as opposed to using the CPIA median. The results in these two tables are very similar. In the cluster of countries with 'weak' scores, public debt has a consistent negative (and mostly significant) coefficient. However, in the cluster of countries with 'strong' scores, public debt mostly has positive (but rarely significant) coefficients. As in table 5, only in one case – i.e. the cluster formed by revenue mobilization, we have a negative coefficient. This distinctive result also conforms to what we see in the boxplots in figure 1. Unlike other indices, most countries score well in 'revenue mobilization', possibly even those countries where public debt is high and unsustainable and already plays detrimental role to growth.

# 5 Conclusion

The concern over the sustainability of public debt and its negative impacts on economic growth is legitimate and has a sound theoretical backing. In this enquiry, however, one has to make distinctions between developing countries. It will be wrong to expect that rising levels of public debt will have similar impacts on economic growth across developing countries with 'strong' and 'weak' institutions. In line with this, our paper investigates the link between economic growth and public debt while focusing on country differences in public sector management.

When we consider our dataset in its entirety, disregarding cross-country differences in public sector management quality, the results from our linear baseline regressions show that public debt has a significant negative relationship with economic growth. The wide arrays of robustness exercises that we conducted also yield comparable results. However, we find a different patter of relationship once we dissected our dataset in to country clusters, on the bases of public sector management quality. In countries with 'weak' or poorly managed public sectors, public debt displays the familiar negative relationship with economic growth. However, in countries with 'strong' or well managed public sectors, public debt generally shows evidence of positive relationship with growth. This outcome largely prevails on alternative country clusters determined using disaggregated indices of public sector management and also on optimal clusters determined using threshold regressions.

The non-linearity tests we made also show signs of dependence on the country clusters used. We have a significant evidence of non-linear ('inverse-U') relationship between public debt and economic growth, when we consider the whole set of our dataset. However, we only have a weak (non-significant) 'inverse-U' relationship between public debt and economic growth after we split our dataset in to country clusters of 'strong' and 'weak' public sector management quality. Interestingly, countries with strong institutions have displayed a higher debt sustainability threshold, as the sovereign debt literature seems to suggest.

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## Annex:

Table 3: Variables' descriptions, sources and summary statistics

| Variable | Descriptions and sources of data | Source | Mean | St.dv. | Min | Max |
|---|---|---|---|---|---|---|
| | Growth, public debt and control Variables | | | | | |
| Growth | log difference of per-capita GDP growth at constant US 2000 prices. | WDI | .0259 | .0455 | -.181 | .316 |
| Init_income | log of initial per-capita GDP. | WDI | 5.987 | .735 | 4.851 | 8.334 |
| Investment | log of gross investment as percentage of GDP. | WEO | 3.037 | .428 | 1.518 | 4.340 |
| Population | log difference of total population. | WDI | .022 | .012 | -.011 | .103 |
| Openness | log ratio of import plus exports to GDP. | WDI | .738 | .396 | 0 | 2.091 |
| Inflation | log difference of average consumer price index. | WEO | .081 | .098 | -.088 | .927 |
| Debt | log of government gross debt as percent of GDP. | WEO | 4.100 | .689 | 1.262 | 6.120 |
| Schooling | log of primary school enrollment. | WDI | 3.737 | .239 | 2.507 | 4.010 |
| TOT | log difference of net barter terms of trade. | WDI | .010 | .116 | -.975 | .518 |
| ODA | log of net Official Development Assistance receipts. | WDI | 1.917 | 1.056 | -2.226 | 4.117 |
| | **Institutional variables** | | | | | |
| PSM | Public Sector Management and Institutions. NB: The five PSM subcomponents are listed beneath. | CPIA | 3.112 | .465 | 2.257 | 3.971 |
| | Alternative PSM index constructed from IEF's indices of 'Property Rights', 'freedom from Corruption', 'fiscal freedom', 'government spending' and 'business freedom' | IEF | 3.634 | .397 | 2.484 | 4.714 |
| Property_right | **Property Rights and Rule-based Governance:** This indicator evaluates the degree to which a rule based administrational structure and judicial system assists the private economic activity within a country (WB, 2011). Specifically, It measures if;<br>• formal and informal property rights are recognized and respected,<br>• formal contractual arrangements are used and enforced,<br>• property rights and contractual agreements are not regularly manipulated,<br>• rules and regulations are not frequently altered,<br>• laws are not altered in a non-trasparent manner to beneft some clients,<br>• the judicial system is not an extension of the executive part of the governement,<br>• there is not widespread corruption within the judicial system,<br>• judicial decisions are made aviailable to the public,<br>• the state is willing or able to protect or enforce property rights<br>• the police force do not commit crime or use violence against citizens | CPIA | 2.922 | .554 | 2 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Budget_mgt | **Quality of Budgetary and Financial Management:** This indicator measures the availability of adequate budget for priortised policies, the presence of effective financial management system, and implementation of precise fiscal reporting and accounting procedures. Specifically, it assesses whether;<br>• there is a meaningful budeget,<br>• there is significant crossreference among the spending ministries,<br>• there is coherence in budget categorization schemes,<br>• expenditures often match the amounts budgeted,<br>• there is evaluation and reporting of public expendings | CPIA | 3.255 | .575 | 1.786 | 4.286 |
| Revenue_mobil | **Efficiency of Revenue Mobilization:** The indicator evaluates the general environment of revenue mobilization (tax and non-tax) in the country of concern. Specifically, the indicator assesses if;<br>• the tax base is not very narrow<br>• much of the tax revenues are not gathered from international trade or distortionary taxes<br>• import tariffs are not high and there is no big variety of them<br>• income taxes are not very small<br>• the tax management is strong and the rate of collection is a big<br>• there is widespread computerization<br>• tax payeers don't need to make a lot of visits to the tax officiess<br>• tax and customs functionaries are not corrupt | CPIA | 3.496 | .499 | 2.5 | 4.357 |
| Public_admin | **Quality of Public Administration:** This measure appraises the degree to which civil cervants efficiently implement government policies. This list includes governments staffs in all ministries and administrative departments such as police, teachers and health workers. It excludes the army, sub-national governments and state-owned enterprises. Some of the basic criterias include;<br>• there is coordination in the administrational apparatus<br>• there are no inefficiant bureucracies, uncertainities or contradictory plocies<br>• there are not many overmlapping responsibilities<br>• there are not multiple decision layers and a few signatures are needed to get things done<br>• there are distinct rules of hiring and promotion and this is based on merit and not bribes, personal connections or ethnicity<br>• employees do not lose their position dues to changes in government<br>• most employees are regularly present at work<br>• wage bills do not deplete all of current spending | CPIA | 3.006 | .465 | 2 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Transparency | **Transparency, Accountability, and Corruption in the Public Sector:**<br>This measure checks the degree of accountability and transparency by the executive and regular employes to their constituencies. For a high score, the list of key attributes to be fulfilled include;<br>• presence of checks and balances to executive power<br>• low prevalnce of corruption bribery among public officials and other employees<br>• government decision making process is not secretive<br>• the public participates and/or is communicated about key government desions<br>• the state is not consumed by narrow goals (economic, political, military, etc.) | CPIA | 2.879 | .604 | 1.786 | 4.5 |

WDI= World Development Indicators, World Bank

WEO= World economic Outlook, IMF

CPIA= Country Policy and Institutional Assessment, World Bank

IEF= Index of Economic Freedom, The Heritage Foundation

Table 4: SYS-GMM regressions with PSM subcomponents

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Init_income | -0.00957*** | -0.00617** | -0.00882*** | -0.00931*** | -0.00930*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Investment | 0.0203 | 0.00505 | 0.0329*** | 0.0187 | 0.0255** |
| | (0.013) | (0.013) | (0.010) | (0.014) | (0.011) |
| POP | -0.819*** | -0.727*** | -0.818*** | -0.847*** | -0.829*** |
| | (0.166) | (0.168) | (0.160) | (0.162) | (0.168) |
| Openness | 0.00335 | 0.00605 | -0.00268 | 0.00409 | 0.00153 |
| | (0.011) | (0.010) | (0.010) | (0.012) | (0.011) |
| Inflation | 0.0969*** | 0.146*** | 0.0664* | 0.0994*** | 0.0908** |
| | (0.034) | (0.040) | (0.035) | (0.034) | (0.036) |
| Debt | -0.00665* | -0.0055 | -0.00598 | -0.00689* | -0.00662 |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Schooling | 0.00351 | 0.00093 | 0.0104 | 0.00374 | 0.00425 |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| TOT | -0.0579* | -0.0522 | -0.0626** | -0.0576* | -0.0612* |
| | (0.032) | (0.033) | (0.031) | (0.033) | (0.032) |
| ODA | -0.00116 | -0.00019 | -0.00128 | -0.00043 | -0.00056 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Property_right | 0.00409 | | | | |
| | (0.006) | | | | |
| Budget_mgt | | 0.0129*** | | | |
| | | (0.005) | | | |
| Revenue_mobil | | | -0.00774* | | |
| | | | (0.004) | | |
| Public_admin | | | | 0.00415 | |
| | | | | (0.007) | |
| Transparency | | | | | 0.000674 |
| | | | | | (0.004) |
| _cons | 0.0358 | 0.0265 | 0.0113 | 0.0373 | 0.0267 |
| | (0.053) | (0.048) | (0.051) | (0.051) | (0.053) |
| N | 643 | 643 | 643 | 643 | 643 |
| AR (1) | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| AR(2) | 0.024 | 0.024 | 0.026 | 0.025 | 0.025 |
| Hansen OIR | 0.063 | 0.130 | 0.084 | 0.053 | 0.057 |

Notes: Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.010.

Table 5: SYS-GMM regressions ('strong' and 'weak' country clusters; using CPIA median of 3.5 as threshold)

| | PSM | | Property rights | | Budget Mgt | | Revenue Mobil | | Public Admin | | Transparency | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country cluster | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong |
| Init_income | -0.00727* | -0.0319*** | -0.0109** | -0.0171*** | -0.00741 | -0.0171*** | -0.0215*** | -0.00267 | -0.00706 | -0.0265*** | -0.00811** | -0.00245 |
| | (0.004) | (0.010) | (0.005) | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.005) | (0.007) | (0.004) | (0.008) |
| Investment | -0.00044 | 0.0815*** | 0.0125 | 0.0775*** | 0.00251 | 0.00446 | 0.026 | 0.011 | 0.00122 | -0.015 | 0.00735 | 0.0172 |
| | (0.014) | (0.030) | (0.016) | (0.020) | (0.012) | (0.014) | (0.018) | (0.013) | (0.015) | (0.030) | (0.016) | (0.020) |
| Population | -0.651*** | -2.843*** | -0.740*** | -1.976*** | -0.115 | -1.257*** | -0.377 | -1.047*** | -0.614** | -2.125** | -0.751*** | 0 |
| | (0.174) | (0.637) | (0.198) | (0.260) | (0.466) | (0.274) | (0.379) | (0.208) | (0.254) | (0.954) | (0.187) | (0.000) |
| Openness | 0.00508 | -0.0790** | 0.0128 | -0.0605*** | 0.0159 | -0.00292 | 0.0278** | -0.0126 | 0.00523 | 0.000308 | 0.0104 | -0.00458 |
| | (0.012) | (0.033) | (0.013) | (0.011) | (0.014) | (0.010) | (0.013) | (0.009) | (0.012) | (0.017) | (0.011) | (0.011) |
| Inflation | 0.138*** | -0.19 | 0.163*** | 0.0682 | 0.110*** | -0.197 | 0.0921*** | 0.116 | 0.136*** | -0.237 | 0.138*** | 0.0107 |
| | (0.050) | (0.184) | (0.055) | (0.110) | (0.037) | (0.127) | (0.031) | (0.148) | (0.046) | (0.161) | (0.048) | (0.134) |
| Debt | -0.0110** | 0.0637** | -0.0102* | 0.00609 | -0.0137*** | 0.0133** | -0.00813 | -0.00446 | -0.0112** | 0.0389*** | -0.0118** | 0.0052 |
| | (0.004) | (0.029) | (0.005) | (0.007) | (0.003) | (0.005) | (0.005) | (0.006) | (0.005) | (0.012) | (0.006) | (0.022) |
| Schooling | 0.00676 | 0.254** | 0.00518 | 0.111*** | -0.00948 | 0.0411*** | -0.00558 | -0.00115 | 0.0126 | 0.0327** | 0.0104 | -0.00028 |
| | (0.009) | (0.110) | (0.010) | (0.031) | (0.016) | (0.014) | (0.011) | (0.025) | (0.012) | (0.014) | (0.010) | (0.092) |
| TOT | -0.0524 | -0.00155 | -0.0388 | -0.151* | -0.0326 | -0.105* | -0.0719** | -0.0845** | -0.0648* | 0.061 | -0.0595* | 0.0466 |
| | (0.033) | (0.079) | (0.033) | (0.080) | (0.040) | (0.055) | (0.034) | (0.039) | (0.034) | (0.047) | (0.033) | (0.433) |
| ODA | 0.00214 | -0.0136** | 0.00229 | -0.00645 | 0.0000 | -0.00501* | -0.0006 | 0.00145 | 0.000976 | -0.00083 | 0.00449 | -0.0047 |
| | (0.003) | (0.007) | (0.004) | (0.004) | (0.003) | (0.003) | (0.004) | (0.005) | (0.003) | (0.005) | (0.004) | (0.006) |
| N | 510 | 133 | 456 | 187 | 326 | 317 | 229 | 414 | 492 | 151 | 522 | 121 |
| AR(1) | 0.004 | 0.044 | 0.009 | 0.012 | 0.017 | 0.023 | 0.030 | 0.008 | 0.005 | 0.013 | 0.003 | 0.413 |
| AR(2) | 0.067 | 0.083 | 0.048 | 0.217 | 0.156 | 0.155 | 0.140 | 0.142 | 0.074 | 0.129 | 0.029 | 0.774 |
| Hansen OIR | 0.638 | 0.868 | 0.347 | 0.380 | 0.940 | 0.484 | 0.300 | 0.829 | 0.530 | 0.748 | 0.380 | 1.000 |

Notes: Regressions include a constant (not reported to save space); standard errors are in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.010.

Table 6: SYS-GMM regressions ('strong' and 'weak' country clusters; using Hansen's threshold regression)

| | PSM | | Property rights | | Budget Mgt | | Revenue Mobil | | Public Admin | | Transparency | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country cluster | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong | Weak | Strong |
| Init_income | -0.00989 | -0.0109** | -0.0110** | -0.0174*** | -0.00345 | 0.0168** | -0.00607 | -0.00472 | -0.00706 | -0.0265*** | -0.0127** | -0.00631 |
| | (0.007) | (0.005) | (0.005) | (0.005) | (0.004) | (0.008) | (0.004) | (0.003) | (0.005) | (0.007) | (0.006) | (0.004) |
| Investment | 0.0304* | 0.011 | 0.0135 | 0.0416** | 0.0108 | 0.00831 | 0.00612 | 0.0339*** | 0.00122 | -0.015 | 0.0397** | 0.0149 |
| | (0.017) | (0.016) | (0.016) | (0.018) | (0.013) | (0.030) | (0.017) | (0.008) | (0.015) | (0.030) | (0.016) | (0.014) |
| Population | -0.956** | -0.981*** | -0.732*** | -1.521*** | -0.435** | 1.236** | -0.771*** | -1.161*** | -0.614** | -2.125** | -1.252*** | -0.989*** |
| | (0.374) | (0.221) | (0.198) | (0.304) | (0.217) | (0.593) | (0.185) | (0.385) | (0.254) | (0.954) | (0.447) | (0.215) |
| Openness | 0.0103 | -0.00843 | 0.0135 | -0.0340*** | 0.00613 | 0.0192 | 0.0123 | -0.0367*** | 0.00523 | 0.000308 | 0.00199 | -0.0199*** |
| | (0.014) | (0.012) | (0.013) | (0.010) | (0.012) | (0.021) | (0.013) | (0.007) | (0.012) | (0.017) | (0.014) | (0.007) |
| Inflation | 0.126*** | -0.048 | 0.165*** | -0.0747 | 0.127*** | -0.286*** | 0.0894** | 0.136 | 0.136*** | -0.237 | 0.144*** | 0.0108 |
| | (0.049) | (0.114) | (0.055) | (0.117) | (0.040) | (0.106) | (0.045) | (0.123) | (0.046) | (0.161) | (0.050) | (0.099) |
| Debt | -0.00888 | 0.00476 | -0.0107** | 0.00273 | -0.00951** | 0.0268*** | -0.00794 | -0.00574 | -0.0112** | 0.0389*** | -0.0129** | 0.00346 |
| | (0.006) | (0.007) | (0.005) | (0.007) | (0.004) | (0.006) | (0.006) | (0.005) | (0.005) | (0.012) | (0.005) | (0.006) |
| Schooling | 0.0106 | 0.0152 | 0.00497 | 0.0535** | -0.0006 | 0.168*** | 0.00727 | -0.00451 | 0.0126 | 0.0327** | 0.0166 | 0.00975 |
| | (0.011) | (0.018) | (0.010) | (0.027) | (0.007) | (0.029) | (0.010) | (0.024) | (0.012) | (0.014) | (0.013) | (0.019) |
| TOT | -0.055 | -0.0491 | -0.0416 | -0.0554 | -0.0516 | -0.0857 | -0.0442 | -0.0381 | -0.0648* | 0.061 | -0.0236 | -0.0746 |
| | (0.034) | (0.052) | (0.033) | (0.072) | (0.038) | (0.058) | (0.032) | (0.055) | (0.034) | (0.047) | (0.028) | (0.055) |
| ODA | -0.00267 | -0.00322 | 0.00234 | -0.00411 | 0.00197 | -0.0268*** | 0.000585 | 0.00275 | 0.000976 | -0.00083 | -0.00673 | 0.00101 |
| | (0.004) | (0.004) | (0.004) | (0.003) | (0.004) | (0.004) | (0.004) | (0.005) | (0.003) | (0.005) | (0.005) | (0.003) |
| N | 330 | 313 | 445 | 198 | 461 | 182 | 426 | 217 | 492 | 151 | 250 | 393 |
| AR(1) | 0.019 | 0.011 | 0.010 | 0.010 | 0.004 | 0.187 | 0.006 | 0.010 | 0.005 | 0.013 | 0.045 | 0.005 |
| AR(2) | 0.051 | 0.237 | 0.041 | 0.360 | 0.167 | 0.160 | 0.126 | 0.065 | 0.074 | 0.129 | 0.037 | 0.501 |
| Hansen OIR | 0.372 | 0.218 | 0.339 | 0.251 | 0.975 | 0.360 | 0.331 | 0.073 | 0.530 | 0.748 | 0.476 | 0.696 |

Notes: Regressions include a constant that is not reported to save space. Standard errors are in parentheses. Significance levels:*p<0.10, **p<0.05, ***p<0.010.

# Chapter 3

# Chapter 3: Assessing Indicators of Currency Crisis in Ethiopia [†]

**Abstract**

Currency crises, generally defined as rapid depreciations of a local currency or loss of foreign exchange reserves, are common incidents in modern monetary systems. Due to their repeated occurrence and severity, they have earned wide coverage by both theoretical and empirical literature. However, unlike advanced and emerging economies, currency crises in low-income countries have not received due attention. This paper uses the signals approach developed by Kaminsky et al. (1998) and assesses currency crisis in Ethiopia over the time frame January 1970 to December 2008. Using the Exchange Market Pressure Index (EMPI), we identify three currency crisis episodes that coincide with the liberalisation following the fall of Ethiopian socialism, the Ethio-Eritrean border conflict, and the zenith of the global financial crisis. The timing shows the importance of both local and international dynamics. More macro-economic indicators picked up the first crisis in a 24 month signalling window, compared to the latter two. Three categories of indicators were used: current account, capital account and domestic financial sector. None of the capital account indicators were significant based on the noise-to-signal ratio rule. One possible explanation for this might be the weak integration of the Ethiopian economy with global capital markets.

Key words: Currency crisis, financial crisis, early warning systems, signals approach, Ethiopia, Africa
JEL classification: F31, F37, F47, G01, C14, N17, N27

[†] Published: African Development Review. 27(3), p. 315-330. A special gratitude goes to John C. Anyanwu, Dennis Essers, Janvier Nkurunziza, Paul Reding, Jean-Marie Baland, Jan Annaert, Guido Erreygers and two anonymous referees for their constructive comments.

# 1 Introduction

Currency crisis and other forms of financial crisis, such as banking and debt crisis, have become the subject of rigorous research following their recurrence in recent decades (Berg and Pattillo, 1999; Adrian and Shin, 2009; Reinhart and Rogoff, 2008 & 2009). The empirical and theoretical work on the subject has usually coincided with historical waves of major currency crisis. The 'first-generation' models of currency crisis, as they are referred to in the literature, correspond to the Latin American currency crisis of the early 1980s (Flood and Garber, 1984). These models supposed that currency crises are fundamentally linked to macroeconomic problems. It was argued that investors attacked currencies when the respective country's macroeconomic problems grew and became unsustainable. Such events often force monetary authorities to devalue their currencies (Ari, 2012). The 'second-generation' models of currency crisis came in the aftermath of the 1992-93 crisis of European Exchange Rate Mechanism (Obstfeld, 1994 & 1996). These later set of models accounted for possibilities where currency crisis might arise even if there was no severe worsening of macroeconomic fundamentals. The third and latest generations of currency crisis models have followed the 1997 Asian currency crisis. These later developments have built on the gaps in previous generation models. The Asian currency crisis has shown the importance of accounting for fragilities in the financial (banking) sector and capital accounts. The countries with weakness in their banking sector and fairly liberalized financial sectors did particularly suffer more (Radelet and Sachs, 1998; Krugman, 1999; Aghion et al., 2000).

Models of currency crisis are designed to foresee them before they ensue. For this reason, they are often referred to as 'early warning systems'. The models try to achieve their objectives by tracking major determinants of currency crisis. The seminal work on 'early warning systems' for currency crisis has been that of Kaminsky et al. (1998). However, various studies on currency crisis have tried to apply the 'early warning systems' procedure, using different datasets and estimation techniques. For instance, Martinez-Peria (2002), Fratzscher (2003) and Abiad (2003) have used Markov-switching approach. Berg and Pattillo (1999), Demirguc-Kunt and Detragiache (2000), Bussiere and Fratzscher, (2006) have applied logit/probit models. Edison (2003), Cesmeci and Onder (2008), Peng and Bajona (2008), and El-Shagi et al. (2013) have used signals approach.

This paper uses the signals approach in identifying currency crises. Kaminsky et al. (1998) have suggested a non-parametric method, known as the signals approach, to foresee banking and currency crisis. It makes an ex-post study of the behaviour of various macroeconomic indicators and tries to see if the indicators exhibit 'unusual' behaviour prior to a currency crisis. The indicators will be categorized as showing 'unusual' behaviour when they cross a certain threshold. These thresholds are calculated as a certain percentiles out of the distribution of the indicators which minimize their noise-to-signal ratio. A composite index is then developed out of the ensuing signals, which is in turn, converted to conditional crisis probabilities.

The signals approach is better suited for this case study, given its simplicity and capacity to accommodate large set of indicators. It also has the ability to treat indicators separately and also in a unified manner, i.e. composite index (see section-3). Further, a reliable use of Markov-switching and logit/probit techniques would require bigger datasets. Much of the existing literature also shows the use of these techniques on multi-country panels. Even if the use of panel datasets delivers the opportunity to use a range of estimation techniques, it limits the analysis to a general overview of currency crises. Further, the fundamentals behind currency volatility are often different, given the structural differences among countries.

So far, the empirics are mostly based on advanced and emerging economies, whose nature is different from those of small low-income economies. This research, therefore, tries to contribute to the limited body of literature on currency crisis in low-income developing economies by examining the phenomenon in Ethiopia. Developing countries like Ethiopia are likely to have sources of fragility that differ from countries that are more financially open and developed. By conducting a country case study, this paper tries to deliver an in-depth analysis in to currency turmoil in a developing country and various underlying macroeconomic and policy issues that span nearly four decades (1970-2008). Over the years, Ethiopia has witnessed big devaluations on its national currency (i.e. birr) and also some volatility in its foreign exchange market, especially since the partial float of the currency in 1994. The fact that Ethiopia has a small undeveloped economy and weak foreign exchange market makes it susceptible to various shocks.

The paper is structured in the following manner. Section 2 gives a brief overview of the Ethiopian economy, describing in particular the history and current state of the financial system. Section 3 explains the methodology of the signals approach. In this section, issues such as crisis definition, indicator variables, the composite crisis index and probabilities of a currency crisis will be addressed. Section 4 discusses the results and section 5 gives the conclusion.

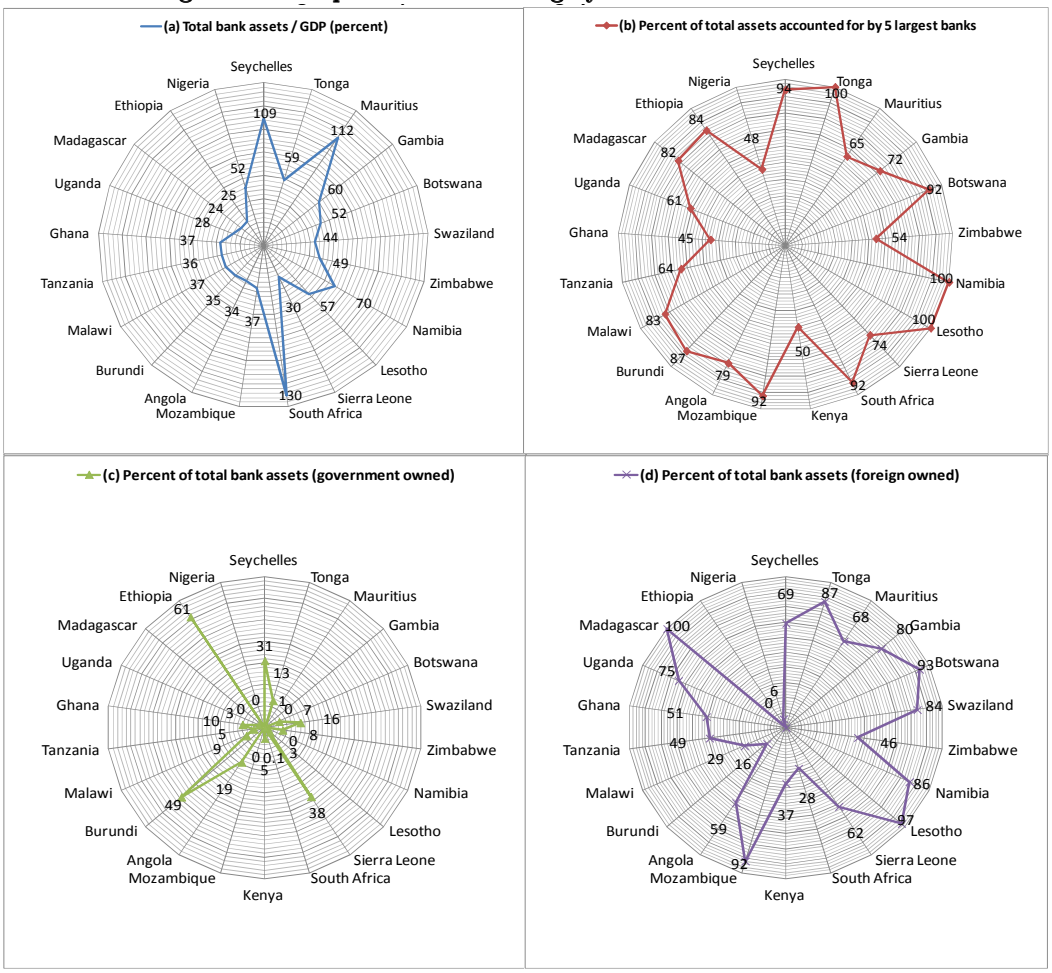
# 2 Overview of Ethiopian economy and its financial system

Ethiopia is a low-income developing nation that is currently witnessing rapid economic growth. Real GDP growth over the past decade (2001-10) averaged 8.4%. As IMF (2011) shows, the country's average growth rate was 11% in the six years up to the height of the global financial crisis in 2009. The main drivers of growth have been agriculture and service sectors. In recent years, the nation has also taken advantage of growing exports (especially coffee and horticulture), foreign aid and FDI. Alongside the fast pace of GDP growth, the nation has been confronted with rising petroleum and food prices, and thus inflation.

The financial sector of the country is relatively small, as is the case in most Sub-Saharan African economies. As can be seen in Figure-1(a), Total bank asset as a share of GDP is low, at 25%.

The largest bank (Commercial Bank of Ethiopia) is owned by the government, which has great control over commercial bank rates and lending. The rest of the banking industry is dominated by few domestic private banks. In fact, the five largest banks accounted for 84% of total bank assets in 2012, see Figure-1(b). Further, foreign exchange transactions are largely dominated by the central bank (National Bank of Ethiopia).

**Figure-1: Comparison of banking systems in African economies**




Computation based on World Bank 2012 survey of banking systems in 180 countries (see Barth et al., 2013)

The government owns the largest share of bank assets, at 61%. This is high even by African standards, See Figure-1(c) for comparison. In recent years, there have been moves to let the domestic private sector participate in the banking business. Yet, the sector is currently closed to foreign ownership. This makes Ethiopia a special case (Barth et al., 2013). In most other African countries, however, foreign investors own significant percent of bank assets, see Figure-1(d). The capital market is relatively undeveloped. The monetary authorities issue treasury bills of 28 days as well as for 3 and 6 months. No stock markets exist at the moment but there are recent moves towards creating specialised equity markets. One example is the ECX (Ethiopia Commodity Exchange), which currently hosts transactions of agricultural goods. It is a spot

exchange set up in Addis Ababa, the nation's capital. Through an open outcry system, a range of spot deals are transacted by traders (Alemu and Meijerink, 2010).

The country's central bank has been the main monetary authority in the economy. Its domain of operation has, however, seen changes over the years. The central bank, which was previously known as the 'State Bank of Ethiopia', was acting as both central and commercial bank from its re-establishment in April 1943 to its dissolution towards the end of 1963. Following the monetary and banking proclamation no. 206 of 1963, the State Bank of Ethiopia split in to a new central bank (National Bank of Ethiopia) and a state-owned commercial bank (Commercial Bank of Ethiopia). The duty of issuing coins, which was previously owned by the Ethiopian treasury, was transferred to the National Bank.

Following the 1974 Marxist revolution, private banks and insurance companies were nationalised. On September 1976, Proclamation No. 99/1976 was passed, giving greater powers to the central bank in terms of control over the financial system (insurance institutions, credit cooperatives and investment banks). This converted the financial system in to a single (exclusively public) banking system. The bank also held a pivotal role in national financial planning. Following the fall of the socialist government in 1991 and the consequent transition to free market economy, a new law (Monetary and Banking Proclamation, No. 93/1994) was passed in January 1994. This brought back the dual (private and public) banking system that was operational before the shift to socialism. Once again, private commercial banks were allowed to operate side by side with state banks.

The local currency was pegged to the US dollar for nearly half a century from 1945 until the nation adopted a managed floating system in 1994. The peg has been revised periodically over the years. On 1$^{st}$ of May 1993, Ethiopia adopted a dual rate system whereby an official peg continued to be used, parallel to an independent float determined through auctions. In this period, the official rate was periodically adjusted by the central bank according to the evolution of the auction rate. Finally, the two rates were officially unified on July 1995. With this brief introduction to the nation's monetary system and history, we proceed to a discussion of the signals approach.

# 3 Methodology (signals approach)

The aim of the signalling technique is to check if certain key macroeconomic variables are behaving 'unusually' in a time period preceding a currency crisis. The approach first constructs a currency crisis index (EMPI), which serves to define periods of currency crisis. It then examines the behaviour of indicator variables in the period prior to the identified crises.

## 3.1 Crisis definition

Kaminisky et al. (1998:15) define a currency crisis as "a situation in which an attack on the currency leads to a sharp depreciation of the currency, a large decline in international reserves, or a combination of the two".[22] They propose an exchange market pressure index (as a measure of currency crisis) as follows:

**Exchange Market Pressure Index (EMPI)**

Suppose we denote:

$e_t$ = The exchange rate at time t (birr/USD)

$R_t$ = Foreign reserves of a nation at time t (in USD)

$\sigma_{\delta R}$ = The standard deviation of the rate of change of foreign reserves

$\sigma_{\delta e}$ = The standard deviation of the rate of change of the exchange rate

Then, the index of exchange market pressure EMPI can be given as:

$$EMPI_{i,t} = \delta e_{i,t} - \left(\frac{\sigma_{\delta e}}{\sigma_{\delta R}}\right)\delta R_{i,t}, where\ \delta e_t = \frac{(e_t - e_{t-1})}{e_{t-1}}\ and\ \delta R_t = \frac{(R_t - R_{t-1})}{R_{t-1}} \quad (1)$$

As indicated in the above equation, an appreciating exchange rate is positively associated with the EMPI index while international reserve accumulation is, negatively related to the index. If the exchange rate instability is severe, it may develop into a currency crisis, which leads to major depreciation of the local currency. In such circumstances of depreciation, central banks often get involved and increase interest rates and also use their foreign reserves to purchase the local currency. Exchange rate instability and reserve losses are, thus, good proxies of a typical currency crisis.

According to the EMPI, a currency crisis is supposed to happen when the index exceeds $m$ standard deviations beyond its mean. If we designate the mean of the index with μEMPI and the standard deviation of the index with σEMPI, $m$ ε IR+, we can formally describe a currency crisis as;

$$CRISIS_{i,t} = \begin{cases} 1, if\ EMPI_{i,t} > \ \mu EMPI_{i,t} + m\sigma EMPI_{i,t} \\ 0, otherwise \end{cases} \quad (2)$$

In this study, the months in which the index is at 1.5 standard deviations or more above its sample mean value are labelled as cases of currency crisis or speculative attacks.[23] The threshold benchmark of 1.5 standard deviations is also used in various other case studies since it gives good estimation of a currency crisis (see Eichengreen et al., 1997; Feridun, 2007; Herrera and Garcia, 1999; Cumperayot and Kouwenberg, 2013). In cases where the index crosses the

[22] Kaminisky et al. (1998) state that a 'crisis' defined in such a way captures both successful and unsuccessful attacks on the currency of a nation under fixed and other exchange rate regimes. See also Dahel (2001), Edison (2003) and Davies (2012).

[23] $m$ =1.5 in equation (2)

threshold multiple times, we will use an exclusion window of 12 months to avoid counting what essentially one crisis is as multiple crises.[24]

As an alternative to the mean plus 1.5 standard deviations threshold level, we also use the Self-Exciting Threshold Autoregression or SETAR technique. This method enables us to endogenously determine thresholds.

**Self-Exciting Threshold Autoregression (SETAR) technique**

SETAR models are nonlinear models that are commonly applied to economic time series data, see Tong (1990). They have been successfully used to track and forecast daily exchange rate movements and explain recessions (see Ades et al., 1999; Kahraman et al., 2012; Montgomery et al., 1998). A single-threshold, dual-regime, first-order lag structure autoregressive SETAR model (2, 1, 1) can be specified as:

$$y_t = \begin{cases} \alpha + \beta y_{t-1} + \lambda_{1t} \; if \; y_{t-d} \leq \gamma \\ \eta + \rho y_{t-1} + \lambda_{2t} \; if \; y_{t-d} > \gamma \end{cases} \tag{3}$$

Where,
$\gamma$ is a threshold level that is estimated over a grid search,
$d$ is a 'delay' parameter,
$\lambda_{1t}$ and $\lambda_{2t}$ are independent random variables and
$\alpha$ and $\eta$ are constants.

The threshold ($\gamma$) is estimated by means of the maximum-likelihood method, using the Akaike Information Criterion (AIC). In other words, it is chosen through a grid search to maximize the likelihood of an alteration in the behaviour of the time series. Due to this, the method is impervious to a possible blame of 'arbitrariness' or subjective selection of thresholds.

## 3.2 Crisis indicators

In their study, Kaminsky et al. (1998) used 15 core macroeconomic and financial indicators which they consider as having potentially good predictive power for currency crises, namely; real exchange rate, exports, stock prices, ratio of M2 to international reserves, output, excess M1 balances, international reserves, M2 multiplier, ratio of domestic credit to GDP, real interest rate, terms of trade, real interest differential, imports, bank deposits and the ratio of lending rate to deposit rate. Due to lack of data, this study will not include the indicators 'industrial output' and 'stock prices'. Industrial production in Ethiopia is rather low and constitutes only a small share of GDP. Further, the indicator 'stock prices' is not relevant as there is no stock market in the country, as of now. The data on the 13 indicators used in this study was gathered

[24] This means that there has to be a minimal gap of one year between two separate incidences of a currency crisis. For further explanation, see Feridun (2007).

from the IMF's International Financial Statistics (IFS). It constitutes monthly values of the set of indicators.[25] All variables are expressed as percentage changes over the duration of 12 months, except those noted otherwise. The information regarding the indicator variables and their description is given in Table-1.

**Table-1: Description of the Indicator Variables**

| Indicator Variable | Description | How is the indicator used? |
|---|---|---|
| Real exchange rate: | Determined from nominal exchange rate (IFS line 00ae) by adjusting for relative consumer prices (IFS line 64). | The indicator is measured as percentage deviation from its trend |
| Imports: | IFS line 71_d | 12-month percentage change |
| Exports: | IFS line 70_d | 12-month percentage change |
| Terms of trade: | Global Development Finance & World Development Indicators.<br>Monthly terms of trade was interpolated from annual data. | 12-month percentage change |
| Reserves: | IFS line 1L.d. | 12-month percentage change |
| M2/reserves: | Determined by converting M2 (IFS lines 34 plus 35) from local currency (i.e. birr) into dollars (using line 00ae) and then dividing it by reserves (line1L.d) | 12-month percentage change |
| Real interest rate differential: | The difference between domestic real interest rate and the real interest rate in the United States. | Percentage difference |
| M2 multiplier | Given as the ratio of M2 (IFS lines 34 plus 35) to base money (IFS line 14) | 12-month percentage change |
| Domestic credit/GDP: | Determined by deflating domestic credit (line 32) by consumer prices and then dividing it by real GDP (line 99b.p.). Monthly real GDP was interpolated from annual data. | 12-month percentage change |
| Domestic real interest rate | Determined by deflating deposit rate (IFS line 60l) by consumer price inflation (IFS line 64) | percentage |
| Lending-deposit rate ratio | Determined by dividing lending rate (IFS line60p) by deposit rate (IFS line 60l) | ratio |
| Excess M1 balances: | Determined by deflating M1 (IFS line 34) by consumer prices (IFS line 64) and then subtracting an estimated demand for money from it. The demand for money, in | millions of nominal currency -birr |

[25] See table-1 for the list of 13 indicators used in this study. Also see Peng and Bajona (2008) and Kaminsky et al. (1998)

| | | |
|---|---|---|
| | turn, is estimated from a regression of real M1 balances on real GDP, consumer price inflation, and a linear time trend. | |
| Bank deposits: | Determined by deflating deposits (IFS line 24 plus 25) by consumer prices (IFS line 64). | 12-month percentage change |

Note: IFS= International Financial Statistics (International Monetary Fund). See also Peng and Bajona (2008)

Similar to the crisis index, the binary signals from individual indicators (1 = warning signal and 0 = none) are defined by a certain threshold level for each indicator variable. Table-2 summarizes the explanations regarding the thresholds used for each indicator. Those indicators which tend to rise before the start of a crisis (such as imports, real interest rates and domestic credit) will have an upper threshold. On the contrary, those indicators which tend to decline before the start of a crisis (such as the real exchange rate, exports and bank deposits) will have a lower threshold. The exact percentiles used to calculate the thresholds for the indicator variables are taken from Edison (2003). These values are given in columns 7 and 8 of Table-5. The threshold percentile used for exports, for instance, is 10%. This means that, the indicator will be issuing a signal if its year-on-year growth is below the first decile of all observations.

**Table-2: Description of Thresholds of the Indicator Variables**

| Category | Indicator | Tail | Comments |
|---|---|---|---|
| Current account indicators [i] | Real exchange rate | Lower | Large negative shocks to exchange rate (i.e. the overvaluation of the real exchange rate) |
| | Imports | Upper | Rapid rise in Imports (a weak external sector) |
| | Exports | Lower | Rapid decline in exports (a weak external sector) |
| | Terms of trade | Lower | Big negative shocks to exchange rate and exports (and, hence, terms of trade) leads to loss of competitiveness of local businesses. This may at times lead to recessions. |
| Capital account Indicators [ii] | Foreign reserves | Lower | Sustained Loss of foreign reserve |
| | M2/ reserves | Upper | Expansionary monetary policy and/or rapid fall in reserves |
| | Real interest rate differential(Domestic/foreign) | Upper | Large interest rate differential which might lead to reversal of capital flows |
| Domestic Financial sector Indicators [iii] | M2 multiplier | Upper | Fast growth of credit |
| | Domestic credit/GDP | Upper | Domestic credit normally expands before a crisis and then contracts in later date. Since we are interested in events before crisis, we take the upper threshold. |

| | | | |
|---|---|---|---|
| | Domestic real interest rates | Upper | Presence of high real interest rates might show a liquidity crunch in an economy. Further, speculative attacks are often dealt with by rising real interest rates |
| | Lending/deposit interest rates | Upper | Lending rates normally appear to go up before a crisis. Yet, rising lending rates show the decline in loan quality. |
| | Excess real M1 balances | Upper | Loose monetary policy (excess liquidity) might lead to a currency crisis |
| | Bank deposits | Lower | Banks lose their deposits as crisis starts to hit the economy |
| Real sector[iv] | Industrial production | Lower | A recession (decline in industrial output) often leads financial crises. |
| | Equity indices | Lower | Burst of asset price bubbles (such as the US housing market bubble in 2007) often lead financial crises |

[i] See Heun (2004); Dornbusch et al. (1995)
[ii] See Edison (2003); Kaminsky and Reinhart (1999)
[iii] See Edison (2003); McKinnon and Pill (1996); Goldfajn and Valdes (1995)
[iv] See Edison (2003); Gorton (1988); Calomiris and Gorton (1991); Heun (2004)

An indicator issues a warning signal about the likely occurrence of a crisis when it crosses its threshold within a particular period called 'signalling horizon/window' of 24 months. A signal will be treated as a 'good signal' whenever it appears within the signalling horizon and a 'false signal' or 'noise' otherwise. Table-3 summarizes the signalling possibilities, which can be used to evaluate the performance of the indicators.

**Table-3: The performance of an indicator**

| | Crisis within 24 months | No crisis within 24 months |
|---|---|---|
| Signal issued | A | B (a 'false positive' = Type II error) |
| No signal issued | C (a 'miss' = Type I error) | D |

Note: The table summarizes the possible outcomes of an indicator variable. Cell A represents a good signal while cell B represents a noise or false alarm. Also note that entries C and B would be zero for a perfect indicator (i.e. a perfect indicator only has cell A and D).

In theory, if an indicator is flawless, it will give only good signals i.e. cell A and Cell D > 0 and there will be no Type I error (a 'miss'; cell C) or Type II error (a 'false positive' signal; cell B). Kaminsky et al. (1998) suggest an indicator threshold which will minimize the ratio of false signals to good signals i.e. (B / B +D)/ (A/ A+C), which they call the 'noise-to-signal ratio'. This measure will help to assess the effectiveness of the individual indicators. If the noise-to-signal ratio is below one, the indicators will be taken as significant. If the ratio is above one, the indicator will be considered insignificant and, thus, dropped.

## 3.3 Composite crisis index and probabilities of a currency crisis

### 3.3.1 Composite index

The main objective behind the use of the composite index is to merge the signals from the particular indicators in a comprehensive manner. Following Kaminsky et al. (1998), we define our composite index as a weighted average of the signals from individual indicators. The signals from the indicators are weighed by the noise-to-signal ratio of the respective indicator. Suppose the signals from indicator j in period t are given as $S_t{}^j \in \{0, 1\}$ and the noise-to-signal ratio of indicator j is denoted as $\omega j$, the weighted composite crisis index is given as;

$$K_t = \sum_{j=1}^{n} \left(\frac{1}{\omega_j}\right) s_t^j \tag{4}$$

As the weights are the inverse of the noise-to-signal ratio, this index gives greater weight to better-performing indicators (only those with a ratio below unity). Furthermore, as the index is a positive sum of the signals, there will be a higher probability that a currency crisis will occur if larger number of indicators are signalling.[26]

### 3.3.2 Probabilities of a currency crisis

The probability of the currency crisis is derived from the composite index. It is calculated by watching how frequently a crisis follows a particular value of the index within 24 months (see also Edison, 2003; Peng and Bajona, 2008; Kaminisky et al., 1998). We may formally define the conditional probabilities of a currency crisis as;

$$\Pr\left(C_{t^n,\, t+24} \,|K_t = j\right) = \frac{\text{Months with K=j and a crisis within 24 months}}{\text{Months with K=j}} \tag{5}$$

**Table-4: Composite crisis Index and Crisis probabilities**

| Value of composite crisis indicator | Probability of crisis |
|---|---|
| 0-0.6 | .14 |
| 0.6-1.2 | .12 |
| 1.2-3 | .17 |
| 3-5 | .25 |
| 5-7 | .32 |
| 7-9 | .33 |
| 9-10 | .43 |

[26]There are other ways in which the signals could be combined. One obvious technique would be to take the composite index as a simple sum of the signals. Kaminsky et al. (1998) and Edison (2003), however, show that the weighted composite index performs better.

| | |
|---|---|
| 10-11 | .51 |
| 11-12 | .49 |
| Over 12 | .50 |

Source: Edison (2003)

# 4 Results and discussion

Figure-2 and Figure-3 plot the exchange market pressure index (EMPI) for Ethiopia over the period January 1970 to December 2008, for the fixed and float (managed) exchange rate regimes respectively. Using the 1.5 standard deviation rule, we identify one longer crisis episode (October 1992-September 1993) in the fixed exchange period and two brief crisis episodes (March-July 1999 and October-December 2008) in the floating exchange regime. When the SETAR technique is employed to determine the threshold, more pressure points are identified both for the fixed and floating exchange rate regimes. The pressure points are closer to the 1.5 standard deviation rule in the case of the floating exchange rate regime. For the fixed exchange rate regime, however, the SETAR method labels wide range of periods as pressure points. We have based our analysis on the 1.5 standard deviation rule, as it is more robust.

**Figure-2: Exchange Market Pressure Index (fixed exchange)**


Note:

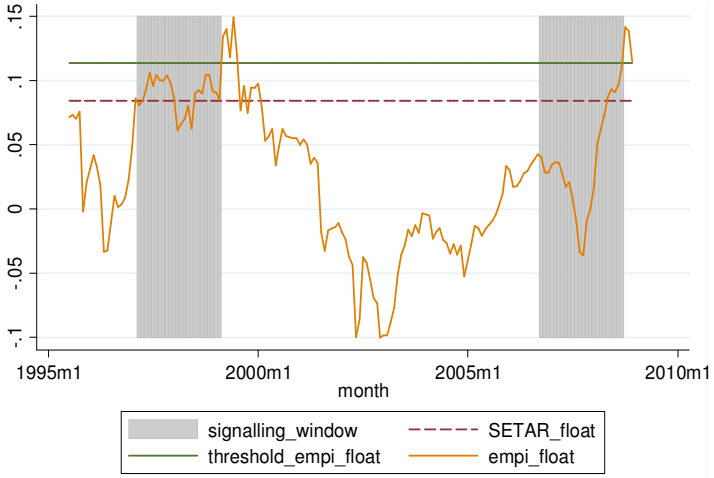
(a) The 'signalling window' represents a 24 month period before the onset of crisis. Good macroeconomic indicators of crisis will show unusual or extreme changes in this period and largely stick to their usual trend in other (normal) period.

(b) 'empi_fixed' refers to Exchange market Pressure Index (EMPI) under fixed exchange rate regime.

(c) 'threshold-empi_fixed' is the benchmark threshold, if crossed by the EMPI would represent a crisis. The threshold is computed by taking the mean of EMPI plus 1.5 of its standard deviation.

(d) 'SETAR_fixed' is an alternative threshold, if crossed by the EMPI would represent a crisis. This threshold is computed by using Self-Exciting Threshold Autoregression (SETAR) technique. It avoids arbitrary setting (self-selection) of thresholds.

**Figure-3: Exchange Market Pressure Index (managed float)**




Note:
(a) The 'signalling window' represents a 24 month period before the onset of crisis. Good macroeconomic indicators of crisis will show unusual or extreme changes in this period and largely stick to their usual trend in other (normal) period.
(b) 'empi_float' refers to Exchange market Pressure Index (EMPI) under floating exchange rate regime.
(c) 'threshold-empi_float' is the benchmark threshold, if crossed by the EMPI would represent a crisis. The threshold is computed by taking the mean of EMPI plus 1.5 of its standard deviation.
(d) 'SETAR_float' is an alternative threshold, if crossed by the EMPI would represent a crisis. This threshold is computed by using Self-Exciting Threshold Autoregression (SETAR) technique. It avoids arbitrary setting (self-selection) of thresholds.

The 1992-93 crisis was clearly grounded in domestic developments. In the early 1990s, the Ethiopian economic and political landscape was dominated by major changes. Following a shift in political power, socialist economic policies that were in place for 17 years were replaced by free market policies, backed by the World Bank and the International Monetary Fund's Structural Adjustment Programmes (SAP). The reform program liberalized exchange rate regimes and foreign trade. Discretional government interference and regulation in setting prices of goods and services were abolished.

Financial market reform opened up commercial banking, micro credit and insurance services for the private sector. Additionally, on 1st of October 1992 the local currency (birr) was devalued from an exchange rate of 2.07 birr/dollar to 5 birr/dollar. The devaluation was made with the intention of advancing local output and employment; removing the difference among the official and the parallel market rates, and enhancing foreign reserves. While still susceptible to changes in climate and foreign aid, the agriculture dominated export sector has, indeed, demonstrated advances after the country gave up the fixed exchange rate policy in 1991 and applied a sequence of macroeconomic adjustment and stabilization plans. In reforming the exchange rate regime, an auction system for foreign exchange was as well introduced in 1993 (Naude, 2008).

The 1999 crisis overlaps with the Ethio-Eritrean border clash. Eritrea seceded from Ethiopia in 1993. Following that, the two nations signed a treaty 'Agreement on Friendship and Cooperation' in 1993. According to Tronvoll (2004), the economy was, possibly, the most crucial part of that accord. In spite of the importance of the treaty, its implementation was weak and both nations went after divergent economic policies. Just before to the eruption of the armed conflict, Eritrea's principal trading partner was Ethiopia, accounting for about two-thirds of its exports (Paulos, 1999).[27] They both used a single currency (the Ethiopian birr), and the port of Assab, in Eritrea, was Ethiopia's key export outlet.

Over time, because of the increasing competition from domestic products, the demand for Eritrean goods in the Ethiopian market diminished. Eritrea laid bigger tariffs on products imported and exported by Ethiopia via the port of Assab to retaliate the new Ethiopian economic policies. Further divergences appeared regarding investment polices and the handling of investors. Eritrea desired to invest without restrictions, while Ethiopia put up confinements, especially in key sectors such as electric power supply, insurance and banking (Tronvoll, 2004). Then in November 1997, Eritrea released its own currency, the Nakfa (also Nacfa). Eritrea demanded a one-to-one parity of the Birr with the new currency and that the two currencies would freely circulate in both economies (dual currency union). These propositions were declined by Ethiopia. In January 1998, following the introduction of the Nakfa, Ethiopia also released new notes of Birr. Such economic policies and measures, added with the political unease, hastened the road to war (see Abbink, 1998 and 2003; and Gedamu, 2008).[28] Apart from the direct impact of the currency wars between the two nations, the huge cost of financing the armed conflict and its ripple effects on the overall economy (investment, trade and tourism) may explain the timing of this currency crisis.

[27] Ethiopia was the principal trading partner for Eritrea before the start of the conflict in May 1998. For instance, according to IMF (2003), more than 63% of Eritrea's exports went to Ethiopia in 1997. Further, 9% of Eritrea's imports came from Ethiopia in the same year (see Table (I) and (II) in Annex). However, given the size of unreported cross-border trade between the two countries at the time, the true level of Eritrea's dependence on its big neighbor would be much higher than these numbers suggest. After the conflict, trade between the two countries has almost entirely stopped.

[28] Before the onset of the conflict, the border was porous and people and goods moved freely between the two countries. Onother key area of economic dispute has been the fact that Eritrean businessmen have been buying Ethiopian coffee and exporting it - thus, weakening Ethiopian exports and, thus, its foreign currency earnings. This process has reportedly elevated Eritrea to become the 13th largest coffee exporter at the time - despite the fact that Eritrea didn't even grow coffee. This was facilitated by the then existing bilateral trade agreement, where Eritrean businessmen were allowed to purchase commodities in Ethiopia duty free in local currency. However, in principle, duty free trade were applicable just for purchases directed to local consumption and not re-export. Although, trade disputes such as this (and other economic woes) are mentioned as the causes of conflict, the border-dispute is seen as the single most important cause of the clash between the two neighbors (Michaelson, 1998).

Yet, the 1992-93 crisis episode also roughly corresponds to the 1992–93 crisis of European Exchange Rate Mechanism, as does the 1999 crisis with the 1997-99 Asian financial crises. However, we believe that domestic events were the key explanators of these two crisis. Further, by 1999 many emerging Asian economies were actually showing signs of recovery. The transmission of financial shocks from the Asian crisis to Sub-Saharan Africa was modest due to the undeveloped nature of financial markets and the small amount of private capital inflows (Hussain et al., 2002). The main ways through which the effect of the external crisis was felt in the region was through the decrease in prices of oil, sugar, and gold (among others) and the increase in the prices of other commodities like coffee and tea (Harris, 1999). As it took advantage of the decline in international oil price (top import item) and the rise in coffee price (top export item), the overall net effect was positive for Ethiopia. It, therefore, seems more plausible that the currency crisis was due to the political and economic conflict with Eritrea, rather than the Asian financial crisis.

The 2008 currency crisis coincides with the zenith of the global financial crisis. Like all other nations, Ethiopia has suffered to some extent from this crisis. The economy has experienced shocks through falling foreign direct investment, trade, remittances, loans and aid. Exports of commodities (coffee, horticulture, hides, cereals, cotton, sugarcane etc.) declined following the downturn in global demand. Mishra (2011) estimates that merchandise exports, merchandise imports, service exports, service imports, private financial transfers and foreign direct investment would have been 30%, 34%, 22%, 61%, 55% and 70% higher (respectively) than their actual value if the crisis didn't hit. In another study, Getnet (2010) estimates that gross domestic investment declined to 20.3% of GDP in 2008/09, from about 24% of GDP in the preceding four years. Even overall GDP growth itself declined from 10.8% in 2008 to 8.7% in 2009, though this was still high compared to other developing economies.[29] Mishra (2011) attributes the relative resilience of the Ethiopian Economy to two major factors. The first has to do with access to foreign financial aid. External financing has been recently rising in the form of long term loans from non-traditional lenders such as China. The other factor has been the policy response by the government. The policy measures included depreciation of the currency, getting rid of fuel subsidies and reducing domestic borrowing by the private and public sector.[30] While much of the rest of the world engaged in easy monetary and fiscal policies in the aftermath of the crisis, Ethiopia started following tight monetary and fiscal policies. These policies were justified as the domestic imbalance involved excess aggregate demand rather than excess aggregate supply.

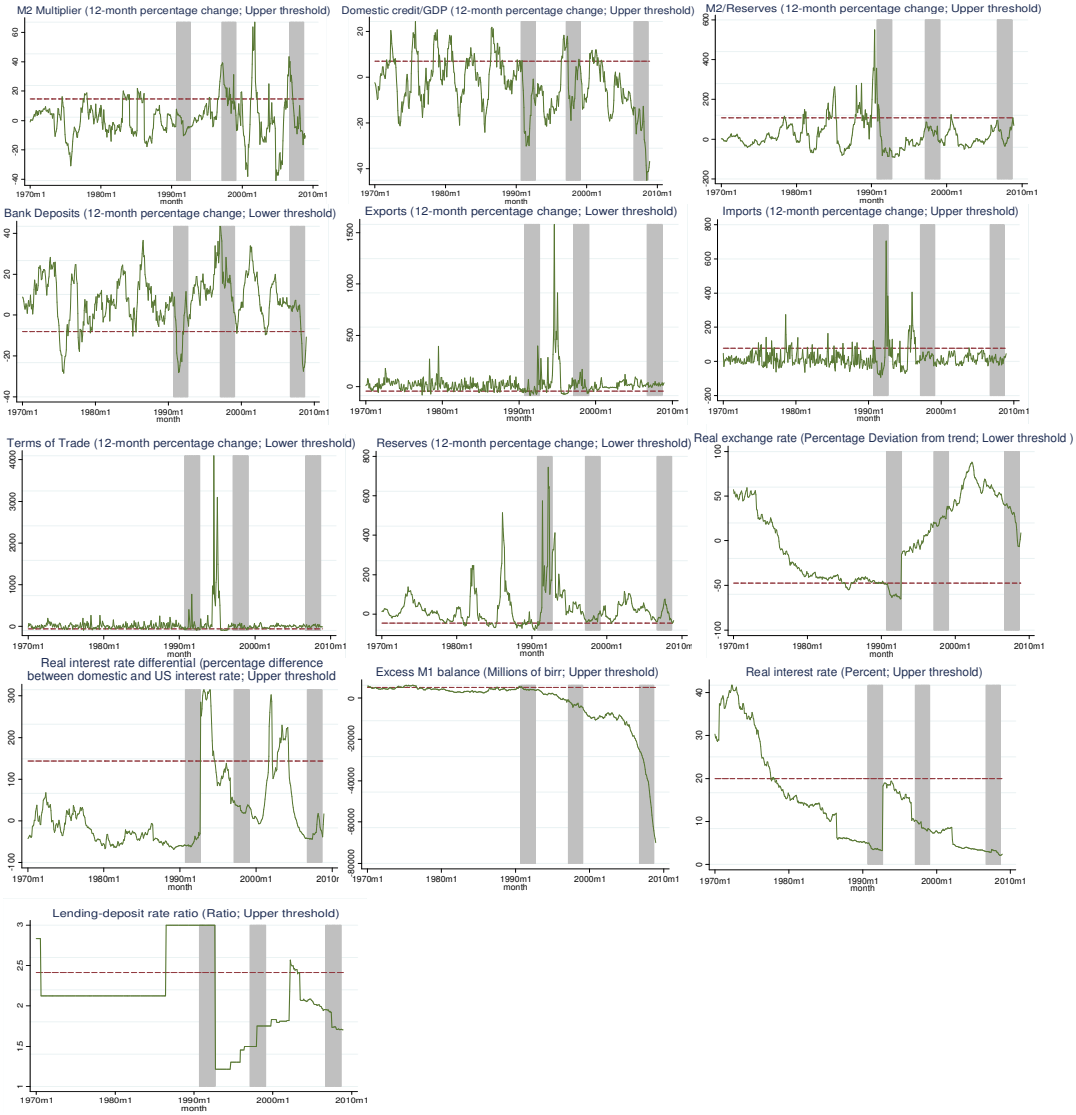
[29] The five year average GDP growth rate of Ethiopia (between 2004 and 2008) was 11.7% while for all Sub-Saharan Africa (SSA) developing economies it was 5.6% (World Bank WDI database).

[30] Recent exercises on IMF's debt Sustainability Analysis (DSA) show that Ethiopia's risk of external debt distress is low (see Megersa, 2015).

Ethiopia's vulnerability to external shocks comes from its overdependence on the export of farm items and raw materials (notably, coffee and gold) whose international prices fluctuate greatly. Considering the country's petroleum imports (which is about 5% of GDP), the rise in fuel prices might significantly affect the balance of trade. Further, vulnerability to external shocks arises from volatilities in financial flows (Lin, 2011; Essers, 2013). There is a necessity to keep sufficient amounts of foreign reserve as a buffer against exogenous shocks. Indeed, the nation had been piling up foreign reserves following the world commodity price surges of the 2000s and IMF's increased support. However, this has been partially reversed since 2011 due to big monetary injections through public infrastructural projects, rising inflation, devaluation of birr and the subsequent sales of foreign reserve to control domestic liquidity. According to IMF (2012), foreign reserves dwindled to US$2.3 billion in April 2012, compared to US$3.5 billion in September 2011. This level of reserve is able to cover just 1.8 months of potential imports (the acceptable minimum is three months of import cover). This trend puts external stability at great risk.

Having determined the periods of currency crises, we will next try to see the evolution of the indicators in the time period under consideration. We are particularly interested to see if the 13 indicators we selected can produce signals in the 24 month signalling window before the onset of the crisis. Figure-4 displays the evolution of the individual indicators over the period under consideration (January 1970 to December 2008).

**Figure-4: The indicators of vulnerability to currency crisis**




Note: The shaded region represents a 24 month period before the onset of crisis. Good macroeconomic indicators of crisis will show unusual or extreme changes in this period and largely stick to their usual trend in other (normal) period. The broken lines represent threshold lines, when crossed the respective indicator would issue a signal.

All indicators are given as annual percentage changes except for the following indicators, namely;

- excess M1 balances (given in millions of nominal currency),
- deviation of the real exchange rate from trend (given in percentage) and
- the three interest rate variables i.e. real interest rate differential, domestic real interest rate, lending-to-deposit rate ratio (given in percentage)

For all indicators in figure-4, the three shaded regions represent the 24 month period of signalling window for the three currency crises defined by the EMP index. The broken horizontal line

represents the threshold (upper or lower as defined for each indicator). The performance of the 13 indicators in figure-4 and their thresholds are summarized in Table-5.

**Table-5: Results from the signals approach**

| | Number of signals in preceding 24 months | | | | | Threshold | | Noise-to-signal ratio (Comparison to other studies) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | This Case study | Edison (2003) | | Kaminsky et al. (1998) Multi country study |
| | 1992 | 1999 | 2008 | Total (Signalling window) | Total (Signalling & tranquil) | Percentile | Value | | Mexico case study | Multi country study | |
| M2 multiplier | 0 | 13 | 5 | 18 | 70 | 85 | 14.69 | 0.53 | N/A | .86 | .61 |
| Domestic credit/GDP | 1 | 4 | 0 | 5 | 93 | 80 | 7.09 | 3.20 | N/A | .75 | .62 |
| M2/reserves | 3 | 0 | 0 | 3 | 46 | 90 | 107.81 | 2.60 | .1 | .52 | .48 |
| Bank deposits | 12 | 0 | 6 | 18 | 46 | 10 | -8.06 | 0.28 | 10.9 | .94 | 1.2 |
| Exports | 12 | 2 | 0 | 14 | 46 | 10 | -43.29 | 0.42 | 1.02 | .6 | .42 |
| Imports | 6 | 0 | 0 | 6 | 46 | 90 | 77.38 | 1.21 | .55 | .88 | 1.16 |
| Terms of Trade | 6 | 2 | 0 | 8 | 46 | 10 | -54.52 | 0.86 | N/A | .93 | .77 |
| Reserves | 3 | 0 | 0 | 3 | 46 | 10 | -46.65 | 2.61 | .86 | .53 | .57 |
| Deviation of Real ER from trend | 24 | 0 | 0 | 24 | 46 | 10 | -47.59 | 0.17 | 0 | .26 | .19 |
| Real interest rate differential | 0 | 0 | 0 | 0 | 46 | 90 | 143.63 | N/A* | N/A | 1 | .99 |
| Excess M1 balances | 2 | 0 | 0 | 2 | 46 | 90 | 5043.60 | 4.00 | .19 | .55 | .52 |
| Domestic real interest rate (deflated by cpi) | 0 | 0 | 0 | 0 | 93 | 80 | 20.00 | N/A* | N/A | .66 | .77 |
| Lending-deposit rate ratio | 24 | 0 | 0 | 24 | 93 | 80 | 2.41 | 0.52 | 3.4 | 2.7 | 1.69 |

N/A= not available N/A*= not available due to division by zero

Note: There are 468 months in the dataset (Jan 1970 to Dec 2008). 72 months (24months X 3 crisis) belong to the signalling window. The rest (396 months) are tranquil periods. The total signals received from an indicator in the 3 signalling windows (72 months) are given in column 5 of table-5. The total signals received from an indicator in the whole study period (468 months) are given in column 6 of the table. Suppose: A=column 5, B= (Column 6 – column 5), C=(72-A), D=(396-B), Then the 'noise-to-signal ratio' can be given as (B / B +D)/ (A/ A+C). In the case of indicator 'M2 multiplier' for instance, A=18; B=53 (i.e. 71-18); C=54 (i.e. 72-A) and D=343(i.e. 396-B). Thus, noise-to-signal ratio will be (53/(53+343))/ (18/(18+54)) ≈ 0.54. See table-2 and the subsequent explanation in section 3.2 for more clarification.

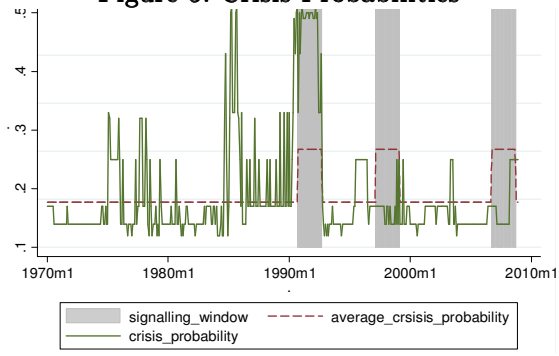
Columns (2, 3, 4 and 5) of Table-5 sum up the information about the signals in the 24 months signalling window. The sixth column gives the total signals received in the overall period under consideration, i.e. 468 months (Jan 1970 to Dec 2008). Columns 7 and 8 show threshold levels as percentiles and values of the indicator. Column 9 shows the noise-to-signal ratio for this study while the last three columns show the results from other studies, for the sake of comparison. Taking the first variable in the table (i.e. M2 multiplier), we see that the indicator gave no signals during the 24 month signalling window preceding the 1992-93 crisis. However, the indicator gave 13 and 5 signals in the signalling windows of the 1999 and 2008 crisis respectively.

During the signalling window for the 1992-93 crisis, three out of 13 variables did not issue any signal: the M2 multiplier, real interest rate differential, and domestic real interest rate. The other indicators cross their thresholds for various months and, hence, issue signals, ranging from 1 signal (domestic credit/GDP) to 12 signals (bank deposits and exports). Two indicators, deviation of real exchange rate from trend and lending-deposit rate ratio, remained above the threshold during the whole period of this signalling window. During the second signalling window, four indicators made signals ranging from 2 (exports and terms of trade) to 13 (M2 multiplier). During the third and latest signalling window, only 2 of the 13 available indicators made signals. Indicator M2 multiplier crossed its threshold 5 times while indicator Bank deposits crossed its threshold 6 times.

In accordance with the noise-to-signal ratio principle, six indicators (M2 multiplier, bank deposits, exports, terms of trade, deviation of real ER from trend and lending to deposit rate ratio) appear to be significant. Five indicators (M2 multiplier, Domestic credit/GDP, bank deposits, exports, and terms of trade) picked two of the three crises. This follows the small number of indicators signalling the 1999 and 2008 crises. Another observation is on the nature of these indicators. They were all either current account indicators (deviation of the real exchange rate, Exports and terms of trade) or domestic financial sector indicators (M2 multiplier, Bank deposits and Lending-deposit rate ratio). None of the Capital account indicators considered in the study (Foreign reserves, M2/reserves and Real interest rate differential) was a good indicator based on the noise-to-signal ratio rule.

Figure-5 gives the probability of currency crisis for Ethiopia, under the period of consideration. As we can see from figure-5, there have been multiple periods where the probability of the currency crisis has been high.

**Figure-5: Crisis Probabilities**

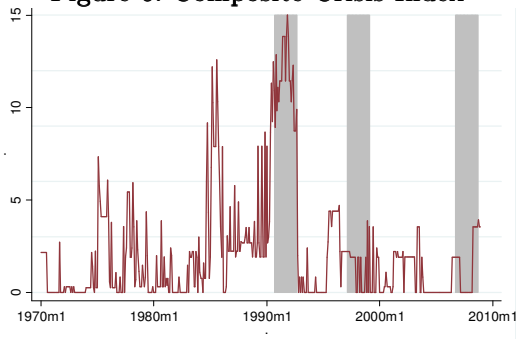



Note: The shaded regions represent a 24 month period before the onset of crisis. Good macroeconomic indicators of crisis will show unusual or extreme changes in this period and largely stick to their usual trend in other (normal) period.

The case studies made by Edison (2003) on Mexico and Peng and Bajona (2008) on China also showed that out-of-sample probabilities are irregular and not always consistent. The results sometimes showed high crisis probabilities not only in the pre-crisis periods but also in 'normal' periods where the probabilities should be low. Edison (2003), however, showed that the average crisis probabilities were generally higher in the pre-crisis signalling window compared to rest of the period under study. This holds true for this case study also (see figure-5). The average crisis probability in the signalling window (0.27) is higher than the average crisis probability in the normal period (0.18).

If we also see the composite index in figure-6, it is clearly elevated during the signalling window of the 1992-93 crises. However, the composite index values in the latter two signalling windows were not exceptionally high. This can be explained by the fact that more indicators signalled in the signalling window of the 1992-93 crisis compared to the signalling windows of the 1999 and 2008 crises.

**Figure-6: Composite Crisis Index**




Note: The shaded regions represent a 24 month period before the onset of crisis. Good macroeconomic indicators of crisis will show unusual or extreme changes in this period and largely stick to their usual trend in other (normal) period.

Our study finds local developments having more explanatory power for currency crises than external factors. This matches the reality of undeveloped capital markets in Ethiopia and the lose integration to the financial world. The first crisis was of domestic origin and was at the crossroads of major economic and political transitions in the country. For this reason, it was easily picked up by more indicators. The second crisis has domestic, regional and international elements. The third crisis has clear external roots and aligns with the time of global financial crisis. The latter two crises were not easily picked by the set of indicators we used. To this end, multilateral surveillance techniques and indicators that are good in tracking external shocks might be needed.

# 5 Conclusion

In this study, we used the signals approach (introduced by Kaminsky et al., 1998) to see as to what extent key macroeconomic indicators have predictive power for currency crisis in Ethiopia, defined by the exchange market pressure index, EMPI. Using this index (and the 1.5 standard deviations above the mean threshold), three crisis episodes were identified; October 1992-September 1993, March-July 1999 and October-December 2008. Relatively more indicators signal the first crisis than to the latter two. Consequently, the composite index and the out-of-sample crisis probabilities were quite high in the period preceding the first crisis. Out of the 13 indicators used, the M2 multiplier, bank deposits, exports, terms of trade, deviation of real ER from trend and lending-deposit rate ratio were significant according to the noise-to-signal ratio rule. Their extreme values were more or less aligned with the signalling windows preceding the crises episodes.

One suggestion that may follow our finding is that, perhaps there is room for more indicators (from both real and financial sectors) that are 'better' in capturing international contagion. In an increasingly interconnected world economy, multilateral surveillance techniques are gaining importance. If the methodological issues of crisis detection are properly addressed and the set of indicator variables are augmented to reflect international financial contagion, the signals approach may continue to be a useful instrument. The technique can be an integral part of an early warning system for different kinds of crises. By analysing past currency crises in a country (or set of countries) and the behaviour of financial indicators in the period before the onset of the crises, the approach derives key lessons. Policy makers, monetary authorities and other stakeholders may use these lessons to take precautionary measures as important financial variables start showing 'unusual' behaviour. The signals approach might, therefore, help to design a good financial early warning system and informed macroeconomic policies.

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# Annex:

Table (I): Eritrea - major export destinations (in Value and share of total)

| | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|
| | | | (In millions of nakfa) | |
| Belgium | 0.0 | 0.2 | 0.0 | 0.3 |
| Djibouti | 2.7 | 0.5 | 28.3 | 0.0 |
| Ethiopia | 238.1 | 52.2 | 0.0 | 0.0 |
| Germany | 2.1 | 3.6 | 5.6 | 4.6 |
| Italy | 18.3 | 10.4 | 8.6 | 7.4 |
| Japan | 0.0 | 26.0 | 0.0 | 0.0 |
| Korea, Rep. of | 0.0 | 0.0 | 0.5 | 0.0 |
| Netherlands | 1.4 | 5.7 | 2.6 | 9.8 |
| Saudi Arabia | 7.3 | 2.3 | 12.9 | 17.4 |
| Sudan | 62.3 | 53.5 | 54.9 | 94.8 |
| Sweden | 0.0 | 0.0 | 0.0 | 0.0 |
| United Arab Emirates | 0.9 | 14.3 | 7.4 | 0.5 |
| United Kingdom | 1.8 | 2.0 | 2.7 | 0.0 |
| United States | 3.2 | 4.0 | 4.8 | 0.0 |
| Yemen | 0.2 | 0.8 | 4.4 | 4.9 |
| Other | 37.0 | 21.4 | 30.9 | 49.0 |
| Total | 375.3 | 196.9 | 163.6 | 188.7 |
| | | | (In percent) | |
| Belgium | 0.0 | 0.1 | 0.0 | 0.2 |
| Djibouti | 0.7 | 0.3 | 17.3 | 0.0 |
| Ethiopia | 63.4 | 26.5 | 0.0 | 0.0 |
| Germany | 0.6 | 1.8 | 3.4 | 2.4 |
| Italy | 4.9 | 5.3 | 5.3 | 3.9 |
| Japan | 0.0 | 13.2 | 0.0 | 0.0 |
| Korea | 0.0 | 0.0 | 0.3 | 0.0 |
| Netherlands | 0.4 | 2.9 | 1.6 | 5.2 |
| Saudi Arabia | 1.9 | 1.2 | 7.9 | 9.2 |
| Sudan | 16.6 | 27.2 | 33.5 | 50.2 |
| Sweden | 0.0 | 0.0 | 0.0 | 0.0 |
| United Arab Emirates | 0.2 | 7.3 | 4.5 | 0.3 |
| United Kingdom | 0.5 | 1.0 | 1.7 | 0.0 |
| United States | 0.9 | 2.0 | 2.9 | 0.0 |
| Yemen | 0.1 | 0.4 | 2.7 | 2.6 |
| Other | 9.9 | 10.9 | 18.9 | 26.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Source: IMF (2003)

Table (II): Eritrea - major sources of import (in Value and share of total)

| | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|
| | | | (In millions of nakfa) | |
| Belgium | 26.8 | 47.3 | 76.8 | 118.1 |
| Djibouti | 79.0 | 57.3 | 26.6 | 15.1 |
| Ethiopia | 274.6 | 25.0 | 1.9 | 3.3 |
| Germany | 168.4 | 152.7 | 125.0 | 103.4 |
| Italy | 420.1 | 469.8 | 480.9 | 436.3 |
| Japan | 125.5 | 107.1 | 74.9 | 25.2 |
| Korea Rep. of | 0.0 | 118.4 | 33.9 | 32.3 |
| Netherlands | 51.2 | 60.1 | 88.2 | 103.7 |
| Saudi Arabia | 480.2 | 15.4 | 521.8 | 374.2 |
| Sudan | 20.3 | 22.0 | 40.7 | 52.4 |
| Sweden | 22.9 | 19.0 | 24.7 | 24.3 |
| United Arab Emirates | 402.0 | 436.8 | 603.5 | 637.0 |
| United Kingdom | 142.1 | 120.5 | 108.5 | 155.0 |
| United States | 96.4 | 113.9 | 90.9 | 177.5 |
| Yemen | 5.4 | 11.4 | 52.1 | 59.8 |
| Other | 747.3 | 916.4 | 778.2 | 1,026.4 |
| Total | 3,062.2 | 2,693.1 | 3,128.6 | 3,344.0 |
| | | | (In percent) | |
| Belgium | 0.9 | 1.8 | 2.5 | 3.5 |
| Djibouti | 2.6 | 2.1 | 0.9 | 0.5 |
| Ethiopia | 9.0 | 0.9 | 0.1 | 0.1 |
| Germany | 5.5 | 5.7 | 4.0 | 3.1 |
| Italy | 13.7 | 17.4 | 15.4 | 13.0 |
| Japan | 4.1 | 4.0 | 2.4 | 0.8 |
| Korea | 0.0 | 4.4 | 1.1 | 1.0 |
| Netherlands | 1.7 | 2.2 | 2.8 | 3.1 |
| Saudi Arabia | 15.7 | 0.6 | 16.7 | 11.2 |
| Sudan | 0.7 | 0.8 | 1.3 | 1.6 |
| Sweden | 0.7 | 0.7 | 0.8 | 0.7 |
| United Arab Emirates | 13.1 | 16.2 | 19.3 | 19.0 |
| United Kingdom | 4.6 | 4.5 | 3.5 | 4.6 |
| United States | 3.1 | 4.2 | 2.9 | 5.3 |
| Yemen | 0.2 | 0.4 | 1.7 | 1.8 |
| Other | 24.4 | 34.0 | 24.9 | 30.7 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Source: IMF (2003)

# Chapter 4

# Chapter 4: Unconventional Monetary Policy Spillovers to South Africa [†]


## Abstract

The paper investigates how recent non-standard monetary policies in advanced economies affected the returns on a wide range of South African assets. We study the impact of nearly all key unconventional monetary policies (UMP) adopted by the Federal Reserve (Fed) and European Central Bank (ECB) since the onset of the global financial crisis. We use high frequency daily data and model foreign investment flows and the returns on sovereign bond yields, credit default swaps (CDS), interbank rate, exchange rates, and key stock market indices. We control for standard monetary policy instruments, market volatility, financial news, and release of macroeconomic data. We also control for endogeneity problems using a novel methodology, 'identification through heteroscedasticity' (IH). The results show that unconventional policies of the Fed has affected South African assets. Generally, the impact of the Quantitative Easing (QE) policy has been lowering yields, lowering the interbank rate, lowering CDS spreads, boosting stock market indices and appreciation of the rand. The impact was strongest for the first phase of QE. The tapering of QE had an impact which, in most cases, reversed the impact of the QE policy. Further, the impact of ECB's 'asset purchases', 'liquidity provision', and 'collateral easing' policies had generally been appreciation of the domestic currency, reduction or sovereign bond yields and CDS, and increase in key stock market indices. Generally, the diverse set of Fed and ECB's asset purchase program had qualitatively comparable spillovers on South African financial assets, although the significance of the effects differed under various settings.



Keywords: monetary policy, spillovers, capital flows, Federal Reserve, ECB, South Africa

JEL classification: E52, E58, G15, N27



[†] A special thanks goes to Paul Reding, Jan Annaert, Janvier Nkurunziza, Jean-Marie Baland, and Guido Erreygers for their valuable comments. All remaining errors are mine.

# 1 Introduction

During the global financial crisis and the period that followed, advanced economies were gripped by retrenched economic and financial distress that limited the effectiveness of conventional monetary policies. In response, major central banks have resorted to 'unusual set of monetary tools' in the quest to deal with 'unusual set of financial and economic challenges'. However, given their size and pivotal role in the international financial system, the policy responses by the Fed (and ECB) are thought to have brought knock-on effects on other economies - far and beyond their own borders. In recent years, a number of studies have taken on the challenge of analyzing these monetary spillovers. Initial studies have focused on analyzing the impact of Fed's QE policies on the rest of the world (e.g. Aizenman et al., 2014; Chen et al., 2014; Lim et al., 2014; Fratzscher et al., 2013).

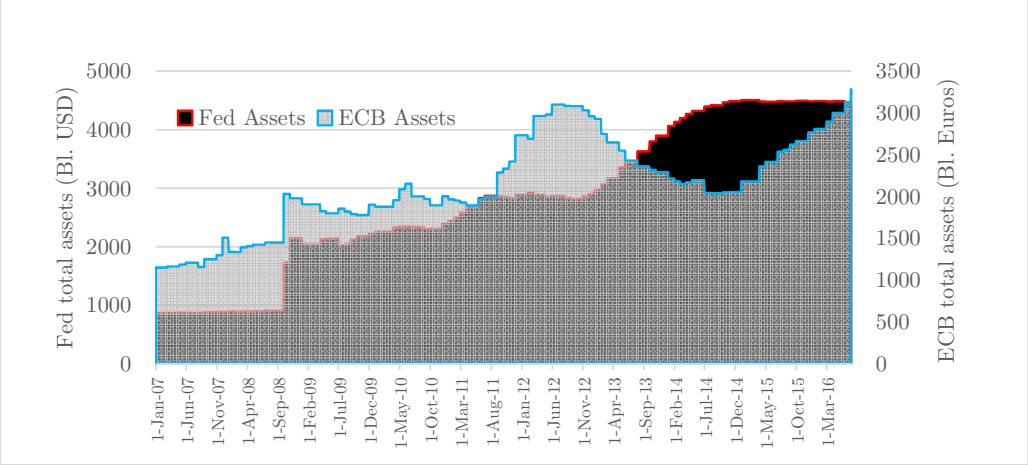
Since the Eurozone crisis, the ECB has also started adopting similar bold unconventional monetary responses to deal with liquidity problems in the Eurozone. Given the expansion of Fed and ECB balance sheets by trillions of dollars and euros following their massive financial market operations (see Figure 1), it is not difficult to assume that there would be a global ramification (Fawley and Neely, 2012; Fratzscher et al., 2016). This is especially true for those economies that are highly connected to international financial markets. Due to ECB's more active role in its market, in recent years, various studies have also tried to analyze the spillover effects of its non-standard monetary policies (e.g. Kucharcukova et al., 2016; Falagiarda et al., 2015; Fratzscher et al., 2016). Big central banks often follow these policies in response to localized problems. For instance, the ECB was fighting liquidity difficulties in specific Euro area economies (or specific asset markets) and persistently low levels of inflation in much of the Eurozone with waves of conventional (e.g. policy rate adjustments) and unconventional (e.g. asset purchase programs) tools. However, as Falagiarda et al. (2015) note, other economies outside the Eurozone that are tightly linked to the Eurozone via financial and real market linkages have faced the unintended consequences of these operations.

This study examines the international propagation of spillovers from non-standard (also called 'unconventional') monetary policies adopted in advanced economies, although standard monetary policy events are also used as controls. The focus will especially be on the policies adopted by the US Fed and Eurozone's ECB.[31] The empirical analysis will focus on a case study conducted on South Africa (SA). The objective here is to deliver an in-depth study on the

[31] The study makes a comprehensive empirical assessment of all major non-standard monetary spillovers from both the US Federal Reserve and ECB using high frequency daily data on asset returns.

country.[32] This enables us to thoroughly assess the internal policy environment and macroeconomic fundamentals that determine how external policy experiments (shocks) get transmitted to the local financial market and make an impact.[33]

**Figure 1: Federal Reserve & ECB balance sheets**




Source: using FRED data[34]

The experiences of individual emerging economies and the degree to which they are affected by international policy environment depends on their domestic monetary policy environment and fundamentals.[35] For instance, unique individual country events, such as macroeconomic data releases and the fact that they are higher or lower than forecasts (i.e. expectations) will drive asset prices in a special way for a specific economy.[36] As such, the experience of individual emerging economies and their vulnerability to the unconventional monetary shocks becomes heterogeneous and different from one another. Therefore, this case study will offer an inquiry focused on one key emerging economy, i.e. South Africa.

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[32] By focusing on South Africa, we get the opportunity to model local events and policy changes that might uniquely explain the country's susceptibility to monetary spillovers.

[33] In doing so, this research complements studies which analyze panels of (diverse) emerging economies. Apart from delivering just the average picture, cross-country studies of monetary spillovers give limited room to country-specific information. This partially has to do with the difficulty of focusing on detailed internal dynamics of multiple countries at the same time.

[34] Federal Reserve Economic Data (FRED)

[35] Although the scope, methodology, type and volume of data analyzed makes this study unique; there are some case studies and reports (mostly descriptive) that have assessed the impact of recent monetary policy shocks on South Africa. One such study is that of BIS (2014), which was a report produced together with the South African Reserve Bank. It presents a basic descriptive discussion of how Fed's unconventional asset purchase programs - and its later tapering - might affect South Africa and how the country's central bank dealt with it. The preliminary assessments of the report largely back the findings of this empirical exercise.

[36] A case study enables us to study (in detail) how external monetary policy shock might affects diverse asset classes in different ways.

The paper will follow the following structure. Section 2 will discuss the pattern of international financial flows to South Africa. Section 3 will discuss the methodology and data used in the paper. Section 4 will deliver the main analysis and results, by focusing on specific transmission channels of policy spillovers from Fed and ECB's unconventional monetary policies. Section 5 conducts a range of robustness exercises. Section 6 concludes the paper.

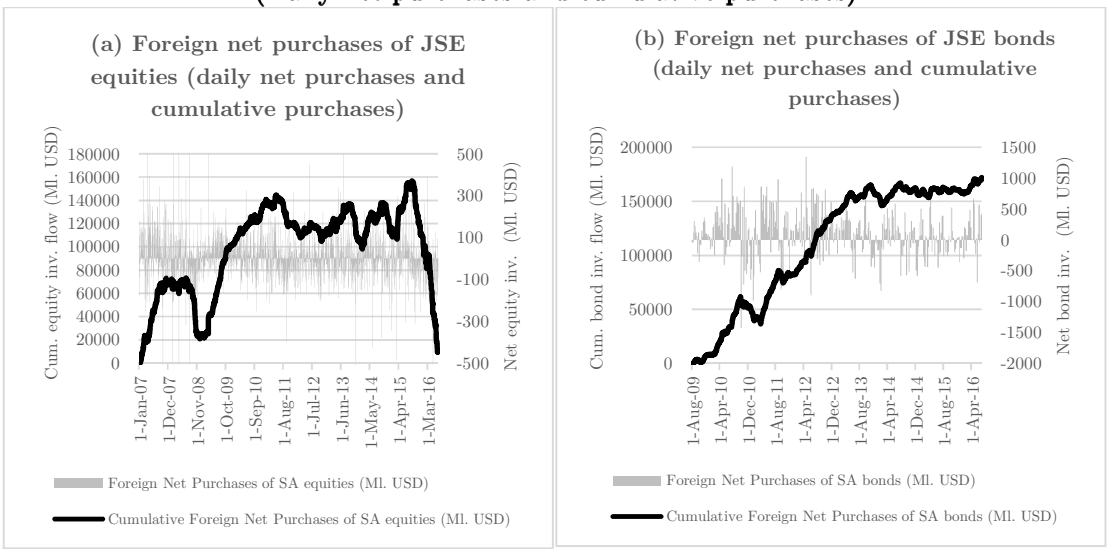
# 2 Financial flows to South Africa

South Africa has one of the most open economies in the developing world, with a highly-developed banking and finance industries. In fact, its stock market (JSE limited), is the 17th largest in the world as of 2015 by market capitalization. JSE's market capitalization of over 900 billion USD (as of Jan. 2015) was more than two and half times the size of the country's GDP itself. Net portfolio investment inflows in to equities of the country rose in the early 2000s. Conversely, South Africa experienced a net outflow of portfolio investments from equities worth 4.7 billion USD in 2008, in connection with the global financial crisis. Similarly, net portfolio investments in bonds fell from 6.8 billion USD in 2007 to a net outflow of 2.4 billion USD in 2008. The country recovered to significant portfolio equity investment inflows in 2009 worth 9.4 billion USD. However, it again witnessed significant outflows in 2011 worth 3.8 billion USD (WDI, 2016). This coincides with heightened distress in international markets, especially second half of 2011, and fear of a 'second recession' (Fawley and Neely, 2013).[37] Generally, the country has been switching between brief cycles of significant foreign investment inflows and outflows in to its financial securities, since 2008. These cycles also match international economic environment and monetary policy actions of key central banks, as we will discuss in subsequent sections.

Looking at high frequency depiction of financial transitions by foreigners in South Africa (Figure 2), there are numerous brief 'financial cycles' of significant inflows and outflows in to bonds and equities. However, focusing on the cumulative net purchases of both bonds and equities in recent years, we notice that foreign investors have been net sellers of equities on the JSE market while they have become net buyers of bonds on the market. We generally observe this divergence between foreign bond holdings vis-à-vis shareholdings since late 2011. The net sells of equities by foreign investors on JSE has, however, dramatically increased since early 2016, where the market has seen outflows worth billions of Rands - in a feat not seen since the financial crisis. This is particularly driven by recent economic and political difficulties (and waning confidence) in the country, as well as due to higher yields on bonds.

[37] The distress in financial markets in this period could also be seen from the 'market volatility' indices given in Figure 1.3 in Annex 4.

**Figure 2: Foreign net purchases of JSE equities and bonds (Daily net purchases and cumulative purchases)**




Source: using Datastream

**Table 1: Foreign banks' claims (consolidated positions) on South African counterparties (Amounts outstanding, Mill. USD - 2016, Quarter 4)**

| | Claims on an immediate counterparty | | | | Net risk transfers (Q) [1] | Claims on an ultimate risk basis (U=F+Q)[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | International | | | | By sector of counterparty | | | | |
| | Total | Total | Of which: Up to and including one year | Local positions in local currencies | | Total | Banks | Official sector | Non-bank private sector | |
| | | | | | | | | | Total | Of which: Non-bank financial |
| **Foreign banks** | **102,679** | **33,865** | **11,754** | **68,814** | **–1,064** | **97,371** | **10,026** | **18,127** | **69,202** | **10,493** |
| Of which: parents | 99,922 | 31,107 | 10,419 | 68,814 | –1,064 | 97,371 | 10,026 | 18,127 | 69,202 | 10,493 |
| Australia | 404 | 404 | 53 | ... | 216 | 619 | 44 | 1 | 574 | ... |
| Austria | 111 | 111 | 29 | ... | –53 | 58 | 16 | 35 | 3 | ... |
| Belgium | 19 | 19 | 8 | ... | 0 | 18 | 7 | ... | 11 | ... |
| Brazil | 1 | 1 | ... | ... | ... | ... | ... | ... | ... | ... |
| Canada | 203 | 203 | 39 | ... | | 262 | | | 226 | |
| Chile | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Chinese Taipei | 534 | 434 | 204 | 100 | 97 | 631 | 431 | 35 | 165 | ... |
| Finland | | | | ... | ... | | | ... | ... | ... |
| France | 4,454 | 3,548 | 184 | 906 | –770 | 3,684 | 825 | 608 | 2,251 | 102 |
| Germany | 4,232 | | | | –1,320 | 2,912 | 840 | 299 | 1,761 | 40 |
| Greece | 171 | 24 | 16 | 147 | ... | 171 | 14 | 5 | 153 | ... |
| Ireland | 42 | 42 | 3 | ... | -1 | 41 | 2 | ... | 40 | 1 |
| Italy | 672 | 672 | 22 | ... | | 629 | 66 | 77 | 487 | 0 |
| Japan | 8,863 | 8,863 | 1,252 | ... | 275 | 9,138 | 1,154 | 2,026 | 5,958 | 1,244 |
| Korea | 191 | 191 | 174 | ... | ... | 191 | 21 | 0 | 170 | ... |
| Mexico | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Netherlands | 590 | | | ... | | 716 | | ... | | |
| Panama | 5 | 5 | 1 | ... | ... | ... | ... | ... | ... | ... |
| Spain | | 167 | 99 | | -106 | 61 | 15 | | 46 | ... |
| Sweden | 68 | 68 | 37 | ... | –31 | 37 | 3 | 0 | 34 | ... |
| Switzerland | 1,234 | 1,234 | 785 | ... | 158 | | ... | ... | ... | ... |
| Turkey | 4 | 4 | | ... | | 4 | | ... | | ... |
| United | 65,532 | 4,488 | 2,553 | 61,044 | –225 | 65,307 | 3,130 | 12,379 | 49,798 | 7,227 |
| United States | 10,377 | 5,615 | 3,537 | 4,762 | 558 | 10,933 | 2,535 | 2,609 | 5,789 | 1,832 |
| Memo:Domest. | | | | | | | | | | |
| Worldwide | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Foreign offices | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

Source: BIS Consolidated banking statistics

Note:

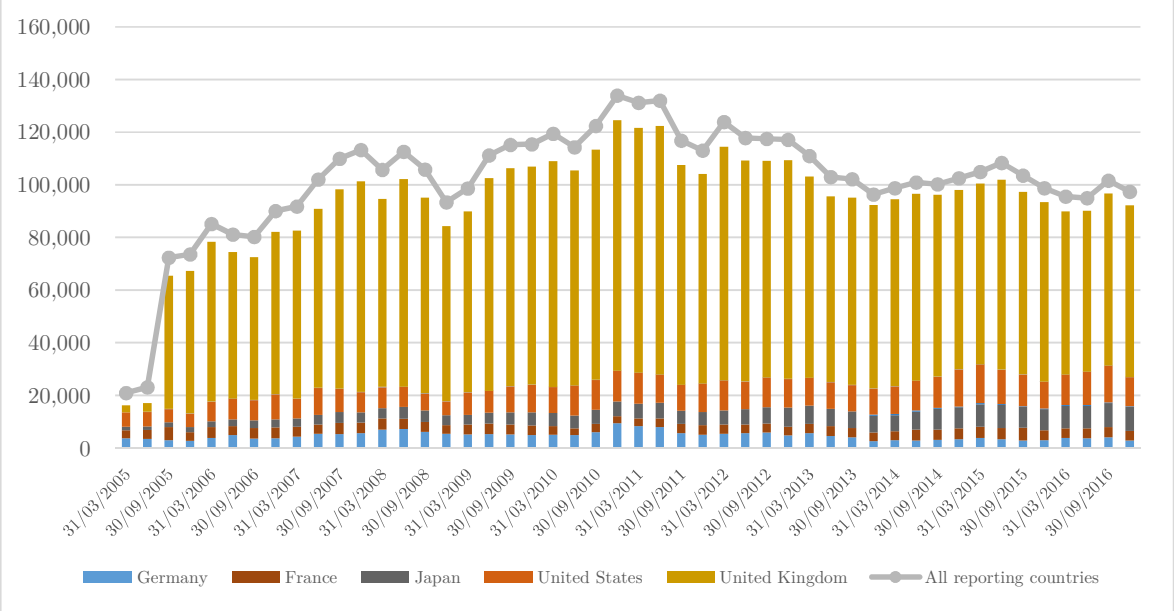
(1) For foreign banks and banks with parents in CBS-reporting countries, F plus Q does not sum to U because F is reported by a larger sample of banks; for the latest quarter, immediate counterparty data are reported by banks in 31 countries and ultimate risk

data by banks in 26. For parents in individual CBS-reporting countries, F plus Q may not sum to U because of rounding differences or inconsistencies in the underlying data reported by banks.
(2) Positions on the country where the controlling parent is located, i.e. on residents of banks' home country. Available only for countries that are CBS-reporting countries.

European economies, the US and Japan are the most important sources of financial inflows. As data from Consolidated Banking Statistics (CBS) of Bank of International Settlement (BIS) shows, foreign banks had close to 100 billion USD worth of claims on various South African counterparties (banks, non-bank private sector, public sector), in the last quarter of 2016. Of this, UK, US, Japan, France and Germany were sources of close to 95% of the cross-border financial flows to South Africa. The dominant role of these countries, as key source of financial flows, has persisted over the years. The only exception has been that of the UK, which has considerably increased its investment in South Africa in the early 2000s. As of 2016 (Quarter 4), UK accounts around 65% of all cross-border claims (see Table 1).

Most of the cross-border financial flows (about 70% of the foreign claims on South Africa or more than 69 billion USD) were directed to the non-bank private sector. Claims of foreign banks on South African banks amounted to 10 billion USD, while the figure for the public sector was slightly over 18 billion USD.

**Figure 3: Consolidated positions on counterparties resident in South Africa (All sectors, USD Mill.)**




Source: using BIS Consolidated banking statistics

The cross-border financial flow between South Africa and its external partners is also facilitated by the fact that a number of foreign controlled banks, or branches of foreign banks, are operational in the market. This includes Absa Bank, whose majority stake (more than 62%) is controlled by Barclays Bank PLC (UK) and branches of major international banks such as Citibank, Bank of China, China Construction Bank, HSBC, Standard Chartered Bank, Deutsche

Bank, JPMorgan Chase Bank, etc. (Table 2). Of these foreign controlled banks or local branches of multinational banks, Absa bank (currently called 'Barclays Africa Group') is the only one that qualifies to be 'systemic' (see Figure 4 (a) and (b)). It dominates the country's banking industry, along with big domestic banks like Standard bank, FirstRand bank, and Nedbank. The role of other foreign banks is visible just in the foreign currency market (Table 2).

**Table 2: Total assets of major domestic & foreign banks in South Africa (Bill. Rand, Feb. 2013)**

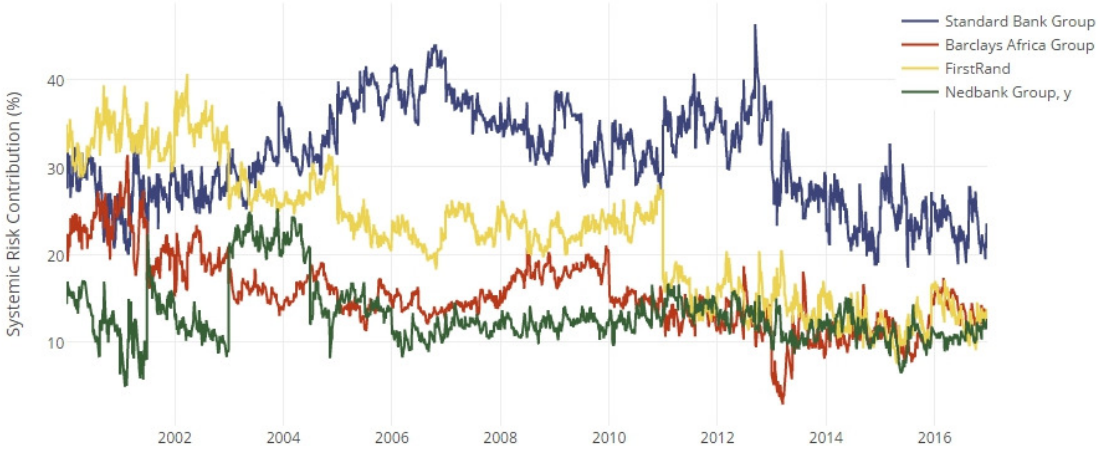
| Bank | Foreign Bank Branch (B), Foreign Controlled (C) | Foreign currency loans & advances | Central bank money & gold | SA banks | Mortgage advances | Overdrafts, loans & advances: private sector | Investments | Total assets ‡ |
|---|---|---|---|---|---|---|---|---|
| The Standard Bank of SA Ltd | | 116.02 | 20.91 | 23.45 | 321.93 | 147.64 | 174.7 | 963.4 |
| FirstRand Bank Ltd | | 29.27 | 20.33 | 12.2 | 174.6 | 157.47 | 136.04 | 733.38 |
| Absa Bank Ltd | Yes(C) | 27.41 | 19.77 | 4.59 | 277.48 | 145.34 | 156.68 | 765.63 |
| Nedbank Ltd | | 25.12 | 22.84 | 11.44 | 221.7 | 137.23 | 68.58 | 617.16 |
| Investec Bank Ltd | | 16.89 | 4.37 | 11.24 | 79.61 | 56.37 | 76.48 | 260.01 |
| Citibank N.A | Yes(B) | 15.2 | 0.97 | 4.74 | | 8.16 | 18.17 | 48.81 |
| Bank of China Ltd – Jhb branch | Yes(B) | 7.8 | 0.13 | 0.61 | 0.01 | 1.98 | 0.36 | 10.89 |
| China Construction Bank Corporation – Jhb branch | Yes(B) | 7.76 | 0.20 | 0.56 | | 2.82 | 2.2 | 14.07 |
| HSBC – Jhb branch | Yes(B) | 7.58 | 0.5 | 0.16 | | 3.44 | 15.35 | 38.36 |
| Standard Chartered Bank | Yes(B) | 4.39 | 0.52 | 3.12 | 0.14 | 6.32 | 5.46 | 20.22 |
| Deutsche Bank Ag | Yes(B) | 3.52 | 0.01 | | | 0.64 | 13.11 | 17.98 |
| JPMorgan Chase Bank | Yes(B) | 1.43 | 0.23 | 0.15 | | 4.32 | 20.23 | 35.12 |
| Bank of Taiwan – SA branch | Yes(B) | 1.16 | 0.05 | 0.01 | 0.53 | 0.19 | 0.15 | 2.09 |
| State Bank of India | Yes(B) | 0.41 | 0.03 | 0.37 | 0.02 | 0.91 | 0.63 | 2.33 |
| Bidvest Bank Limited | | 0.24 | 0.11 | 1.06 | 0.13 | 0.18 | 0.17 | 4.1 |
| Bank of Baroda | Yes(B) | 0.2 | 0.02 | 0.28 | 0.09 | 0.79 | 0.09 | 1.45 |
| HBZ Bank Ltd | Yes(C) | 0.2 | 0.04 | 1.44 | 0.23 | 0.7 | 0.5 | 3.13 |
| Mercantile Bank Ltd | Yes(C) | 0.16 | 0.17 | 0.00 | 2.44 | 3.09 | 0.3 | 7.06 |
| Sasfin Bank Ltd | | 0.04 | 0.05 | 0.54 | | 0.84 | 0.52 | 3.07 |
| Habib Overseas Bank Ltd | Yes(C) | 0.03 | 0.02 | 0.57 | | 0.28 | 0.13 | 1.03 |
| The S A Bank of Athens Ltd | Yes(C) | 0.03 | 0.05 | 0.09 | 0.99 | 0.29 | 0.09 | 2.01 |
| Société Générale–Jhb branch | Yes(B) | 0.02 | 0.00 | 5.49 | | 0.22 | 0.47 | 6.46 |
| Capitec Bank | | 0.00 | 2.04 | 3.2 | | 31.39 | 3.23 | 38.34 |
| African Bank Ltd | | | 1.28 | 3.19 | | 54.09 | 4.25 | 65.9 |
| Albaraka Bank Ltd | Yes(C) | | 0.18 | 0.77 | 1.97 | | 0.45 | 3.85 |
| Bank of India | Yes(B) | | 0.00 | 0.23 | | 0.02 | 0.00 | 0.25 |
| BNP Paribas SA | Yes(B) | | 0.00 | 0.35 | | | | 0.36 |
| Finbond Mutual Bank | | | 0.00 | 0.06 | | 0.29 | | 0.62 |
| GBS Mutual Bank | | | 0.02 | 0.04 | 0.5 | 0.01 | 0.09 | 0.91 |
| Grindrod Bank Ltd | | | 0.34 | 1.83 | 0.84 | 1.89 | 0.34 | 6.01 |
| Ubank Limited | | | 0.3 | 0.54 | | 1.27 | 1.19 | 3.63 |
| VBS Mutual Bank | | | 0.01 | 0.05 | 0.24 | 0 | 0.01 | 0.31 |
| Total | | 264.88 | 95.47 | 92.34 | 1083.45 | 768.18 | 699.95 | 3677.94 |

Source: PWC (2013)

Note:

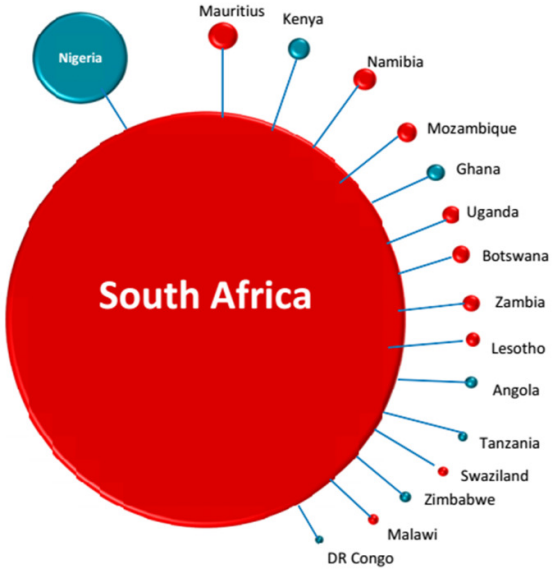
‡ Total assets includes other assets not shown in the table. Such as, Credit card debtors; Overdrafts, loans and advances to public and private sector; non-financial assets, etc.

**Figure 4 (a): Major South African Banks: Systemic Risk Contribution**




Source: AIFMRM [38]

**Figure 4 (b): Standard Bank: Systemic position in African banking networks**




Sources: Mecagni et al. (2015)
Note:
(a) Figure depicts Standard Bank (South Africa) and its various markets of operation within Africa
(b) Countries in which Standard Bank is 'systemically important' (i.e. the bank's deposit share exceeds 10% of respective country's banking system deposits) are represented in red
(c) The size of each ball indicates the asset share in consolidated assets of that subsidiary

The fact that South Africa i) witnesses significant cross-border capital flow ii) has a banking industry that sees considerable involvement of major foreign banks and banking groups; leads us to argue that it will be susceptible to financial shocks and spillovers that are international in nature. Further, given that its own banks are operational in various emerging and frontier

[38] African Institute of Financial Markets and Risk Management (AIFMRM) http://www.systemicrisk.org.za/

economies, especially those in Africa; the dynamics in South Africa's financial sector will be of interest to them.[39] For instance, Standard Bank, the largest bank in the country with a market share of around 25% of the domestic banking industry (BAS, 2014), is also systemic[40] in about nine other African economies (see Figure 4 (b) and Mecagni et al., 2015).[41]

# 3 Methodology and data

In this study, we will try to identify how the announcement of unconventional monetary policies by the Fed and ECB have affected a diverse set of asset classes in South Africa. Using daily data that extends over the Jan 01, 2007 to June 30, 2016 period, we highlight the international spillovers of these recent policies.[42] Apart from the announcement of non-standard monetary policies by ECB and Fed, we also make controls for local monetary policy decisions, i.e. from South African Reserve Bank (SARB), and release of key macroeconomic data. Including the later information is useful as the release of data (e.g. employment, industrial output, exports, etc.) has an impact on investor sentiment, and thus, affects cross-border flow of capital.

The key monetary policy announcements might be conveyed through press releases, speeches and conferences (see Tables in Annex 3). With regards to Fed's policy communications, we focus on the three waves of the Quantitative Easing (QE) policy and also its tapering, see Table A1 in Annex 3. We also study the impact of ECB's 'asset purchases', 'liquidity provision', and 'collateral easing' policies.

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[39] Apart from the financial connection created by SA banks with various Southern African countries, another important link is the Common Monetary Area (CMA). The CMA is a monetary zone between Lesotho, Swaziland, Namibia vis-à-vis South Africa. The SA rand is a legal tender in all CMA countries - although, the member states also issue their own currencies. Yet, their national currencies are pegged at par to the rand (Wang et al., 2007). This creates another source of vulnerability to these economies by tying their financial cycles with their bigger neighbour, South Africa.

[40] A 'systemic' bank here refers to banks with deposit share exceeding 10% of total banking system deposits (Mecagni et al., 2015).

[41] The South African banking industry is dominated by four large banking groups, namely: Standard Bank, First Rand, Barclays Africa Group (formerly ABSA group), and Nedbank (originally Netherlands Bank of South Africa Limited). These banking groups have international operations and subsidiaries. For instance, Standard Bank has made expansions and acquisitions in to various African countries (Cote d'Ivoire, Mozambique, Nigeria, Malawi, Tanzania, and Uganda) and other international markets (e.g. Argentina, UK, Turkey, Russia, etc). Some of these banks are owned either by major international banking groups (e.g. ABSA) or by institutional and private investors on the JSE limited (e.g. First Rand and Nedbank).

[42] The empirical analysis focuses on the Jan 01, 2007 to June 30, 2016 period - i.e. the period since the Global Financial Crisis when unconventional monetary policies became operational in advanced economies. However, we also use the data over the Jan 01, 2000 to June 30, 2016 period to compare the dynamics of various South African assets before and after the crisis (e.g. see Table 3.1, Table 3.1, Table 3.1, Table 5.1).

## 3.1 Empirical method

The econometric model adopted here closely follows those of Fallagiarda et al. (2015), Fratzscher et al. (2016); Chen et al. (2014) and Szczerbowicz (2015). We will estimate the following model while trying to capture the impact of unconventional external monetary policies on key South African financial assets.

$$\Delta Y_t = \alpha + \beta UMP_t^F + \gamma_1 \Delta IR_t^F + \gamma_2 \Delta IR_t^{SA} + \theta_1 \Delta MKTVolatility_t + \theta_2 News_t + \varepsilon_t \qquad (1)$$

Where, $\Delta Y_t$ represents the return on our set of dependent variables (i.e. financial assets) such as the returns on bilateral exchange rates (Rand vs USD and Rand vs Euro), JSE stock market indices, 3 month interbank rate, sovereign bond yields of 5 and 10 years, credit default swap (CDS) of 5 and 10 years as well as foreign investment flows in to equities and bonds. The choice of these financial assets also closely follows the literature (e.g. Fratzscher et al. 2016; Hofmann and Takats, 2015; Fallagiarda et al., 2015; Chen et al., 2014; Fratzscher et al., 2013). Further, $UMP_t^F$ accounts for unconventional monetary announcements by the US Fed and ECB. These are event dummies that will assume the value of '1' on the days of the event and '0' otherwise. $IR_t^F$ represents US Federal Funds rate and ECB's policy rate while $IR_t^{RSA}$ represents South Africa's policy rate. $MKTVolatility_t$ captures market volatility.[43] Further, $News_t$ accounts for key news items in the financial media and the publication of key South African macroeconomic data.[44] We additionally account for the fact that the data releases could be above or below market forecast or expectation (e.g. increase in employment, rise in industrial output, decrease in deficit, etc.)[45]

## 3.2 Data

**A)** Unconventional monetary policy measures (Shock-I): (Sources: Fed, ECB, Literature)
All major asset purchase programs, their date of announcements, actual market commencements and termination, and also other key non-standard market operations by US Fed and ECB, in the period since the global financial crisis, is considered (see Table A1 and A2 in Annex 3).

**B)** Conventional monetary policy measures (shock-II): (Sources: SARB, Fed, ECB)
All interest rate cuts and hikes on the Jan 01, 2007-June 30, 2016 period for SARB, Fed and ECB. This includes a review of large number of SARB Monetary Policy Committee meeting briefs and their key rate decisions (see Table A3 in Annex 3).

**C)** Asset classes and financial flows (dependent variables): (Sources: Datastream)

[43] We use the SAVI index to proxy volatility in the South African Market and the VSTOXX index for volatility in external markets. See Figure 1.3 in Annex 4 for an overview of their historical dynamics.
[44] As a number of papers in the literature note (e.g. Fratzscher et al., 2016; Fallagiarda et al., 2015), the release of major macroeconomic statistics might affect our financial variables.
[45] Both actual values of data releases as well as forecasts are taken from Tradingeconomies.

➢ Exchange rates
- South African Rand to USD
- South African Rand to Euro

➢ Key government bond yields
- South African Government benchmark 5 year yields
- South African Government benchmark 10 year yields

➢ Credit Default Swaps (CDS)
- South African Sovereign CDS - 5 years
- South African Sovereign CDS - 10 years

➢ Interbank rate
- South Africa Interbank Rate - 3M

➢ Stock market Indices
- JSE All share price index
- JSE Financial & Industrial index

➢ Investment flows
- Foreign net purchases of JSE equities
- Foreign net purchases of JSE bonds

**D)** Market Volatility: (Sources: Datastream)
- Global market volatility index
- South African market volatility index

**E)** News on financial media relating to SARB: (source: Financial Times)

Event dates for news items on Financial Times relating to South African Reserve Bank; where the search is conducted on Financial Times news archives using the search terms "South African Reserve Bank" and "SARB" (see Table A4 in Annex 3).

**F)** News and market surprise relating to macroeconomic data releases: (source: Trading economies)

Dates of various macroeconomic data releases, and information on whether the data released was higher or lower than forecasts. These key information reflect the economic fundamentals of the South African economy and determine the strength or vulnerability of the local economy to external shocks. The key macro data releases covered include:

- Balance of Trade
- Barclays Manufacturing PMI [46]
- KAGISO Manufacturing PMI
- Standard Bank PMI
- Business Confidence
- Consumer Confidence
- Core Inflation Rate
- Foreign Exchange Reserves
- Current Account
- GDP Growth Rate
- Gold Production
- Industrial Production
- Inflation Rate
- M3 Money Supply
- Manufacturing Prod
- Mining Production
- Private Sector Credit
- Producer Price Index
- Retail Sales
- Reuters Econometer
- Total New Vehicle Sales
- Unemployment

For more details and summary statistics on these variables, see Annex 5 (particularly Tables 1.1, 1.2 and 1.3).

# 4 Transmission channels and analysis of impact

The transmission channels for the non-standard monetary policies (see Annex 2 and 3 for a detailed list of these policies) are not mutually exclusive and could operate side by side, Fratzscher et al. (2016). Therefore, it can become challenging to separate one from the other. Further, different studies adopt different techniques to model the transmission channels (e.g. Georgiadis, 2015; Aizenman et al., 2014; Fratzscher et al., 2016; Bauer and Neely, 2013; Fratzscher et al., 2013; Christensen and Rudebusch, 2012; Krishnamurthy and Vissing-Jorgensen, 2011).

As Hausken and Ncube (2013) note, non-standard monetary interventions such as QE follow the same purpose as cutting the policy rate (i.e. standard monetary intervention). When central banks announce large scale asset purchase programs, they deliver a picture of future monetary policies to market actors such as financial institutions and investors.[47] In other words, it shows to the market that central banks are dedicated to keep interest rates 'low', and boost economic activity and financial transactions. This gives the market the 'certainty' and 'confidence' it needs for 'normal' operation in 'abnormal' times. A QE backed interest rate cut will have more power in generating market confidence than a mere policy rate cut for a simple reason: policy cuts could easily be reversed by central banks, making the future of monetary policy path less certain.[48] However, when QE follows rate cuts, it is difficult for central banks to abruptly reverse

[46] Purchasing Managers' Index (PMI) is an indicator of the manufacturing sector's business conditions. Purchasing managers of firms at manufacturing, construction and/or services sectors will be tracked by PMI surveys to determine sentiments. PMI surveys often track trends in production, orders, inventories, employment, prices, etc. (See https://www.bloomberg.com/quote/SAPMI:IND)

[47] This is sometimes termed as the 'signaling channel'.

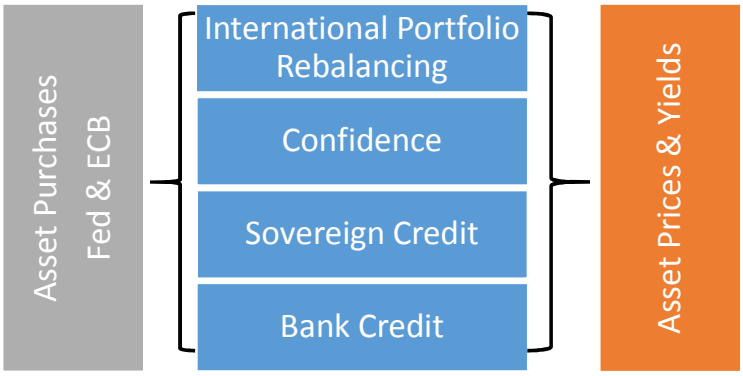
[48] However, sudden rate hikes by major central banks are less common in recent years due to very slow recovery in advanced economies.

monetary policy. A sudden rate hike will bring big losses up on central bank assets purchased under the QE policy.

Big asset purchase programs have the power of altering the relative supply of assets that are being purchased in the market, since central banks purchase large quantities of private sector assets. Their actions, therefore, have impacts on the relative yields of various assets (Krishnamurthy and Vissing-Jorgensen, 2011; Hauksen and Ncube, 2013, Andrade et al., 2016). QE, for instance, raises the prices of asset classes that are under purchase and their 'substitute assets' (i.e. assets that share close characteristics), relative to the price of other (non-substitute) assets. This is addressed in the literature as the "Portfolio rebalancing" effect. The asset purchases by central banks under QE injects liquidity to markets. Therefore, QE may also increase asset prices due to the reductions of 'illiquidity Premiums' (Joyce et al., 2012). Conversely, as Krishnamurthy and Vissing-Jorgensen (2011) note, QE might increase government bond yields (relative to other more liquid assets). This is possible due to QE's role in liquidity expansion and reductions in risk-premia of sovereign bonds. Nevertheless, such effects will only be limited to the period were central banks are in the process of conducting their asset purchases (Hauksen and Ncube, 2013).

In addition to their effect on asset prices, 'asset purchase programs' might also have an impact on the real sector, since they might also affect inflation and economic growth. With improved market liquidity and rise in market confidence, banks might be motivated to lend more for real economic activity. However, there was limited empirical evidence for this as banks (following the global financial crisis, weak capital fixation, and era of deleveraging) chose instead to hold on to central bank injections - rather than lend it out. The boost to confidence following QE might also lead to more investments by firms and spending by consumers.

**Chart 1: The transmission channels of QE**




The key channels of transmission, however, could be grouped in to the following core categories:

### 4.1 'International portfolio balance' channel:

Non-standard monetary policies are mainly set up to bring changes in the yields and prices on local assets. However, this could also have a global reach as 'substitute assets' in other countries could be affected by the unconventional monetary policies. Whenever the Fed and ECB buy US and Euro-area bonds, the yields on these bonds decline as compared to the yields on similar assets (e.g. sovereign bonds) in emerging markets. In such circumstances, investors that are looking for assets with higher yield - factoring in their risks - would move on to emerging markets (Mohanty, 2014; Fic, 2013; Joyce et al., 2012).

In addressing Fed's responses (i.e. QE) to the subprime crisis, Bernanke (2009) noted that the portfolio channel operates by transmitting its intended effects (or spillovers) to asset prices in "different market segments" and "different countries", not just in the 'intended market segments' or the local economy of the advanced nations. Asset purchases by central banks will 'crowd out' investors from certain segments of the financial market in the target economies. This process will force investors to look for substitute assets, i.e. causing portfolio rebalancing. Although the non-standard monetary policies first impact the yields and risk-premium of specific (key/benchmark) asset categories, such as sovereign bonds, they will later on affect the prices of wide categories of assets as investors start to rebalance their portfolios.

For instance, Mohanty (2014) explains how Fed policies affected emerging markets' long term interest rates. First, the long term rate set by the Fed determine the international benchmark yields and also the risk appetite prevalent in the market. Conversely, the global benchmark yields and market risk appetites will determine the price of different types of bonds issued by emerging markets. This applies both to international bonds issued in dollars or euros and local currency bonds. However, the strength of this transmission channel depends on the degree to which emerging market bonds could serve as substitutes to sovereign bonds from advanced economies. Given the growing risks in some advanced countries and generally better yields in emerging economies, this is plausible. Fallagiarda et al. (2015) argue that the portfolio rebalance channel could be the primary Channel of transmission for non-standard monetary policies from advanced economies. This particularly applies to the policies which involve direct purchase of assets. Chinn (2013) also notes that the portfolio-rebalancing channel could be the most important transmission channel as non-standard monetary policies are mainly set up to work through changes in the yields and prices of local assets.[49]

We assess the impact of the UMP policies via the international portfolio rebalancing channel by directly looking at how they affect the flow of international capital to South African bonds and equities as well as indirectly by evaluating how these policies affect the returns on assets. In this

[49] While studying the impact external unconventional monetary policies have on the sovereign bond yields of South Africa, if portfolio rebalancing has indeed happened from government bonds in advanced countries, then the price of 'substitute assets' (i.e. South African government bonds) should be affected.

regard, we first run a regressions (using equation 1), where the dependent variable is the net portfolio investment inflows to South African bonds and equities. Specifically, we use the daily net purchases of equities and bonds by foreign investors as a percentage of total investments (see Table 1.1 in Annex 1 for further clarification).

The regressions based on Fed's and ECB's unconventional monetary policy events are given below. These tables (and others that follow for different transmission channels) give regressions of financial flows, asset returns or dynamics up on different non-standard monetary policy events. The first column of each table reports the benchmark result, while the other columns use different controls.

The results show that announcements of asset purchase programs by the Fed have led to some financial inflows to SA equities and bonds - in line with arguments of the 'international portfolio rebalancing' channel. Conversely, announcements of the tapering of QE program have led to outflows, especially from SA equities. The unconventional policy announcements by ECB for asset purchases by ECB do not show significant impact. The Liquidity provision program shows statistically significant inflow in to SA bonds, while the collateral easing program shows some inflows to equities. However, the cumulated inflows or outflows on these announcements (for both Fed and ECB) were small when put in perspective to total foreign funds invested in SA. They generally represented inflows or outflows that are less than 1% of total foreign investments in the country's financial assets (both in the benchmark estimates without control and also in additional regressions with controls).

These results highlight two important realities. First, even if these announcement dates see statistically significant flows (worth hundreds of millions of USD), their size is diminished by the large amount of financial investment outstanding in South Africa (see Section 2). Moreover, significant net inflows in one period could be followed by outflows in the following period, or vice versa. Therefore, observing an 'economically' significant financial inflow or outflow often requires persistent inflow or outflow over longer periods of time.[50]

**Table 3 (a) Fed Unconventional Monetary Policy: Foreign invest. flows to SA equities**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, ECB announc. | Mkt. Vol., IR, ECB announc., News | Mkt. Vol., IR, ECB announc., News (Robust) | Mkt. Vol., IR, ECB announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) | (F1.8) |
| QE1 | 0.5734*** | 0.5730*** | 0.5722*** | 0.5723*** | 0.5722*** | 0.5722 | 0.0642 | 0.1737** |
| | (0.11) | (0.11) | (0.11) | (0.11) | (0.11) | (0.46) | (0.11) | (0.07) |
| QE2 | 0.0620 | 0.0633 | 0.0627 | 0.0625 | 0.0625 | 0.0625 | 0.0614 | 0.0561 |
| | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) | (0.04) | (0.07) | (0.07) |
| QE3 | -0.0518 | -0.0544 | -0.0556 | -0.0555 | -0.0555 | -0.0555 | 0.0943 | -0.0677 |
| | (0.14) | (0.14) | (0.14) | (0.14) | (0.14) | (0.13) | (0.14) | (0.15) |
| Taper | -0.0230 | -0.0234 | -0.0230 | -0.0229 | -0.0232 | -0.0232 | -0.0646 | -0.0365 |
| | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.04) | (0.06) | (0.08) |

[50] This section (and the paper at large) mainly focuses on the announcement effects of the unconventional policies. For some discussion on the short term and long term impact of these policies, see Section 5.3.2.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| _cons | 0.0206*** | 0.0206*** | 0.0214*** | 0.0213*** | 0.0213*** | 0.0213*** | 0.0228*** | 0.0311*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| N | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 |
| R-sq | 0.014 | 0.014 | 0.018 | 0.018 | 0.019 | 0.019 | 0.006 | 0.015 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the change in daily net purchases of South African equities by foreigners.

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for ECP non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (7), while the other regressions use a 1-day event window.

d) Regression (8) also includes interaction terms for Federal Open Market Committee (FOMC) meeting dates. Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

## Table 3 (b) Fed Unconventional Monetary Policy: Foreign invest. flows to SA bonds

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, ECB announc. | Mkt. Vol., IR, ECB announc., News | Mkt. Vol., IR, ECB announc., News (Robust) | Mkt. Vol., IR, ECB announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) | (F1.8) |
| QE2 | 0.3886* | 0.3958* | 0.4005** | 0.3997** | 0.3601* | 0.2037 | 0.6473*** | 0.1737 |
| | (0.20) | (0.20) | (0.20) | (0.20) | (0.20) | (0.27) | (0.20) | (0.21) |
| QE3 | 0.1838 | 0.1860 | 0.1891 | 0.1894 | 0.1570 | 0.0773 | -0.3392 | 0.3604 |
| | (0.40) | (0.40) | (0.40) | (0.40) | (0.40) | (0.49) | (0.40) | (0.44) |
| Taper | -0.7036*** | -0.7034*** | -0.6732*** | -0.6729*** | -0.5959*** | -0.6150*** | -0.7320*** | -0.5477* |
| | (0.18) | (0.18) | (0.18) | (0.18) | (0.18) | (0.13) | (0.18) | (0.29) |
| _cons | 0.2293*** | 0.2294*** | 0.2276*** | 0.2274*** | 0.2510*** | 0.2393*** | 0.2518*** | 0.2683*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| N | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| R-sq | 0.013 | 0.013 | 0.015 | 0.015 | 0.022 | 0.019 | 0.030 | 0.039 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the change in daily net purchases of South African bonds by foreigners.

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for ECP non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (7), while the other regressions use a 1-day event window.

d) Regression (8) also includes interaction terms for Federal Open Market Committee (FOMC) meeting dates. Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

f) We are not able to estimate the impact of QE1 announcements due to data unavailability in bond flows (this series starts only from 31 Jul, 2009).

## Table 3 (c) ECB Unconventional Monetary Policy: Foreign invest. flows to SA equities

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, Fed announc. | Mkt. Vol., IR, Fed announc., News | Mkt. Vol., IR, Fed announc., News (Robust) | Mkt. Vol., IR, Fed announc., News (Lags) | Mkt. Vol., IR, Fed announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) | (E1.8) |
| Asset Purchase | 0.1194 | 0.1228 | 0.1192 | 0.1184 | 0.1225 | 0.0673 | 0.0589 | 0.2885** |
| | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) | (0.08) | (0.09) | (0.11) |
| Liquidity Provision | -0.0794*** | -0.0703** | -0.0828*** | -0.0834*** | -0.0832*** | -0.1155*** | -0.1167*** | -0.0577 |
| | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.04) | (0.03) | (0.05) |
| Collateral Easing | 0.1522** | 0.1512** | 0.1526** | 0.1525** | 0.1483** | 0.1728*** | 0.1480** | 0.0523 |
| | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.05) | (0.06) | (0.11) |
| _cons | 0.0118*** | 0.0113*** | 0.0121*** | 0.0125*** | 0.0118*** | 0.0268*** | 0.0130*** | 0.0096** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| N | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 | 2152 |
| R-sq | 0.008 | 0.009 | 0.014 | 0.015 | 0.017 | 0.011 | 0.019 | 0.014 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the change in daily net purchases of South African equities by foreigners.
c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 1-day event window to regression (5), while the other regressions use a 3-day event window.
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Table 3 (d) ECB Unconventional Monetary Policy: Foreign invest. flows to SA bonds**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, Fed announc. | Mkt. Vol., IR, Fed announc., News | Mkt. Vol., IR, Fed announc., News (Robust) | Mkt. Vol., IR, Fed announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) | (E1.8) |
| Asset Purchase | 0.4008 | 0.3958 | 0.4069 | 0.4033 | 0.3390 | 0.2384 | 0.4580 | -0.2507 |
| | (0.42) | (0.42) | (0.42) | (0.42) | (0.42) | (0.49) | (0.42) | (0.57) |
| Liquidity Provision | 0.3429** | 0.3460** | 0.3477** | 0.3447** | 0.3109** | 0.1792 | 0.3457** | 0.3316 |
| | (0.15) | (0.15) | (0.15) | (0.15) | (0.15) | (0.17) | (0.15) | (0.25) |
| Collateral Easing | -0.1504 | -0.1487 | -0.1499 | -0.1500 | -0.0374 | -0.0374 | -0.1227 | 0.1484 |
| | (0.25) | (0.25) | (0.25) | (0.25) | (0.25) | (0.33) | (0.25) | (0.45) |
| _cons | 0.2139*** | 0.2138*** | 0.2116*** | 0.2141*** | 0.2410*** | 0.2320*** | 0.2390*** | 0.2491*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| N | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| R-sq | 0.005 | 0.005 | 0.008 | 0.010 | 0.018 | 0.015 | 0.019 | 0.016 |

Notes:
a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The dependent variable is the change in daily net purchases of South African bonds by foreigners.
c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 1-day event window to regression (5), while the other regressions use a 3-day event window.
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.
f) The bond flows series starts only from 31 Jul, 2009 - due to data unavailability.

### 4.2 'Confidence' channel:

Central banks have the capacity to instill confidence in their respective financial markets using appropriate interventions and policy responses. Their actions might, therefore, boost asset prices by reducing uncertainty and risk premium on assets (Joyce et al., 2011; Joyce et al., 2012; Bowdler and Radia, 2012).[51] When large scale asset purchases happen by the Fed and ECB, the confidence which they instill in the markets might lead to cross border financial flows.[52] Capital might target assets overseas (i.e. those external markets that have high degree of linkage with advanced economies) though 'carry trade' where investors chase after higher yield assets.

[51] The impact of unconventional monetary interventions on asset prices (or portfolio flows) due to reduced risk-premia on sovereign credits, has also been alternatively addressed in the literature as the 'sovereign credit risk channel' and has been empirically examined using CDS spreads (Fratzscher et al., 2016).

[52] Various monetary policy announcements (especially the non-standard policies that we are more interested in) are tools that were put in place with the intention of dealing with market uncertainties in advanced economies. However, as we have noted in the forerunning sections, these policies have consequences far beyond the domestic financial markets of advanced economies - as their spillover effects are also felt in emerging economies such as South Africa.

However, the same 'carry trade' argument might also imply capital outflow from emerging economies if they are especially perceived to be 'vulnerable' and assets in advanced economies are deemed to be 'safer' bets, although these have lower yields.

Fallagiarda et al. (2015) note that the transmission mechanism which followed the announcement of ECB OMT policies impacted international capital markets through the confidence channel. OMT operations work by reducing the perceived risks associated with sovereign bonds that are issued by euro area economies.[53] This would make a big difference especially to the sovereign bond issuances coming from countries under financial and economic pressure. The result would be an inflow of capital in to those euro area economies. This might affect emerging economies such as South Africa by reducing the appeal (and purchase) of their sovereign bond issuances, in favor of the bonds issued by Eurozone members. This relates not only to the bonds issued by the stronger economies such as Germany but also to those issued by the countries in the periphery - as their perceived risks are reduced by the OMT. However, it may also have the opposite effect if it leads to portfolio rebalancing and crowding-out of investors to alternative (substitute) markets like South Africa. The final impact of these policy intervention on South African assets would be difficult to predict since different transmission channels operate side by side (e.g. 'confidence' and 'portfolio-rebalancing' channels) and yet various events in individual countries could shape market sentiments.

The impact of unconventional monetary policies on the 'confidence channel' could be examined by their effect on market volatility indices, which reflect market uncertainty (Fratzscher et al., 2016). For this, we run regressions where the dependent variable is the daily change in South African Volatility Index. As can be seen from the results in the following tables, the announcements of the policies did not immediately (i.e. on dates of announcements) bring substantial changes to market confidence. Generally, the cumulated impact on the volatility index on the announcement dates was less than one percentage point. However, a visual overview of the volatility index in Figure 5 shows that market confidence in South Africa significantly improved through the span of QE1 and initial phases of ECB's asset purchase program from end 2008 to early 2010. Later on, the periods around end of QE, Eurozone debt crisis, and Fed's QE tapering announcements have seen temporary jumps in market volatility or reduced market confidence. However, the scale of market volatility in recent years is lower when compared to the environment around late 2008 (i.e. the global financial crisis).

[53] Saka et al. (2014) also note that the confidence in the Eurozone's sovereign bond market has been reinstated by the OMT policy of the ECB. This was possible as investors perceive ECB's commitment (via OMT) to act in its unique role as 'lender of last resort' within the Eurozone - whenever this would be necessary.

## Table 4 (a) Fed Unconventional Monetary Policy: SA Market Volatility

| Controls | No controls | IR | IR, ECB announc. | IR, ECB announc., News | IR, ECB announc., News (Robust) | IR, ECB announc., News (Lags) | IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) |
| QE1 | 0.3298 | 0.3290 | 0.3291 | 0.2419 | 0.6471 | -0.7309*** | 0.1040 |
| | (0.29) | (0.29) | (0.29) | (0.29) | (0.90) | (0.21) | (0.17) |
| QE2 | 0.5894* | 0.5884* | 0.5886* | 0.5309* | 1.2536** | -0.3684 | 0.3543** |
| | (0.31) | (0.31) | (0.31) | (0.31) | (0.61) | (0.24) | (0.18) |
| QE3 | 0.5568 | 0.5560 | 0.5561 | 0.4689 | 1.4078** | -0.2905 | 0.5990*** |
| | (0.38) | (0.37) | (0.37) | (0.37) | (0.61) | (0.28) | (0.22) |
| Taper | 0.5090 | 0.5076 | 0.5078 | 0.4439 | 0.4264 | 0.1565 | -0.1924 |
| | (0.34) | (0.34) | (0.34) | (0.34) | (0.33) | (0.21) | (0.20) |
| _cons | -0.0440*** | -0.0426*** | -0.0428*** | -0.0510*** | -0.0010 | -0.0483*** | -0.0577*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) |
| N | 2456 | 2456 | 2456 | 2456 | 2456 | 2456 | 2456 |
| R-sq | 0.003 | 0.011 | 0.011 | 0.013 | 0.010 | 0.019 | 0.016 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the difference in p.p. on the South African Volatility Index (SAVI).

c) Apart from the variables given in the table, additional controls are also used. Regressions (3) to (7) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (7) control for ECP non-standard monetary policy announcements; regressions (4) to (7) control for the release of key macroeconomic data; regression (5) implements robust regression; regression (6) uses the lags of explanatory variables; regressions (7) applies a 3-day event window to regression (4), while the other regressions use a 1-day event window.

d) Regression (7) also includes interaction terms for Federal Open Market Committee (FOMC) meeting dates. Regressions (4) to (7) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

## Table 4 (b) ECB Unconventional Monetary Policy: SA Market Volatility

| Controls | No controls | IR | IR, Fed announc. | IR, Fed announc., News | IR, Fed announc., News (Robust) | IR, Fed announc., News (Lags) | IR, Fed announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) |
| Asset Purchase | -0.8242*** | -0.8210*** | -0.8194*** | -0.7936*** | -0.4611 | -0.6218** | -0.7832*** |
| | (0.26) | (0.25) | (0.25) | (0.26) | (0.38) | (0.26) | (0.26) |
| Liquidity Provision | -0.0950 | -0.0964 | -0.0949 | -0.0884 | -0.0280 | -0.1372* | -0.0864 |
| | (0.08) | (0.08) | (0.08) | (0.08) | (0.15) | (0.08) | (0.08) |
| Collateral Easing | 0.2190 | 0.2202 | 0.2203 | 0.2104 | 0.1109 | 0.1492 | 0.1362 |
| | (0.17) | (0.17) | (0.17) | (0.17) | (0.14) | (0.17) | (0.17) |
| _cons | -0.0374*** | -0.0365*** | -0.0372*** | -0.0441*** | 0.0046 | -0.0426*** | -0.0576*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) |
| N | 2456 | 2456 | 2456 | 2456 | 2456 | 2456 | 2456 |
| R-sq | 0.005 | 0.014 | 0.014 | 0.016 | 0.004 | 0.016 | 0.012 |

Notes:

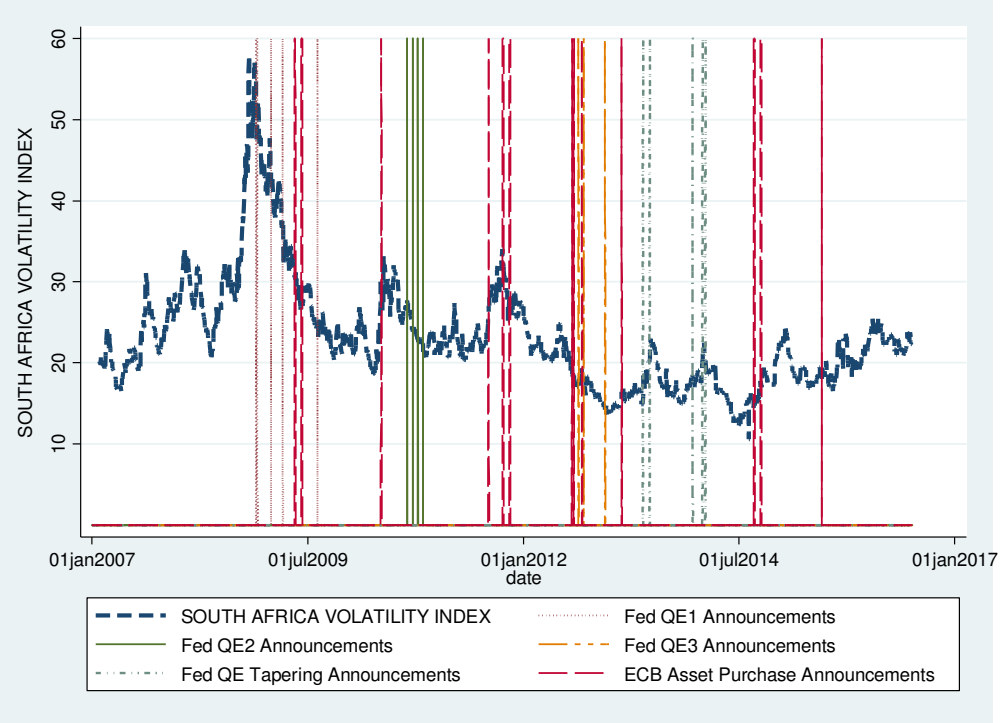
a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the difference in p.p. on the South African Volatility Index (SAVI).

c) Apart from the variables given in the table, additional controls are also used. Regressions (3) to (7) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (7) control for Fed non-standard monetary policy announcements; regressions (4) to (7) control for the release of key macroeconomic data; regression (5) implements robust regression; regression (6) uses the lags of explanatory variables; regressions (7) applies a 3-day event window to regression (4), while the other regressions use a 1-day event window.

d) Regressions (4) to (7) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Figure 5: South African Volatility Index**

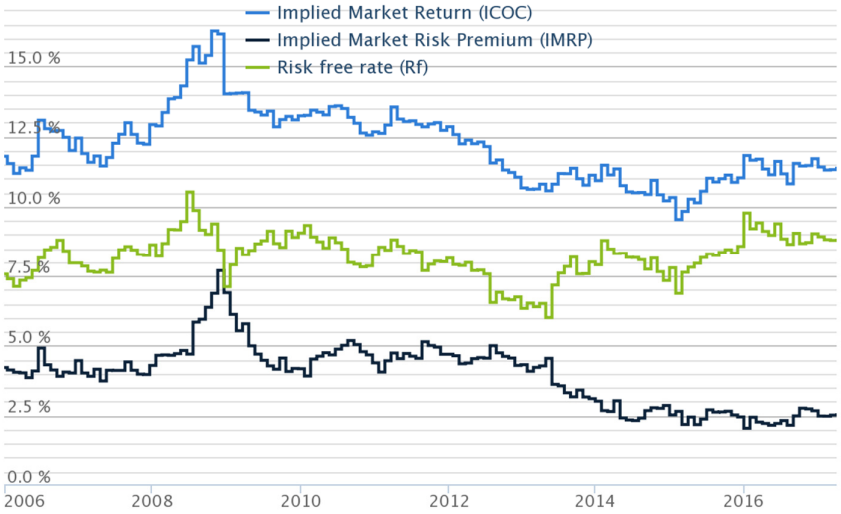



Source: Using Datastream

### 4.3 'Sovereign Credit' channel:

Asset prices (and portfolio flows) might be affected by non-standard monetary policies as these policies have the capacity to minimize the risk premia associated with sovereign credits. Asset purchase programs of the Fed, e.g. the different waves of the QE policy, or similar policies of ECB, e.g. the securities market program (SMP) or the outright monetary transaction (OMT), help to ease difficulties in monetary policy transmission mechanisms. This is due to the capacity of these policies to absorb sovereign risk premia that might be deemed excessive by the market (Fratzscher et al., 2016). During the European sovereign debt crisis, for instance, worsening market sentiments about the euro and member states in the periphery were driving up sovereign risk premia. ECB's response with the purchase of longer term sovereign bonds (via SMP) and short term sovereign bonds (via OMT) have indirectly targeted the risk premia on sovereign bonds of specific Eurozone economies as well as the overall sovereign debt markets, in general. Indeed, implied market risk premia in South African equity markets have been declining since early 2009 and have stabilized around 2.5% since late 2014 (see Figure 6).

**Figure 6: Implied Market-risk-premia in South African Equity market**




Source: Fnebris.com

The impact of the policy interventions on sovereign credit risks can be evaluated by looking at their effect on sovereign CDS spread. Prices of sovereign bonds might rise due to a decrease in risk premium that is linked to falling credit risks. Here we regress daily changes in five year South African sovereign yields (in percentage points) and changes in CDS (in basis points) on Fed and ECB announcements. The results show that announcements for asset purchase programs of the Fed (particularly QE1) and ECB have led to a statistically significant reductions in sovereign yields. Further, Fed's announcements of QE asset purchase programs and ECB's liquidity provision program show reductions in CDS. Nevertheless, the cumulated economic impact of these announcements is again not large. Announcements relating to Fed's QE1 and ECB's asset purchase program, for instance, represented a reduction of about 0.01 percentage point in 5 year yields.

**Table 5 (a) Fed Unconventional Monetary Policy: Sovereign Yields (5yr)**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, ECB announc. | Mkt. Vol., IR, ECB announc., News | Mkt. Vol., IR, ECB announc., News (Robust) | Mkt. Vol., IR, ECB announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) | (F1.8) |
| QE1 | -0.0108** | -0.0110** | -0.0110** | -0.0110** | -0.0111** | -0.0110*** | -0.0029 | -0.0042* |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| QE2 | -0.0040 | -0.0042 | -0.0042 | -0.0043 | -0.0044 | -0.0041 | -0.0075 | -0.0041 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| QE3 | -0.0042 | -0.0052 | -0.0052 | -0.0052 | -0.0053 | -0.0051 | 0.0024 | 0.0002 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.00) | (0.01) | (0.00) |
| Taper | 0.0010 | 0.0014 | 0.0009 | 0.0009 | 0.0019 | -0.0034 | 0.0168*** | 0.0065** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| _cons | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | -0.0000 | 0.0002 | -0.0000 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| N | 2480 | 2479 | 2479 | 2479 | 2479 | 2479 | 2479 | 2479 |
| R-sq | 0.003 | 0.044 | 0.045 | 0.046 | 0.048 | 0.088 | 0.051 | 0.047 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the daily difference in p.p. on the 5 year South African sovereign bond yields.

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (7).
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Table 5 (b) Fed Unconventional Monetary Policy: Sovereign CDS (5yr)**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, ECB announc. | Mkt. Vol., IR, ECB announc., News | Mkt. Vol., IR, ECB announc., News (Robust) | Mkt. Vol., IR, ECB announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) | (F1.8) |
| QE1 | -0.0535*** | -0.0408** | -0.0408** | -0.0408** | -0.0407** | -0.0407 | 0.0033 | -0.0364** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.03) | (0.01) | (0.02) |
| QE2 | -0.0654*** | -0.0563*** | -0.0563*** | -0.0561*** | -0.0560*** | -0.0560** | -0.0088 | -0.0529*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.03) | (0.01) | (0.02) |
| QE3 | -0.0537*** | -0.0479*** | -0.0478*** | -0.0481*** | -0.0480*** | -0.0480* | -0.0018 | -0.0452*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.03) | (0.01) | (0.02) |
| Taper | 0.0704*** | 0.0561*** | 0.0560*** | 0.0560*** | 0.0559*** | 0.0559** | | 0.0525*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.03) | | (0.02) |
| _cons | 0.0004 | 0.0005 | 0.0006 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0002 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| N | 2016 | 2016 | 2016 | 2016 | 2016 | 2016 | 2016 | 2016 |
| R-sq | 0.010 | 0.258 | 0.260 | 0.260 | 0.260 | 0.260 | 0.256 | 0.260 |

Notes:
a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The dependent variable is the daily difference (in b.p.) on the 5 year South African sovereign credit default swaps (CDS).
c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (7).
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Table 5 (c) ECB Unconventional Monetary Policy: Sovereign Yields (5yr)**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, Fed announc. | Mkt. Vol., IR, Fed announc., News | Mkt. Vol., IR, Fed announc., News (Robust) | Mkt. Vol., IR, Fed announc., News (Lags) | Mkt. Vol., IR, Fed announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) | (E1.8) |
| Asset Purchase | -0.0093** | -0.0093** | -0.0084** | -0.0090** | -0.0090** | -0.0140*** | -0.0029 | -0.0090** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| Liquidity Provision | 0.0008 | 0.0008 | 0.0013 | 0.0012 | 0.0012 | 0.0003 | 0.0015 | 0.0010 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Collateral Easing | -0.0009 | -0.0008 | -0.0009 | -0.0008 | -0.0008 | 0.0007 | 0.0039 | -0.0010 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| _cons | | -0.0074 | -0.0049 | -0.0074 | -0.0074 | 0.0029 | -0.0061 | -0.0075 |
| | | (0.00) | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| N | -0.0002 | -0.0002 | -0.0002 | -0.0002 | -0.0002 | 0.0001 | -0.0001 | -0.0003 |
| R-sq | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |

Notes:
a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The dependent variable is the daily difference in p.p. on the 5 year South African sovereign bond yields.
c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (5).
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Table 5 (d) ECB Unconventional Monetary Policy: Sovereign CDS (5yr)**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, Fed announc. | Mkt. Vol., IR, Fed announc., News | Mkt. Vol., IR, Fed announc., News (Robust) | Mkt. Vol., IR, Fed announc., News (Lags) | Mkt. Vol., IR, Fed announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) | (E1.8) |
| Asset Purchase | -0.0216 | -0.0216 | -0.0221* | -0.0224 | -0.0225 | -0.0421 | -0.0168 | -0.0216 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.03) | (0.01) | (0.01) |
| Liquidity Provision | -0.0144*** | -0.0144*** | -0.0106** | -0.0151*** | -0.0152*** | -0.0015 | -0.0074 | -0.0157*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.02) | (0.00) | (0.01) |
| Collateral Easing | -0.0059 | -0.0059 | -0.0094 | -0.0061 | -0.0061 | -0.0054 | 0.0218** | -0.0096 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) |
| _cons | | 0.0009 | 0.0045 | 0.0009 | 0.0009 | 0.0007 | -0.0013 | 0.0002 |
| | | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| N | 0.0001 | 0.0001 | 0.0005 | 0.0000 | 0.0001 | 0.0010 | -0.0005 | -0.0009 |
| R-sq | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the daily difference in b.p. on the 5 year South African sovereign credit default swaps (CDS).

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 1-day event window to regression (5), while the other regressions use a 3-day event window.

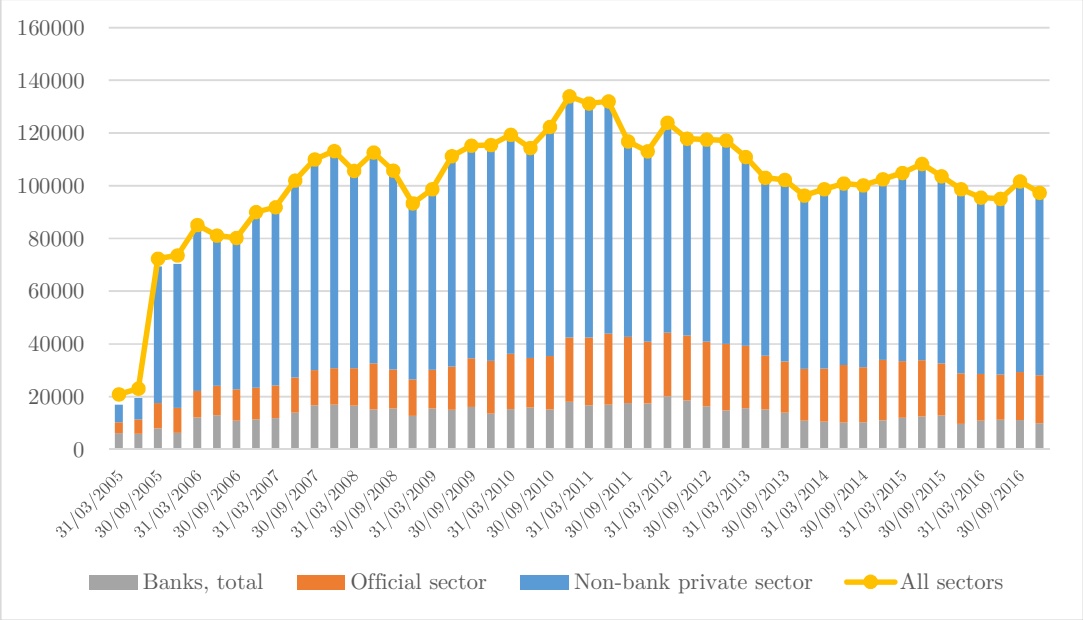
d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

### 4.4 'Bank Credit' channel:

One key target area of the non-standard policies (especially for ECB) was liquidity provision to the banking sector. ECB's main refinancing operations (MROs), long-term refinancing operations (LTROs) and foreign currency funding (FOR) operations are some of these dedicated liquidity provision programs. However, due to the relationship between liquidity and credit risk, the liquidity provision policies could have spillovers on bank credit risk.

As ECB and Fed succeed in lowering liquidity problems in their domestic banking systems (some of which are major global banks) through, for instance, currency funding operations; they will lower the credit risk in the global banking system. This may, in turn, translate to rising asset prices and an overall fall in risk premia (Fratzscher et al., 2016). Although a large part of the cross border financial flow that South Africa receives goes to the non-bank private sector and the public sector (which together accounted for 90% of foreign investments as per the last quarter of 2016, see Figure 7), South African banks still receive inflows worth billions of USD. Further, considering the important roles foreign owned banks (and branches of major international banks) play as sources of foreign currency loans and advances (see Section 2), one could expect spillovers via the international bank lending channel.

**Figure 7: Consolidated positions on counterparties resident in South Africa (Sectoral breakdown, Mill. USD)**




Source: using BIS Consolidated banking statistics

To capture the spillovers of the UMP on the South African banking system, we will specifically look at how changes in 3-month interbank rate, respond to policy announcements. The results show that Fed's QE1 announcements had led to a cumulated reduction of the interbank rate (amounting to about 0.013 percentage point). The announcements relating to the tapering of QE had a small reverse impact, where the interbank rate rose during these announcements (by a margin close to 0.01 percentage point). On the other hand, ECB's announcements did not show a statistically significant effects.[54]

**Table 6 (a) Fed Unconventional Monetary Policy: Interbank rate**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, ECB announc. | Mkt. Vol., IR, ECB announc., News | Mkt. Vol., IR, ECB announc., News (Robust) | Mkt. Vol., IR, ECB announc., News (Lags) | Mkt. Vol., IR, ECB announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (F1.1) | (F1.2) | (F1.3) | (F1.4) | (F1.5) | (F1.6) | (F1.7) | (F1.8) |
| QE1 | -0.0126*** | -0.0127*** | -0.0120*** | -0.0120*** | -0.0122*** | -0.0122* | -0.0099*** | -0.0120*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| QE2 | -0.0040* | -0.0040* | -0.0039* | -0.0039* | -0.0041* | -0.0041** | 0.0001 | -0.0037 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| QE3 | -0.0001 | -0.0002 | -0.0002 | -0.0001 | -0.0003 | -0.0003 | 0.0020 | 0.0001 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Taper | 0.0095*** | 0.0094*** | 0.0085*** | 0.0084*** | 0.0081*** | 0.0081 | 0.0044*** | 0.0098*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| _cons | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0001 | -0.0001 | -0.0001 | -0.0002 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |

[54] Although looking at banking sector CDS would have been complementary, this study has not done so due to unavailability of adequate high frequency data. However, the dynamics in bank sector CDS would be closely aligned with sovereign CDS, as the latter is often used as a benchmark for the CDS of banks as well as other major South African private and state companies such as Eskom (IMF, 2016).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N | 2480 | 2479 | 2479 | 2479 | 2479 | 2479 | 2479 | 2479 |
| R-sq | 0.053 | 0.053 | 0.095 | 0.095 | 0.098 | 0.098 | 0.105 | 0.064 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the daily p.p. difference in 3-month interbank rate.

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 3-day event window to regression (7).

d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

**Table 6 (b) ECB Unconventional Monetary Policy: Interbank rate**

| Controls | No controls | Mkt. Vol. | Mkt. Vol., IR | Mkt. Vol., IR, Fed announc. | Mkt. Vol., IR, Fed announc., News | Mkt. Vol., IR, Fed announc., News (Robust) | Mkt. Vol., IR, Fed announc., News (Lags) | Mkt. Vol., IR, Fed announc., News (Alt. event window) |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Model | (E1.1) | (E1.2) | (E1.3) | (E1.4) | (E1.5) | (E1.6) | (E1.7) | (E1.8) |
| Asset Purchase | 0.0014 | 0.0014 | 0.0016 | 0.0014 | 0.0014 | 0.0014 | 0.0006 | 0.0017 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Liquidity Provision | -0.0004 | -0.0004 | -0.0004 | -0.0005 | -0.0005 | -0.0005 | -0.0000 | -0.0002 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Collateral Easing | -0.0009 | -0.0009 | -0.0009 | -0.0009 | -0.0009 | -0.0009 | -0.0010 | -0.0017 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| _cons | | 0.0001 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0005 | -0.0002 |
| | | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| N | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0000 | -0.0000 | -0.0001 | -0.0003** |
| R-sq | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) The dependent variable is the daily p.p. difference in 3-month interbank rate.

c) Apart from the variables given in the table, additional controls are also used. Regressions (2) to (8) control for market volatility; regressions (3) to (8) control for standard monetary policy (interest rate) changes by Fed, ECB & SARB; regressions (4) to (8) control for Fed non-standard monetary policy announcements; regressions (5) to (8) control for the release of key macroeconomic data; regression (6) implements robust regression; regression (7) uses the lags of explanatory variables; regressions (8) applies a 1-day event window to regression (5), while the other regressions use a 3-day event window.

d) Regressions (5) to (8) additionally use interaction terms for the release of macroeconomic data that is higher than markets expected.

# 5 Robustness exercises

The analysis in Section 4 has focused on four key transmission channels for the spillovers. To quantify these channels; the analysis has investigated the dynamics of foreign portfolio investment flows in to equities and bonds, South African market volatility index, sovereign yields (5 year), and interbank rate (3 month). In this section, we go through a number of robustness exercises; where we address specification issues, isolate initial announcements from other announcements and implementations, evaluate monetary policy independence, highlight short and long-term impacts, and address endogeneity issues. In doing so, we also assess the impact on additional financial assets, apart from the ones discussed in Section 4; e.g. stock market returns, currency returns, 10 year sovereign yields and CDS (see Section 5.3).

## 5.1 Addressing specification issues

In the regression tables reported within Section 4.1 to 4.4, we make various modifications and specification checks on the benchmark estimates without 'no controls' - given in the first column of each table. Namely; we control for market volatility; standard monetary policies; ECB and Fed announcements; macroeconomic data releases; news items relating to SARB; robust standard errors to deal with common persistent shocks and heteroscedasticity; lags of explanatory variables; and alternative three day event windows before and after event dates, instead of a one day event window.

We control for market volatility since it plays an important role in determining market confidence and financial flow patterns (Tillman, 2016; Bernal et al., 2016; Chen et al., 2014; Krishnamurthy and Vissing-Jorgensen, 2011; Prabu et al., 2016). Other things remaining constant, the presence of significant market risks in South Africa might lower the net financial inflow to the country and/or raise the yields of financial instruments. Standard monetary policy operations are also need to be accounted for since domestic rate rises relative to advanced economies (or rate cuts in advanced economies) will lead to more financial inflows. We account for releases of macroeconomic data since the release of positive information may encourage more financial flows and negative information (worse than expected data) may potentially do the reverse (Gagnon et al., 2017; BIS, 2014; Rigobon and Sack, 2004). Related to this, the coverage of news items on influential media[55], especially those which involve activities of central banks, may shape investor sentiments and, thus, affect financial inflows (Fratzscher et al., 2016; Aizeinman et al., 2014; Rigibon and Sack, 2005). We also run robust regressions. We use Davidson and MacKinnon (1993) and Newey and West (1987) robust standard error estimates, which yield better results when the model could potentially be heteroskedastic and also control for persistent shocks. The issue of heteroscedasticity, in connection with a novel technique to deal with potential endogeneity issues, is discussed at length in Section 5.4. We run regressions with lagged explanatory variables to catch scenarios where announcements in advanced economies take time to influence financial flows in South Africa. The delayed response of assets to announcements and news is often noted in the literature (Fratzscher et al., 2016; Evans and Lyons, 2005). Moreover, we run regressions with three day event windows before and after events in an effort to alternatively catch the delayed as well as anticipated reactions of financial assets to announcements (Fallagiarda et al., 2015; Aizeinman et al., 2014; MacKinlayy, 1997).[56]

However, as could be seen from the tables reported in Section 4; the sign, size and significance of coefficients reported under the benchmark 'no controls' regression persists across the later

[55] For more on this, see Section 3 as well as Table A4 in Annex 3.

[56] Some events might have delayed impacts that may not be captured in a single day event window. However, making the event window too wide also risks attributing the impact of other events (modelled and un-modelled) as if they were due to the event under investigation (Fratzscher et al., 2016; Fallagiarda et al. 2015; MacKinley, 1997). Altough not reported here, we also run additional regressions to control for holidays (non business days). This is done to see if the days immediately after holidays have a special impact. However, we do not find significant differences for this in most cases.

exercises involving the insertion of additional control variables. This is particularly true for most of these specifications; although the exercises involving robust standard errors, lagged explanatory variables and alternative event windows occasionally change the level of significance or mildly change the size of coefficients.

## 5.2 Impact of initial announcements, policy updates and implementations

Another important argument that could be raised is the likely difference in weight attached to series of announcements about the same policy. Programs such as Fed's QE or ECB's asset purchase or liquidity provision programs (e.g. QE1, SMP, OMT, LTRO, etc.) involve series of announcements on different dates. Many programs of ECB, in particular, involve frequent media communication and updates. Analyzing the cumulated impact of all announcements, although gives the overall impact of the programs, fails to show distinctively how different announcements about the same policy may have different impact.[57] Specifically, the initial announcement (i.e. introduction) of a policy might be argued to have a much stronger effect and already shape market expectations, while follow-up announcements (or updates) may not carry as much weight. To address this issue, we separately estimate the impact of initial announcement of each category of programs as well as follow-up communications about them. We also make a further distinction and control for dates of actual implementations (i.e. market operations) of the policies. Indeed, the literature notes that announcements and implementations of these policies could have a different outcome (Andrade et al., 2016; Fratzscher et al., 2016; Fratzscher et al., Fratzscher et al., 2013). Particularly, actual market operations of a policy (often unlike announcements) could have an outcome that is variable depending on their size, intensity and duration.[58]

The results (reported in Annex 4, Table 1.1 and 1.2) show that, the impact of the policies (at their initial introduction as well as implementation) mostly fall in line with the results we had in Section 4, for the cumulated impact of all announcements. For instance, the implementation phase of QE1 and QE2 saw increased portfolio investment inflows in to equities (although the net figure is rather small). The initial announcements of QE1 on Nov. 25, 2008, on the other hand, led to net outflows from equities while the initial announcement of QE2 on Aug. 27, 2010 led to net inflows in to equities. The initial announcement of QE2 as well as its implementation phase saw net inflows in to South African bonds (where net inflows to bonds totaled about 1.5% total foreign investments during the initial announcement and a net figure of about 0.3% during the implementation phase). ECB's announcements of asset purchases and liquidity provisions

[57] One could also analyze the impact of every single announcement separately, however, this would become cumbersome - given the number of announcements covered here.

[58] Announcements, unlike actual market implementations, are often difficult to quantify (unless the announcements carry specific reference to factors such as operational size, intensity and duration) and mostly work by shaping expectations.

also saw some cumulated inflows in to bonds. Market volatility also appears to have slightly reduced during announcements of ECB's asset purchases programs. Conversely, the implementation phase of the asset purchases programs seems to show net outflow from both bonds and equities.

## 5.3 Monetary Policy independence in South Africa

The country's central bank, South African Reserve Bank (SARB), follows an inflation targeting monetary policy - specifically since February 2000.[59] In following such a policy, the central bank explicitly announces an inflation target and works towards achieving the policy target.[60] Inflation targeting policies are useful for a healthy functioning of financial markets since they bring a degree of certainty and transparency in to the monetary policy environment in an economy.[61]

A recent study was made by Takats and vela (2014) compared inflation targeting emerging economies with exchange rate targeting emerging economies regarding the responsiveness of their central banks to the monetary policy changes in advanced countries. Their analysis using policy rates shows that inflation targeting emerging economies respond more to monetary policy actions of the US Fed. [62] Yet, under the 'trilemma hypotheses', monetary policy in inflation targeting countries should be insulated from external effects since under (strict) inflation targeting policy exchange rate is allowed to move freely against other currencies.

The 'trilemma hypotheses' (also referred to as the impossible trinity) is a theory about monetary policy option from the menu of 'financial integration', 'exchange rate stability' and 'monetary

[59] In the period before 'Inflation targeting' (i.e. pre Feb. 2000 period), SARB followed a wide variety of monetary tools - ranging from exchange rate targeting, discretionary monetary policy, and monetary aggregate targeting, to a heterogeneous set of techniques (SARB, 2016b).

[60] Although there are a number of countries that follow inflation targeting as a monetary policy, the way the policy is implemented varies from one country to another. Specifically, countries differ in the way they set their inflation targets. Some economies settle for a point (i.e. fixed) target while others adopt a ranges of targets with lower and upper bands. Some countries also follow an inflation targeting which is a combination of setting point targets together with certain range. While point targets offer simplicity, setting ranges offers the flexibility required to face uncertainties in macroeconomic dynamics.

[61] The 'price stability' and 'low inflation' component of the 'monetary policy target' is crucial since it also helps to protect the purchasing power of consumers, apart from introducing macroeconomic certainty. Especially, in emerging economies like South Africa (which has one of the highest levels of inequality and unemployment); appropriate measures against rapid rises in price levels are vital (SARB, 2016a). Otherwise, the poorest segment of the society will face significant reductions in welfare.

[62] The SARB and its Monetary Policy Committee (MPC) set monetary policy - with a rather full operational autonomy. The bank follows a flexible inflation targeting policy. This gives the SARB the necessary policy fluidity - where inflation can be momentarily out of the target range. This allows the bank to decide on the necessary time horizon required for inflation to be brought back to its target range. First-round effect of supply shocks might push inflation out of its target range. With this policy in place, however, the bank has the room to adopt interest rate smoothing over the cycle. This helps to deal with variability of output from the response of monetary policy to shocks (SARB, 2016a).

independence'. As the Mundell-Fleming framework shows, monetary authorities have to choose between only two of these three policy targets (see Obstfeld et al., 2005; Rey, 2015; Aizenman et al., 2014). For instance, if South Africa wanted to set the value of the Rand (its currency) fixed against dollar or euro, and also if the SARB wants to set interest rates without influence from external events or major economies; then capital cannot be allowed to freely move in and out between the domestic and international capital markets. If the US Fed or ECB were to set interest rates lower than the rates in South Africa (in the hypothetical environment of fixed ER regime and free international flow of capital), a big amount of foreign capital would flood in to the country. This would accelerate the demand for the Rand and the peg to the dollar or the euro would not hold. In reverse, if Fed and ECB rates were set higher than South African rates, capital would flood out of the country. This would create severe depreciatory pressures on the Rand. If the SARB wanted to maintain the peg (i.e. the value of the Rand), then it would have to perhaps severely deplete its reserves in trying to buy out the Rand with its dollar or euro reserves. When restrictions to capital flows to a country become undesirable (as is often the case in highly open and financially integrated economies like South Africa), then there remain only two policy options. Either a country chooses fixed exchange rate regime and loss of control over monetary policy, or it adopts a flexible exchange rate policy and obtains control over its monetary policy. Advanced economies (especially those outside the Eurozone) follow the second option. South Africa too has, in recent years, settled for this option.

However, recent research (e.g. Rey, 2015; Aizenman et al., 2015) shows that, unlike what is implied by the 'trilemma hypothesis', full monetary autonomy might not be necessarily witnessed by economies even if they adopt floating exchange rate regimes and are also open to free flow of capital. The price of high yield bonds, shares, and other risky assets moves up and down together with (bank) credit easing and size of international capital flows. Thus, Rey (2015) concludes that the dynamics in investor sentiments and risk appetites have been driving 'global financial cycles'. Conversely, monetary policies of the Fed, play a crucial role by sharing investor risk sentiments. Given the large amounts of bank Credit denomination in dollars, the monetary policies adopted by the Fed had worldwide consequences. Lower rates set by the Fed to create dollars and help the US recovery also created cheap dollar credits for foreign businesses and households. This leads to rising asset prices globally. Rey (2015) also shows that sudden rise in rates by the Fed to have knock on effects of rising mortgage spreads in many advanced countries (with floating currencies and monetary policy autonomy), and not just in the US.

The 'trilemma' is, therefore, actually a 'dilemma' where countries have to choose between either free flow of international capital or independent control of monetary policy and domestic financial market conditions. Rey noted that having floating exchange rate regimes are not fully capable of gauging cross border capital flows to the extent that monetary policy independence is gained by countries. Thus, countries sometimes adopt additional tools (e.g. extra requirements on bank capital, selective capital controls, or other forms of macro prudential instruments) to

tame rapid and excessive credit growth. This is especially appealing in the current global financial environment characterized by high cross border flow of capital, less restrictions of capital flows (in many advanced and emerging economies), growing risk appetites of investors, and presence of excessive cheap dollars and euros in international capital markets.

With regards to the issues of 'trilemma' or 'dilemma', SARB states that monetary policy independence its top priority. Further, the South African Rand is a free floating currency and capital controls are 'generally limited' (Mohanty, 2014).

### 5.3.1 Impacts on domestic monetary policy

SARB's monetary policy operations since the GFC were, by and large, conventional (e.g. Mminele, 2010; BIS, 2014). In dealing with the significant financial inflows linked to the large scale asset purchase programs by the major foreign central banks, SARB primarily relied on the policy rate (see Table A3). For instance, the Deputy Governor of SARB noted that:

> "…Other emerging markets lowered policy rates to support growth; they also intervened in the exchange rate markets to try and stem appreciation pressure, or imposed capital controls. South Africa's policy rate was also lowered, although we were less aggressive than other emerging markets in dealing with these inflows as we did not at any time feel it necessary to intervene in the exchange rate market nor were any capital controls imposed…" Mminele (2012).

Given SARB's contempt to 'unconventional' monetary policies of its own, we focus on interest rate changes (conventional domestic monetary policy) as key additional determinant of domestic asset returns. Table 6.1 reports the impact of SARB's standard monetary policy announcements on various South African asset returns. Clearly, the 3-month (interbank) rate responds positively to a rise in domestic interest rate. Further, an increase in interest rate also implies an upsurge in bond yields. As interest rates rise, the price of bonds falls and this translates to higher bond yields. Aside from the more straightforward impact on interbank rates and bond yields, a more interesting (and rather complicated) relationship is the linkage interest rates have with the stock market and exchange rates.

The results in Table 6.1 show that rise in interest rate by SARB negatively affects South African stock market returns. For instance, an increase in interest rates by 100 basis points reduces the 'JSE all shares' index by about 5%, on average.[63] The same magnitude change in interest rate would reduce the 'JSE financial and industrial shares' by about 4%. Ceteris paribus, higher interest rates imply lower stock market prices since the expected stream of dividends face a higher discount rate. Although the likely impact on the stock market also depends on the source of the interest rate change (e.g. high inflation rate, overheating economy, international market conditions and risks, etc.) This relationship could be even more complicated as there could be a

[63] South Africa's JSE All Shares Index includes companies listed on the Johannesburg Stock Exchange. The index makes up for about 99% of the market capitalization of all listed companies.

two-way relationship, where stock market dynamics may also affect monetary policy decisions. Central banks may react to higher stock prices by raising interest rates. However, this by itself depends on additional factors, e.g. the state of the economy. Rigobon and Sack (2003), nevertheless, note that there is little empirical evidence - even in the case of the US Federal Reserve - about monetary policy reactions to the stock market.

The results also show that a rise in South Africa's interest rate implies the depreciation of the rand against the dollar and the euro, although this is not highly significant. Economic theory, however, dictates that a rise in domestic interest rate in a small open economy would imply an appreciation of the domestic currency vis-à-vis foreign currencies - other things remaining constant. This is because a higher interest rate in an open and financially integrated economy attracts foreign investments; which further leads to higher demands for the domestic currency and, thus, rising currency value. However, there is less of an empirical evidence for this, since the actual link between interest rate and exchange rate depends on different (interrelated) macroeconomic relationships. Apart from the appreciatory pressure from increased foreign investment, we can also expect further increase in the value of the domestic currency due to rising demand for deposit and, thus, the monetary base of the economy. On the other hand, these appreciatory forces might be offset by other depreciatory factors. For instance, rising interest rate may make bank loans expensive and have impact on firms and output (i.e. contractionary role of interest rate hike). An increase in interest rate may also further strain the fiscal burden of the government and its finances, leading to rising inflation expectations (Hnatkovska et al., 2008; Sanchez, 2005). The final link between interest rate and exchange rate movements, thus, depends on which of these factors is prominent.

### 5.3.2 Short-term vs. long-term impact of monetary policy spillovers (alternative specification for spillovers)

As discussed above (Section 5.3), monetary policy in advanced economies could affect policy rate setting in emerging economies - even in those mature emerging economies that follow inflation targeting policies and have floating currencies (Rey, 2013; Takats and vela, 2014; Aizenman et al., 2015). The discussion of spillovers from unconventional monetary policies in advanced economies to the rest of the world basically centers around three areas of impact. Namely; i) effects on 'quantities' - such as the changes in quantity of portfolio investment flows and cross border bank lending (see Section 2 and 4) ii) effect on 'prices' - i.e. change in asset prices or yields (see Section 4)[64] iii) 'endogenous policy responses' - a scenario where central banks across

[64] It is important to note that changes in asset 'prices' could happen without changes in 'quantities' of investment flows (Takats and vela, 2014).

the world adjust their policy in response to actions of big central banks in advanced economies, e.g. Fed or ECB (Takats and vela, 2014).

The spillover effects through changes in 'quantities' and 'prices' have been discussed in Section 4. However, countries also adjust their domestic policy setting (as a response to Fed monetary policies changes) to control the dynamics in asset 'prices', 'quantity' of portfolio investment flows or cross-border bank lending.[65] Although the exercise conducted here closely follows those made in previous sections, there is one key distinction. In Section 4, for instance, we were analyzing the impact of unconventional monetary policies indirectly using dichotomous variables to capture announcement dates. Here, we follow the 'financial cycle theory' and directly capture the impact of the unconventional monetary policies using US interest rates (e.g. bond yields). That is, the effect of unconventional monetary policies will be conveyed to South Africa via their impact on US asset prices - to which South African asset prices adjust to.

In general, the co-movements in policy rates (i.e. endogenous policy responses) between countries that also drive the 'price' and 'quantity' of financial variables have been captured in the 'financial cycle theory' (Borio, 2012). Much of the analysis of the theory has focused on credit cycle (Schularick and Taylor, 2012; Jorda et al., 2011; Dell'Arriccia et al., 2012). However, one could combine various financial 'price' and 'quantity' variables - including interest rates, risk premia, volatilities, asset prices, etc. (Borio, 2012; Claessens et al., 2011). Further, Borio (2012) notes that, while the analysis of international dynamics in financial variables (such as equity prices) is well picked at higher frequencies, others such as credit or property prices tend to co-vary across countries at low-frequencies.[66] Drehmann et al. (2012) also note that the financial cycle has a much lower frequency when compared to the traditional business cycle.

In our analysis here, first, we try to see the role of external factors like US monetary policy, while also accounting for key domestic factors, e.g. business cycle and inflation. In this regard, we try to investigate the spillovers from US rate on both short-term and long-term domestic rates. In trying to see the impact of US monetary policy on short-term South African policy rate, we fit an augmented domestic Taylor equation - where the South African policy rate is the dependent variable and inflation rate, output gap[67] and US policy rate are the explanatory

[65] Section 5.3 and 5.3.1 try to give an overview in to the supposed 'policy independence' of South Africa. However, it has been noted that actual policy independence hardly exists in emerging economies.

[66] The co-movement between credit and real economic activity is also widely studied in the literature. For instance, Houssa et al. (2013; 2015) look at how global and domestic credit supply shocks affect macroeconomic fluctuations in Emerging economies. Using quarterly data, they show that global credit shocks indeed significantly affect macroeconomic aggregates in South Africa. However, a detailed analysis of the nexus between global financial shocks and real economic activity, although interesting, is beyond the scope of this particular paper and its area of focus.

[67] We use monthly industrial production to compute output gap, using HP filter.

variables (see Takats and vela, 2014 for specification). The results on this and additional specifications with lags as well as additional independent variables such as exchange rate and reserves is given in Annex 4 (Table 4.1). Our analysis using monthly data over the January 2007 - June 2016 period shows a statistically and economically significant direct relationship between US and South African short-term policy rates. Our finding also matches that of Takats and vela (2014), who conduct similar analysis on a group of emerging economies using quarterly data over the 2000-2013 period.[68]

Yet, the long-term interest rate in advanced countries can also affect the dynamics of financial flows in to South Africa. This mostly happens through its ability to shape portfolio investment decisions. And as capital flow restrictions become lower, the degree of substitution between emerging economy long-term bonds and similar advanced economy bonds grow. This sets the stage for stronger expected impact of US rates, for instance, on South African yields (Turner, 2014; Takats and vela, 2014). Nevertheless, bond yields could adjust across countries - even in the face of no significant capital flows - through 'price effects' (Takats and vela, 2014). To empirically explore the long-term spillovers, we run a regression of South African long-term interest rates on US long-term rates (see Annex 4, Table 4.2). However, we also run specifications incorporating lagged domestic short-term rates, government deficit, inflation rate, and reserves. This builds on the specifications of Turner (2014) and Takats and vela (2014). Using five-year interest rates as long-term rates for both US and South Africa and running a monthly regression over the January 2007 - June 2016 period, we find an economically and statistically significant direct relationship between US and South African long-term interest rates.

## 5.4 Addressing endogeneity issues:

### 5.4.1 'Identification through Heteroscedasticity'

There is a potential of facing endogeneity problem when introducing conventional monetary policies (i.e. changes in interest rates) as controls in equation (1) to explain part of the changes in asset returns. This is so since asset returns can also influence monetary policy (Rigobon, 2003; Rigobon and Sack, 2004). To tackle this endogeneity problem, we will employ a method called 'Identification through heteroscedasticity'. Further, 'Identification through heteroscedasticity'

[68] However, we see some differences in the size of coefficients, pertaining to difference in data type and frequency. Takats and Vela (2014) also note that emerging economies experiencing domestic economic crisis tend to have larger coefficients attached to changes in US policy rates since they become sensitive to sudden changes in international financial and economic environment.

(IH) is a technique that could deliver a consistent estimate of pass-through under weaker and more realistic assumptions.[69]

The methodology was introduced by three series of papers; Rigobon (2003) and Rigobon and Sack (2003, 2004). Following Rigobon and Sack (2004), we specify the next two simple simultaneous equations, equations (2) and (3). These simple specifications make it easy to discuss about the key attributes of the methodology. However, as Rigobon (2003) shows, these system of simultaneous equations could be expanded to incorporate various exogenous shocks and lags of endogenous variables. The two equations linking the changes in asset prices ($\triangle Y_t$) and changes in interest rates ($\triangle IR_t$) may be given as:

$$\Delta IR_t = \beta \Delta Y_t + \gamma X_t + \varepsilon_t, \tag{2}$$

$$\Delta Y_t = \alpha \Delta IR_t + \delta X_t + \eta_t, \tag{3}$$

The rest of the notations being same as before (see Section 3.1), $X_t$ represents common exogenous shocks that simultaneously affect both asset prices and interest rate (e.g. unconventional monetary policy announcements by Fed and ECB, release of macroeconomic data, etc).[70] Further, $\eta_t$ represents the shock to asset prices while $\varepsilon_t$ represents a monetary policy shock. We are especially interested in coefficients $\alpha$ and $\delta$. The coefficient $\alpha$ represents the impact of monetary policy shocks on asset prices via changes in interest rates. On the other hand, $\delta$, represents the impact of the common exogenous shock (i.e. $X_t$) on asset prices.

As Arai (2016) and Gilchrist and Zakrajsek (2013) note, the estimation with IH methodology for the coefficients of equation (3) using OLS will lead to bias since both asset price changes ($\triangle Y_t$) and interest rate changes ($\triangle IR_t$) are simultaneously determined in the system of equations given in equations (2) and (3) above. Specifically, there will be a bias in the estimation of the coefficients using OLS since the regressor $\triangle IR_t$ in equation (3) will be correlated with the shock term $\eta_t$ due to the response of interest rate to changes in asset markets $\triangle Y_t$, i.e. coefficient $\beta$ in equation (2). Rigobon and Sack (2004) also note that the exclusion of some unobservable

[69] Standard 'Event study' methodology makes strong assumptions where no other event is assumed to occur on the policy event date, apart from the event which is being investigated itself. Thus, any 'abnormal' changes in asset prices on that day are assumed to be solely due to that particular event. In reality, however, different events could occur on the same date. There is no possibility to control for other variables or events in standard event-study methodologies. This is certainly the case in the 'Constant Mean Returns' model of event-studies (MacKinlay, 1997). At best, in 'Market Return' models, one additionally accounts for the dynamics of the market. However, this still leaves no flexibility to control for other 'relevant' concurrent events, which sometimes includes standard monetary policy announcements (see Table A3 in Annex 3) or other non-standard monetary policy announcements (e.g. Table A1 and Table A2). This is one of the reasons why this study adopts an empirical approach that accommodates other factors (see Section 3.1).

[70] See Rigobon (2003) for more on these specifications.

exogenous shocks (i.e. $X_t$) from the specification of our models might generate some bias. This will be contingent to value of coefficient $\gamma$ in equation (2). Estimating the dynamics in asset returns (equation 3) using OLS will yield estimates of pass-through for the monetary policy shocks ($\alpha$), where the mean of the parameter could be given as:

$$E\ \bar{\alpha} = \alpha + (1 - \alpha\ \beta)\ \frac{\beta\delta_{\eta+(\beta+\gamma)\delta_X}}{\delta_\varepsilon\ +\ \beta^2\delta_\eta\ +\ (\beta+\gamma)^2\ \delta_x} \tag{4}$$

Here, each $\delta$ signifies the variance from each respective shocks. Rigobon and Sack (2004) note that the estimates (for a true value of $\alpha$) will be biased as inferred from equation (4) as a result of a simultaneity bias when $\beta \neq 0$ and $\delta_\eta$>0. There will also be an omitted variables bias when $\gamma \neq 0$ and $\delta_X$>0. The derivation of this potential bias in OLS estimates is given in Annex 1.

The bias in OLS estimation could be overcome with regressions using instrumental variables or GMM. The technique basically uses the shift in the variances of the endogenous variables from 'non-event' to 'event' dates as instruments for identification. Suppose, we denote the dates when policy events are announced as (P) and denote all other business dates, i.e. those with no policy announcement, as (NP). Thus, the total number of days in our sample (T) could be given as the sum of the two subset of dates, i.e. $T=T_P+T_{NP}$. The methodology assumes that the variance of the shocks is bigger on announcement dates (i.e. $T_P$), but the parameters of the simultaneous equations (2) and (3) are stable.

Given this assumption, the conditional variance-covariance matrices ($\Omega_P$ and $\Omega_{NP}$) for these two respective sets of dates ($T_P$ and $T_{NP}$) will have a difference that can be explained by the variance in monetary policy shocks ($\triangle\Omega$). Using these notations, we could give the difference between the conditional variance-covariance matrices as:

$$\triangle\Omega = \Omega_P - \Omega_{NP} = \frac{\delta^2_{\varepsilon|P}-\delta^2_{\varepsilon|NP}}{(1-\alpha\beta)^2}\begin{bmatrix}1 & \alpha\\ \alpha & \alpha^2\end{bmatrix}, \tag{5}$$

In this setting, $\delta^2_{\varepsilon|P}$ represents the conditional variance of monetary policy shocks on policy announcement days, while $\delta^2_{\varepsilon|NP}$ represents the shocks on non-announcement days. See Annex 1 for the derivation of the conditional variance.

The IH methodology derives a consistent estimate of $\alpha$ in equation (3) by using $\triangle\Omega$ as an instrument of identification (Rigobon and Sack, 2004; Arai, 2016).

To formalize the instruments (i.e. $\triangle\Omega$), we next define our endogenous variables. We suppose that our endogenous variables $\triangle Y_P$ and $\triangle IR_P$ are ($T_P$ x 1) vectors of variables on the announcement days. Conversely, $\triangle Y_{NP}$ and $\triangle IR_{NP}$ are ($T_{NP}$ x 1) vectors of variables that belong to the non-announcement days. These two vectors could be combined to yield another vector of endogenous variables of a (T x 1) dimension.

$$\Delta IR \equiv [\Delta IR_P, \Delta IR_{NP}]' \quad (6)$$

$$\Delta Y \equiv [\Delta Y_P, \Delta Y_{NP}]' \quad (7)$$

The instruments will be assembled by normalizing our endogenous variables by the total number of business days in the policy ($\frac{1}{T_P}\Delta Y_P$ and $\frac{1}{T_P}\Delta IR_P$) and non-policy days ($-\frac{1}{T_{NP}}\Delta Y_{NP}$ and $-\frac{1}{T_{NP}}\Delta IR_{NP}$), where additionally the signs of the variables are reversed for the non-policy days. That is;

$$Z_{IR} \equiv [\tfrac{1}{T_P}\Delta IR_P, -\tfrac{1}{T_{NP}}\Delta IR_{NP}]' \quad (8)$$

$$Z_Y \equiv [\tfrac{1}{T_P}\Delta Y_P, -\tfrac{1}{T_{NP}}\Delta Y_{NP}]' \quad (9)$$

$Z_{IR}$ and $Z_Y$ serve as appropriate instruments for the goal of identifying the monetary policy pass through (as given in equation 3). Given that the variances for the policy and non-policy dates are different (i.e. our underlying assumption), then these instruments will be correlated to our endogenous variables. In contrast, the instruments are not correlated with the shocks to asset prices described in equation (4) above. It is shown, in Annex 1, why these instruments (i.e. $Z_{IR}$ and $Z_Y$) are orthogonal.

The orthogonality of these instruments could be used as the moment condition, enabling us to have a GMM estimate of equation (3). However, as Rigobon and Sack (2004) show, both IV and GMM regressions could be used for the process of estimation, overcoming the bias from OLS. Similarly, Arai (2016) notes that GMM estimates of the system yields efficient estimates from his analysis of the effects of monetary policy announcements at the zero lower bound in Japan. This study will use both IV and GMM estimates.

The moment condition that will be used could be described as:

$$E[f(\alpha)] = 0, \quad (10)$$

Where,

$f_t(\alpha) = Z_t \cdot e_t,$

$Z_t = [z_{IR,t}, z_{Y,t}]',$

$e_t = \Delta Y_t - \alpha\Delta IR_t.$

Solving the following minimum disturbance problem will yield the estimates of $\alpha$ through GMM:

$$\alpha_{GMM} = \arg_\alpha \min f_T(\alpha)' W f_T(\alpha), \quad (11)$$

Where, $f_T(\alpha) = \sum_{t=1}^{T} f_t(\alpha)$ and W represents an appropriate weighting matrix of a 2x2 dimension. In a system of two-step GMM, the minimization problem could be first solved using the identity matrix as a weighing matrix. The inverse of the variance-covariance matrix of moment conditions, which is estimated in a first step, is then used in second step as a weighting matrix. The estimator bases itself on the assumption that $\lim_{T \to \infty} \frac{1}{T} f_T(\alpha) = 0$ (Rigobon and Sack, 2004). For the details of the orthogonality of instruments and application of GMM and IV estimates for IH methodology, refer to Annex 1.

### 5.4.2 Results from 'Identification through Heteroscedasticity'

The key assumption of the IH methodology is that there is a shift in variance between policy announcement days and non-announcement days (Section 5.4.1). In this regard, we first compare the daily changes in asset returns on announcement vs. non-announcement days. Then, we implement the methodology to determine the impact (i.e. pass-through) of conventional monetary policy shocks, as well as shocks stemming from exogenous factors (e.g. Fed and ECB unconventional monetary policies). Table 7.1 to Table 7.9 deliver the variance ratio tests. Specifically, the tables display the standard deviation of various asset returns on announcement and non-announcement days and a variance ratio test.[71] The test examines if there is a robust evidence for the non-equality of the standard deviations.

Before we go to the comparison of various policy event days with non-policy days, we first compare the period since the Global Financial Crisis (Jan 1, 2007 to June 30, 2016) with the period before (Jan 1, 2000 to Dec 31, 2006).[72] The results show that the standard deviations of daily asset returns were higher under the period since the GFC than the 'normal' period before. This is the case virtually for all assets investigated (see Table 7.1). This is to be expected, given the considerable financial and economic shocks within the period. The variance ratio test also confirms that there is a significant rise in volatility of asset returns during the GFC period than the period before. Also looking at the largest daily gains and losses in asset returns over the Jan 01, 2000-Jun 30, 2016 period, in Table 3.1 and Table 3.2, we notice that the single biggest daily movements are witnessed in the GFC period - nearly for all assets.[73] Particularly, the 20 largest single day gains and losses for 5 and 10 year South African sovereign bond yields and 5 and 10 year CDS have all been witnessed in the period since 2008.[74]

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[71] see Annex 1 for more on the variance-ratio test.

[72] Although the shock on the real sector and GDP from the GFC was seen in South Africa as from late 2008 to early 2009, the financial sector has already started to feel the shock from US Sub-prime crisis, which started to clearly propagate to the banking industry in 2007.

[73] See Table 3.3 to Table 3.6 for the changes in daily returns corresponding to key Fed and ECB unconventional monetary policy announcement dates.

[74] Looking at historical trends in key South African asset and market volatility indices (Figure 1.1 to Figure 1.6), the 2008-2009 (GFC) period was clearly turbulent.

We also observe higher standard deviations of asset returns often on policy dates, as compared to non-policy dates for Fed QE, Fed QE Tapering, Fed and ECB conventional monetary policy changes, Fed and ECB unconventional monetary policy changes, Fed FOMC meeting dates and ECB Governing Council sessions). This is evident in the sample variance ratios for most asset returns, as the variance ratios are typically bigger than one. This is similarly accompanied by the significance tests of the variance ratios.[75] Even simply looking at the figures depicting movements in daily asset returns, and overlaying them with Fed (Figure 2.1.1 to Figure 2.1.9) and ECB (Figure 2.2.1 to Figure 2.2.9) unconventional monetary policy announcements, we notice that event dates roughly overlap with biggest changes in asset returns. Given the apparent evidence in shift in variances on policy announcement dates from the variance ratio comparisons, we move on to the IH regressions.

## Impact of Fed and ECB unconventional monetary policy

Table 6.2 to Table 6.11 report the impact of various Fed and ECB unconventional monetary policy announcements on the returns of South African assets. These exercises try to measure the impact of the unconventional monetary policies (UMP), while accounting for the endogeneity issue explained in Section 5.4.1 by using the IH methodology. The results show that the QE policy of the Fed (see Table 6.2) had the impact of appreciating the rand, lowering bond yields, and CDS. The 3-month interbank rate also shows that it decreased, although this was not significant. The stock market indices appear to have gained during this asset purchase program of the Fed. These results from the IH methodology are consistent over IV and GMM estimations. The tapering of the QE program (see Table 6.3), by contrast, overturned the impact of the QE. The nominal exchange rate increased. Further, bond yields, CDS, and interbank rate rose. The stock market indices, meanwhile, fell. The impact on financial and industrial stocks appear to be more significant than the JSE aggregate index of all shares. These results are broadly in line with our earlier findings in Section 4.

The results of the IH regressions that investigate the impact of ECB's unconventional monetary policies on different South African assets (pooling all ECB UMP together) are reported in Table 6.4. The results basically mirror the impact of large scale asset purchase programs of the Fed. The rand appears to have appreciated. The stock market has also gained following ECB's UMP announcements. Further, ECB's unconventional monetary policies, overall, imply a significant fall in 5 and 10 year bond yields and CDS. Yet, the interbank rate, although carries a negative coefficient, fails to be significant. It could be argued that ECB's unconventional policies may not 'directly' affect the 3-month money market rates in inflation targeting economies with monetary

[75] Apart from comparing announcement and (all) non-announcement days, I additionally compared announcement days with non-announcement days that are just 5 days before the announcements. This is done as a comparator to exclude the potential shocks from other major events. The results, however, largely mirror the outcomes of the policy vs. all non-policy date variance comparisons.

policy independence, in line with the expectation of the trilemma hypothesis discussed in Section 5.3.

However, this is less convincing, considering the lack of empirical evidence for full 'monetary independence' (Rey, 2015; Aizenman et al., 2015). Even if we fail to see significant 'direct spillover' effects from ECB's unconventional liquidity operations in to South African money market rates, there might still be some 'indirect' channels. An example for this is the link between some South African banks with banking groups in the Eurozone.[36] A parent bank in the Eurozone benefiting from ECB's liquidity operations may inject some liquidity in to its subsidiaries in South Africa. This, in turn, may be used as substitute for the liquidity in South African money market. This might translate in to lower money market rates, since it reduces the demand for bank funding in South African. However, this 'international bank lending' channel - although couldn't be ignored - is not significant enough in linking South Africa with Eurozone, as is evident in our empirical results. In their investigation of ECB's monetary policy spillovers in Central and Easter European countries (a region far more integrated to Eurozone than South Africa), Fallagiarda et al. (2016) were able to see such results just in Romania.

The assessment of individual ECB unconventional monetary policies are given in Table 6.5 to Table 6.14. This is a useful exercise since the different list of ECB instruments were launched with different objectives (see Annex 2 and 3). First, the impact of three main groups of ECB's unconventional monetary policy instruments, namely 'Asset purchases', 'Liquidity Provisions' and 'Collateral Easing' are shown in Table 6.5 to Table 6.7. Next, the impact from specific ECB's instruments, namely - 'Outright Monetary Transactions' (Table 6.9); 'Foreign Currency Funding' (Table 6.10); 'Securities Markets Program' (Table 6.11); 'Covered Bond Purchase Program' (Table 6.12); 'Long-Term Refinancing Operations' (Table 6.13); 'Public Sector Purchase Program' (Table 6.14); 'Forward Guidance' (Table 6.8) are shown.

Generally, the impact of these diversified ECB's policies appear to be qualitatively similar. In line with expectations, the results from the IH regressions show that the 'asset purchases', 'liquidity provision', and 'collateral easing' programs led to appreciation of the local currency, reduction in bond yields and CDS, and an increase in stock market indices. The impact on the interbank rate, although negative, was not significant for all the three group of unconventional policies investigated. These findings largely match the results from the standard (non-instrumental) regression analysis for the 'asset purchases' and 'liquidity provision' policies (Section 4). The 'collateral easing' policies from the standard regressions, however, did not deliver significant results - unlike the IH regressions.

Next, we also look at the specific instruments constituting the three core unconventional policy operations of ECB. From the specific asset purchase programs, the announcements of 'Covered

bond purchases programs', which saw ECB buying securities from credit institutions so as to reassure the markets about medium and longer term refinancing of securities, implied the reduction of yields and CDS in South Africa. The rand also showed an appreciation. The other asset purchase policy (Securities Markets Program), also shows significant decline in CDS and some decline in 5 year bond yields. However, both CBPP and SMP show no significance impact either on CDS or the stock market indices. The spillovers on South African sovereign bond yields and CDS imply the presence of 'portfolio rebalancing' and 'sovereign credit risk' channels. However, the lack of spillovers in to the stock market might suggest weak spillovers from these policies (via 'confidence channels') to the stock market. We also see weak evidence for spillovers via the 'international bank lending' channel as seen from the weak evidence on the 3-month South African money market rate. Around late 2014, ECB also announced a move to expand its asset purchase programs to include sovereign bonds (PSPP). The spillovers from this 'purchase program for public sector securities' to South African assets was, however, weak (see Table 6.10). GMM estimates show no significant coefficients while IV estimates show some evidence of negative spillovers in to the nominal exchange rate and sovereign bond yields, in a manner typical to asset purchase programs.

The third, and one of the main, asset purchase programs of ECB (OMT) shows an impact on the stock market. JSE stock indices show gains on OMT announcement days. This positive spillover to the stock market from OMT, unlike SMP or CBPP1 or CBPP2, could probably be linked to the timing of the announcements, vis-à-vis other major events in the Eurozone and international markets. SMP and CBPP programs were largely communicated in 2010 and 2011 as the sovereign debt crisis in the Eurozone were starting (see Table A2). Global market sentiments were low and there was even expectation of a 'double-dip' recession, especially in 2011. Thus, the international impact of these policies might not be strong enough to offset the prevailing risk assessments by investors. The IV estimation also shows significant impact on 5 and 10 year bond yields and CDS. The money market rate, on the other hand, did not seem to be impacted from the OMT - just like those of the SMP and CBPP policies.

Within ECB's unconventional monetary policy instruments, the ones that had the objective of liquidity provision included the 'Foreign Currency Funding' (FOR) and the extensions of maturity via 'Long-Term Refinancing operations' (LTRO).[76] The foreign currency funding operations of ECB had very strong spillovers, virtually to all asset returns we investigated for South Africa. The program of large liquidity provision in foreign currencies (mostly of US dollars) to Eurozone's banking system had spillovers in to South Africa's nominal exchange rate, where it appreciated the currency. The money market rate, which hasn't been significantly affected by

[76] I additionally investigated the impact of another liquidity provision program, namely the "unlimited" provision of liquidity through 'fixed rate tenders with full allotment' (FRTPFA). IH estimates using instrumentation via both GMM and IV did not show significant impact of this policy, although the signs of the coefficients were similar to the other 'liquidity provision' programs.

other ECB instruments, appears to have been significantly reduced by the FOR policy. This is consistent over both IV and GMM estimations. In combination with international bank lending channel, significant 'foreign currency funding' to banks by ECB would increase the supply of foreign currency (relative to supply of the rand). This would exert a downward pressure on the nominal exchange market as well as the interbank market of South Africa (see Table 6.6). The FOR policy also resulted in significant gains by the stock market and decrease in 5 and 10 year bond yields and CDS. Further, ECB's maturity extension program (LTRO), which was a liquidity injection measure that enabled Eurozone banks to borrow more than a trillion euros (see Annex 2), had impacts that are largely similar to ECB's FOR policy instrument. Nonetheless, significant spillovers were witnessed form it mainly in the currency market and bond yields.

# 6 Conclusion

This study has assessed the spillovers from recent non-standard monetary policies from the Federal Reserve and European Central Bank on South Africa, a key emerging economy. By documenting major announcements of unconventional monetary policy tools by the Fed and ECB and also using a high frequency daily data, this study has examined how the returns on different South African assets are affected.

There is some evidence that yields on 5 and 10 year sovereign bonds declined in announcements relating to QE1. Later phases of the QE program also show similar impacts, although these were not as significant. This program also led to a decline in 5 and 10 year CDS spread. The impact on CDS spread was significant across all phases of QE and estimations under different specifications. The significance of the impact was especially stronger on 5 year CDS spreads. The interbank rate also responded to the different phases of QE announcements with a decrease in rates, although this impact was significant under the initial phase of QE. The returns on the stock market index were positive and highly significant in the different phases of the QE program. The asset purchase programs under Fed's QE also generally led to appreciation of the rand. The announcements relating to the tapering of Fed's asset purchase programs overall led to the depreciation of the rand. CDS of 5 and 10 years strongly responded to the tapering of QE with significant increases. Similarly, there is some evidence that 5 year Sovereign yields increased. The interbank rate also showed significant increment during events relating to the tapering of the QE. In addition, the returns on the stock market index were negative and significant during the announcements of the tapering.

The results from the regression analysis on asset returns generally fall in line with the international transmission channels for the unconventional monetary policies noted in the literature (e.g. Lim et al., 2014; Takas and Vela, 2014; Ehrmann et al., 2011). The transmission channels noted in the literature, carry the impact of large scale asset purchase programs from

their initial intended asset markets in advanced economies and specific asset categories to other countries (i.e. substitute markets) and broad asset classes (substitute assets). Fed's QE program boosted confidence in international capital markets and increased capital inflows in to emerging markets, as investors started targeting higher yield assets overseas and portfolio rebalancing. This is evidently seen in rising returns during the QE program. Although, for some assets, the effect is mainly significant during the first phase of QE. Conversely, the outflow of capital from emerging markets (in response to the tapering of QE) has seen falling returns on South African assets. The empirical finding in other countries and studies also confirms this (BIS, 2014).

The diversified unconventional monetary policies of ECB also appear to have had spillovers on South African assets. In line with expectations, the 'asset purchases' policy led to appreciation of the local currency, reduction in bond yields and CDS, and an increase in stock market indices. The 'liquidity provision' and 'collateral easing' policies also show impacts on asset returns that are similar to the 'asset purchases' policy, especially in the IH regressions. Looking at the specific unconventional monetary policy instruments constituting these three policy groups, the 'covered bond purchases programs', reduced South African sovereign bond yields and CDS. The rand also appreciated during these announcements. The 'securities markets program' also conveyed significant decline in CDS and 5 year bond yields. These spillovers to sovereign bond yields and CDS imply the likely occurrence of international 'portfolio rebalancing' and 'sovereign credit risk' channels between ECB's policies and South African asset returns. However, neither of these two asset purchase programs showed significant impact either on CDS or the stock market indices. The 'outright monetary transactions' program (another asset purchase instrument), on the other hand, shows some gains by the JSE stock indices. The lack of spillovers in to the stock market by some of the asset purchase programs may imply weak spillovers through 'confidence' channel) to the stock market. The weak spillovers to the money market rate might also imply weak transmission via the 'international bank lending' channel.

The 'foreign currency funding' program (part of the 'liquidity provision' policy of ECB) had very strong spillovers, virtually to all asset returns we investigated for South Africa. During the announcements events of the policy; the rand appreciated, the stock market made gains, while 5 and 10 year bond yields and CDS declined. Even the money market rate, which did not face significant spillovers from all other ECB policies, was significantly reduced by the program. The 'long-term refinancing operations' of ECB (i.e. maturity extension program), had impacts that are essentially comparable to the 'foreign currency funding' instrument. Nevertheless, significant spillovers from it were seen just on the currency market and South African sovereign bond yields. Overall, there is evidence that South African assets were affected by the spillovers from Federal Reserve's and ECB's policies. However, different policy events have affected different assets in different ways and some events had more significant impacts than others.

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# Annex:

## Annex 1 (econometric issues)

### 1.1 The bias in IH parameter estimates under OLS

If we denote equations (2) and (3) in matrix notations, we will get:

$$\begin{bmatrix} 1 & -\beta \\ -\alpha & 1 \end{bmatrix} \begin{bmatrix} \Delta \mathrm{IR}_t \\ \Delta \mathrm{Y}_t \end{bmatrix} = \begin{bmatrix} \gamma \\ \delta \end{bmatrix} \mathrm{X}_t + \begin{bmatrix} \varepsilon_t \\ \eta_t \end{bmatrix} \tag{12}$$

The reduced form solution can be obtained by solving:

$$\begin{bmatrix} \Delta \mathrm{IR}_t \\ \Delta \mathrm{Y}_t \end{bmatrix} = \frac{1}{1-\alpha\beta} \left[ \begin{bmatrix} \beta\delta + \gamma \\ \alpha\gamma + \delta \end{bmatrix} \mathrm{X}_t + \begin{bmatrix} 1 \\ \alpha \end{bmatrix} \varepsilon_t + \begin{bmatrix} \beta \\ 1 \end{bmatrix} \eta_t \right] \tag{13}$$

The OLS estimate of $\alpha$ in equation (3) could, then, be given as a covariance-variance ratio follows:

$$\hat{\alpha}_{OLS} = \frac{Cov\ (\Delta IR_t,\ \Delta Y_t)}{Var\ (\Delta IR_t)} \tag{14}$$

If we denote the variances of the three respective shocks as $\delta_X^2$, $\delta_\varepsilon^2$ and $\delta_\eta^2$, we could also give the estimate as:

$$\hat{\alpha}_{OLS} = \frac{(\beta\delta+\gamma)(\alpha\gamma+\delta)\delta_X^2+\alpha\delta_\varepsilon^2+\beta\delta_\eta^2}{(\beta\delta+\gamma)^2\delta_X^2+\delta_\varepsilon^2+\beta^2\delta_\eta^2} \tag{15}$$

The bias in OLS estimate, which is the difference between the estimated and actual value of $\alpha$ can be given as:

$$\hat{\alpha}_{OLS} - \alpha = \frac{(1-\alpha\beta)[\delta(\beta\delta+\gamma)\delta_X^2+\beta\delta_\eta^2]}{(\beta\delta+\gamma)^2\delta_X^2+\delta_\varepsilon^2+\beta^2\delta_\eta^2} \tag{16}$$

This bias will be different from zero if there are no extra restrictions on parameters, e.g. $\alpha.\beta = 1$.

### 1.2 The IH conditional variance

Following the foregoing notations in Section 5.4.1 and Annex 1 (1.1), suppose we denote the conditional variance of the shocks on the announcement days as $\delta_{X|P}^2$, $\delta_{\varepsilon|P}^2$, and $\delta_{\eta|P}^2$ . Conversely, we denote the conditional variance of the shocks on the non-announcement days as $\delta_{X|NP}^2$, $\delta_{\varepsilon|NP}^2$, and $\delta_{\eta|NP}^2$. Following the reduced form solution to the system given in equation (13), we may, then, estimate the conditional variance-covariance matrices for the systems, $\Omega_{\mathrm{P}}$ and $\Omega_{\mathrm{NP}}$, as:

$$\Omega_{\mathrm{P}} = \frac{1}{(1-\alpha\beta)^2} \begin{bmatrix} (\beta\delta+\gamma)^2\delta_{X|P}^2 + \delta_{\varepsilon|P}^2 + \beta^2\delta_{\eta|P}^2 & (\beta\delta+\gamma)(\alpha\gamma+\delta)\delta_{X|P}^2 + \alpha\delta_{\varepsilon|P}^2 + \beta\delta_{\eta|P}^2 \\ . & (\alpha\gamma+\delta)^2\delta_{X|P}^2 + \alpha^2\delta_{\varepsilon|P}^2 + \delta_{\eta|P}^2 \end{bmatrix} \tag{17}$$

$$\Omega_{\text{NP}} = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix}(\beta\delta+\gamma)^2\delta^2_{X|NP}+\delta^2_{\varepsilon|NP}+\beta^2\delta^2_{\eta|NP} & (\beta\delta+\gamma)(\alpha\gamma+\delta)\delta^2_{X|NP}+\alpha\delta^2_{\varepsilon|NP}+\beta\delta^2_{\eta|NP}\\ . & (\alpha\gamma+\delta)^2\delta^2_{X|NP}+\alpha^2\delta^2_{\varepsilon|NP}+\delta^2_{\eta|NP}\end{bmatrix} \quad (18)$$

We further assume that the variance of the monetary policy shocks is bigger in the days with policy announcements when compared to the days without announcements. Whereas, the variance of other shocks is assumed to remain similar in these two subset of days. That is, the following assumptions will hold on the second moments of the shocks.

$$\delta^2_{\varepsilon|P} > \delta^2_{\varepsilon|NP}, \quad (19)$$

$$\delta^2_{X|P} = \delta^2_{X|NP} \text{ , and} \quad (20)$$

$$\delta^2_{\eta|P} = \delta^2_{\eta|NP} \quad (21)$$

Based on these assumptions, the difference between the conditional variance-covariance matrices $\Omega_{\text{P}}$ and $\Omega_{\text{NP}}$ , i.e. equations (17) and (18), could be given as:

$$\triangle\Omega = \Omega_{\text{P}} - \Omega_{\text{NP}} = \frac{\delta^2_{\varepsilon|P}-\delta^2_{\varepsilon|NP}}{(1-\alpha\beta)^2}\begin{bmatrix}1 & \alpha\\ \alpha & \alpha^2\end{bmatrix}, \quad (22)$$

That is, only the variances of the monetary policy shocks remain since the variances of other shocks are nullified.

## 1.3 The orthogonality of IH instruments and moment condition

We may show that two instruments $z_{\text{IR}}$ and $z_{\text{Y}}$ are orthogonal to the residuals **e** as follows:

$$\sum_{t=1}^{T} z_t . e_t = \ Z' . e \quad (23)$$

$$= \begin{bmatrix}z'_{IR}\\ z'_{Y}\end{bmatrix}\ (\Delta Y - \alpha\Delta IR) \quad (24)$$

$$= \begin{bmatrix}\frac{1}{T_P}\Delta IR'_P\ , -\frac{1}{T_{NP}}\Delta IR'_{NP}\\ \frac{1}{T_P}\Delta Y'_P\ , -\frac{1}{T_{NP}}\Delta Y'_{NP}\end{bmatrix}\ (\Delta Y_P - \alpha\Delta IR_P\ , \Delta Y_{NP} - \alpha\Delta IR_{NP}\ ) \quad (25)$$

$$= \begin{bmatrix}\frac{1}{T_P}\Delta IR'_P\ (\Delta Y_P - \alpha\Delta IR_P) - \frac{1}{T_{NP}}\Delta IR'_{NP}(\Delta Y_{NP} - \alpha\Delta \text{IR}_{\text{NP}})\\ \frac{1}{\text{T}_\text{P}}\Delta \text{Y}'_\text{P}\ (\Delta \text{Y}_\text{P} - \alpha\Delta \text{IR}_\text{P}) - \frac{1}{\text{T}_\text{NP}}\Delta \text{Y}'_\text{NP}(\Delta \text{Y}_\text{NP} - \alpha\Delta \text{IR}_\text{NP})\end{bmatrix} \quad (26)$$

$$= \begin{pmatrix} \left(\widehat{\Omega}_{\mathrm{P},12} - \alpha\widehat{\Omega}_{\mathrm{P},11}\right) - \left(\widehat{\Omega}_{\mathrm{NP},12} - \alpha\widehat{\Omega}_{\mathrm{NP},11}\right) \\ \left(\widehat{\Omega}_{\mathrm{P},22} - \alpha\widehat{\Omega}_{\mathrm{P},21}\right) - \left(\widehat{\Omega}_{\mathrm{NP},22} - \alpha\widehat{\Omega}_{\mathrm{NP},21}\right) \end{pmatrix} \tag{27}$$

$$= \begin{pmatrix} \Delta\widehat{\Omega}_{12} - \alpha\Delta\widehat{\Omega}_{11} \\ \Delta\widehat{\Omega}_{22} - \alpha\Delta\widehat{\Omega}_{21} \end{pmatrix} \tag{28}$$

Given $\Delta\Omega = \mathrm{C}\begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix}$, we will get

$$\sum_{t=1}^{T} z_t . e_t \rightarrow_p 0. \tag{29}$$

Thus, $\mathrm{E}\left[z_t . e_t\right] = 0$, will be the moment condition.

Note: Section 1.1 to 1.3 of Annex 1 closely follows Rigobon and Sack (2004). For more on parameter bias, conditional variance, orthogonality of instruments as well as application of the identification through heteroscedasticity methodology, please see Rigobon and Sack (2003), Rigobon and Sack (2004), Rigobon (2003), Gilchrist and Zakrajsek (2013), Arai (2016), Caporalea et al. (2005).

## 1.4 The variance ratio test

The variance ratio test which we conduct here makes a test on the equality of the standard deviations of two groups. The test ($\delta_{\mathrm{P}} = \delta_{\mathrm{NP}}$), for instance comparing standard errors of asset returns on policy announcement dates (P) with non-policy announcement dates (NP), is given as $\mathrm{x}^2$ distribution with n-1 degrees of freedom, where, the test is specified as $\mathrm{x}^2 = \frac{(\mathrm{n}-1)\mathrm{s}^2}{\delta^2_{\mathrm{NP}}}$. Further, the test for $\delta^2{}_{\mathrm{P}} = \delta^2{}_{\mathrm{NP}}$ could be given as an F distribution with $\mathrm{n}_1$ -1 and $\mathrm{n}_0$ -1 degrees of freedom, where, the test is specified as $\mathrm{F} = \frac{s_P^2}{s_{NP}^2}$.

Suppose $\mathrm{Y}_{\mathrm{i,j}}$ represents the jth observation of a return on asset Y for the ith group (e.g. dates with unconventional monetary policy announcements). Further, suppose $\mathrm{Z}_{\mathrm{ij}} = |\mathrm{Y}_{\mathrm{i,j}} - \overline{\mathrm{Y}}_{\mathrm{i}}|$, where the mean of Y in the ith group is represented by $\overline{\mathrm{Y}}_{\mathrm{i}}$. Levene's test statistic for equality of variances could be given as:

$$W_0 = \frac{\sum_i n_i(\bar{Z}_i - \bar{Z})^2/(g-1)}{\sum_i \sum_i (\bar{Z}_{i,j} - \bar{Z}_i)^2 / \sum_i (n_i - 1)}$$

Where, g represents the number of groups while $\mathrm{n_i}$ shows the number of observations in group i (e.g. number of announcement events per specific unconventional monetary policy type). In our case, where we have two groups (e.g. announcement dates vs. non-announcement dates), the test statistic could simply be given as:

$$W_0 = \frac{\sum_i n_i(\bar{Z}_i - \bar{Z})^2}{\sum_i \sum_i (\bar{Z}_{i,j} - \bar{Z}_i)^2 / \sum_i (n_i - 1)}$$

The above Levene's test statistic for equality of variances is robust even under non-normal distributions (Gastwirth et al., 2009; Brown and Forsythe, 1974; Levene, 1960).

# Annex 2 (Recent monetary policy environment in the US and Eurozone)

## 2.1 Recent monetary policy instruments adopted by the Fed

The economic environment in late 2008, characterized by severe recession and financial crisis, overwhelmed standard monetary policy tools and short term rates were close to zero. Faced by these difficulties, the US Federal Reserve (Fed) resorted to strong unconventional monetary tools such as 'quantitative easing' (QE), as did other major central banks such as ECB.[77] (For the chronological list of key unconventional monetary policies adopted by the Fed and ECB, see Table A1 and Table A2 in Annex 3). However, the key unconventional instruments followed by the Fed differed from that of the ECB in that Fed's QE was focused on bond purchases while ECB's actions were mainly focused on direct lending to banks, although it also made asset purchases. Fawley and Neely (2013) attribute this to the fact that bond markets play the main role in the US while banks play the main role in Eurozone.

During financial crisis, some assets may suffer liquidity problems or may be undervalued by financial markets. Central banks can address liquidity problems and undervaluation of assets by purchasing them and modifying the composition of assets which they hold. This is precisely part of the key instruments used by the Fed and the ECB during the subprime and Eurozone debt crisis. Such policies are generally termed as 'credit easing' and they could take the form of 'pure credit easing' when central bank purchases of assets with liquidity issues is sterilized by the sale of other central bank assets. When the credit easing involves the purchase of assets without the sale of other assets (and leads to expansion of central bank balance sheets) it is termed as 'quantitative easing' (Szczerbowicz, 2015). Credit easing policies, be it 'pure credit easing' or 'quantitative easing', mainly achieve their target via the 'portfolio rebalancing effect'. When a central bank targets and makes large purchases of a specific asset group, it alters the quantity of asset available for the private investors. This increases the price of the asset and reduces its yield.

**First Round of Quantitative Easing (QE1):** Around late 2008 the Fed introduced its first Quantitative Easing program (QE1), while the ECB worked on expanding its operations of bank lending. This round of QE is commonly termed as QE1, to put it apart from two follow-up rounds of the policy (i.e. QE2 and QE3). The Fed publicized on November 25, 2008 that it will make purchases of 100 billion USD worth of government-sponsored enterprise (GSE) debt and $500 billion USD worth of mortgage-backed securities (MBS) issued by GSEs. On December 1, 2008 the Fed suggested that asset purchases under QE might extend also to treasuries. Further announcements were made on March 18, 2009 that the Fed will make an additional purchase of MBS securities worth 750 billion USD, long term treasury securities worth 300 billion USD, and GSE debt worth 100 billion USD. As Fawley and Neely (2013) note, these operations by the Fed almost doubled the monetary base of the US. Over the span of QE1, assets worth 1.75 trillion USD were purchased by the Fed (Chadha et al., 2013). Long term US real interest rates were also lowered by QE1 through its effect on term premia (Gagnon et al., 2011; Hausken and Ncube, 2013). As markets stabilized from the

[77] The Bank of Japan (BOJ) and Bank of England (BOE) had also followed their own asset purchase programs (Fawley and Neely, 2013).

subprime crisis around end of 2009 and beginning of 2010, the Fed decided to conclude its QE1 operation in the first quarter of 2010.

**Second Round of Quantitative Easing (QE2):** The Fed hinted its plan to continue its QE operation as the then Fed chairman, Ben Bernanke, noted on August 27, 2010. The need for another round of QE came not primarily because of problems in the financial market but due to slow recovery and 'worryingly' low inflation. After repeated communications about QE2, the Fed on November 3, 2010 formally announced its intention to make purchases of extra 600 billion USD worth of US treasuries. QE2 had explicit targets of lowering longer term US real interest rates and also pushing inflation to its target levels.

However, markets had already anticipated the formal commencement of QE2 on November 2010. As Fawley and Neely (2013) note, almost all of primary dealers polled by Reuters (a month before actual launch of QE2) expected Fed to announce QE2 on its November 3, 2010 Federal Open Market Committee (FOMC) meeting. This meant that the formal announcement of QE2 environment create a big surprise effect on the market, as the market has correctly foreseen this and already adjusted to this expectation of Fed's policies. This market anticipation for the 'renewal' of Federal Reserve's asset purchase programs (QE2) stands in stark contrast to significant market surprise associated with the initial launch of the program (QE1) in November 25, 2008 and the commencement of treasury purchases (with expanded QE1) on March 3, 2009 (see Table A1).[78]

**Third Round of Quantitative Easing (QE3):** In light with the poor performance of the labor market, the Fed already hinted on August 2012 that it will undertake 'additional monetary accommodations' (see Table A1). Consistent with clear market expectation, the Fed communicated the launch of a third quantitative easing round (QE3). The Fed committed itself to the purchase of 40 billion USD worth of MBS securities per month until conditions in the labor market improve 'substantially' and even expand purchases if necessary. The Fed further expanded QE3 on December 12, 2012 by committing itself to continue the purchase of long term treasuries worth 45 billion USD per month.

**'Taper Tantrum':** In his testimony to the US congress On May 22, 2013, Ben Bernanke motioned the plan for normalization of US monetary policy and end of asset purchases by stating "In the next

[78] The Fed announced another round of purchases for long term treasuries, on September 21, 2011. This follows the renewed financial distress and market anxiety about another recession in the second half of 2011. This program is popularly known as 'operation twist', although it is formally known as 'Maturity Extension Program and Reinvestment Policy'. The program earned its nickname since its effect was to twist the shape of the yield curve. It does so by reducing long term interest rate as compared to short term interest rates. For this objective, the Fed sold 400 billion USD worth of short term assets while at the same time purchasing 400 billion USD worth of long term assets. Unlike the QE policy, the program environment expand the monetary base (i.e. no money creation). This is because the amount of the assets sold and purchased by the Fed were of equal magnitude. The Fed extended 'Operation twist' on June 20, 2012 and committed itself to continue this policy till the end of 2012. It decided to purchase long term securities worth 45 billion USD per month, which was funded by the sale of short term securities worth 45 billion USD.

few meetings, we could take a step down in our pace of purchase". In a press conference on June 19, 2013, Bernanke also reiterated that "the central bank may start dialing down its unprecedented bond buying program this year and end it entirely in mid-2014 if the economy finally achieves the sustainable growth the Fed sought since the recession ended in 2009" (Table A1). This speech on QE tapering (i.e. gradual winding down of asset purchases) caused a surge in US treasury yields in 2013, hence, the name 'taper tantrum'. Financial markets strongly reacted to Bernanke's tapering speech as they anticipated short term interest rate normalization (i.e. rate hike), apart from the obvious (gradual) termination of asset purchases programs (Aizenman et al., 2015; Chen et al., 2014; Mohanty, 2014).

### 2.2 Recent monetary policy instruments adopted by the ECB

Since the onset of the global recession, ECB followed a diverse list of unconventional monetary policies that could broadly be grouped as 'assets purchases', exceptional 'liquidity provisions' and 'collateral easing'.[79] The full list of these policies and their event dates are given chronologically in Table A2.

i) **Assets purchases:** Some of the key asset purchase programs of the ECB included:

- Securities Markets Program (SMP): the SMP was launched on May 9, 2010 as an effort to stabilize the euro during the sovereign debt crisis of the time, which was triggered by the Greek public debt crisis. The ECB used this policy tool to purchase sovereign bonds. However, there were concerns of inflation (and other issues related to ECB's mandate) tied to the SMP. These same concerns were also raised against the asset purchase programs of the US Fed, i.e. the 'Quantitative Easing' policy. The ECB has tried to present the SMP as different from the Fed's QE policy. In this regard, the ECB was sterilizing its sovereign bond purchases in secondary markets and re-absorbing the liquidity injected to the markets by the SMP policy.

- Outright Monetary Transactions (OMT): the OMT policy is also a purchase program of sovereign bonds. The program was launched on September 6, 2012 to address the lingering debt crisis in the Eurozone. It was initiated following the rapid rise in sovereign yields of Eurozone's periphery economies. The OMT, although closely related to the SMP, was different in some aspects. The SMP targeted the purchase of longer term bonds while the OMT was operational on relatively short maturity sovereign bonds, where the maximum was 3 years. Further, euro-area governments had to comply with a number of requirements (macroeconomic adjustment policies) before OMT purchases of their sovereign bonds were made.

[79] The ECB also followed certain monetary policy conducts that are 'unconventional' but are not necessary 'asset purchases', 'liquidity provisions' or 'collateral easing'. One such example is the adoption of 'forward guidance' (FWG) policy adopted by ECB on July 4, 2013. This is essentially a change in monetary policy communication strategy. FWG has significant impact on markets since it alters expectations of future policy rates. In its July 4, 2013 press conference communication, ECB's monetary policy committee (i.e. 'the Governing council') stated that it "…expects the key ECB interest rates to remain at present or lower levels for an extended period of time..."
https://www.ecb.europa.eu/press/pressconf/2013/html/is130704.en.html

- Covered bond purchases programs (CBPP1 and CBPP2): this programs involved the purchase of securities issued by credit institutions (i.e. covered bonds) by ECB. The main objective was to assure the markets about the medium and longer term refinancing of these securities. These securities are often collateralized by public-sector loans or mortgage loans. Covered bonds often have higher ratings than the credit ratings of the banks that issued them. This is due to the quality of the collateral attached to the covered bonds. This made them safe and, thus, more liquid. The low risk and higher return on these bonds also normally makes them more attractive than sovereign bonds. However, as the experience from the subprime and Eurozone crisis period shows, private investors might still prefer sovereign bonds (despite their lower returns) - especially in times of financial crisis. The ECB announced its first covered bond purchases program (CBPP1) on May 7, 2009 and noted that it will purchase covered bonds (euro-denominated) worth 60 billion. A follow up covered bonds purchases program (CBPP2) was announced on October 6, 2011, where ECB would purchase a 40 billion worth of covered bonds with euro-denomination. The purchases took place in both primary and secondary markets. CBPP3, a follow up of covered bond purchase program CBPP2, was announced on October 2, 2014. The ECB further announced its expanded Asset Purchase Program (APP), which integrates the already operational asset-backed securities (ABSPP) and covered bond purchase program (CBPP3) with a new purchase program for public sector securities (PSPP) on January 22, 2015. The PSPP added bonds issued by governments and Eurozone institutions in to the pool of assets purchased by ECB. These combined purchases represented 60 billion euros worth of assets by September 2016. On April 21, 2016, the ECB also announced details of new corporate sector purchase program (CSPP).

ii) **Liquidity provisions:** At the start of the 2008 financial crisis, the ECB acted strongly to calm down the interbank market. The central bank accepted a diverse list of collaterals and also provided liquidity to a big number of banks. However, as the global recession and the Eurozone government debt crisis started to make the interbank market even worse, ECB started to resort to additional measures that address liquidity.[80] These measures are dubbed 'unconventional' since their scope and way of operation goes beyond conventional open market ECB operations (Szczerbowicz, 2015). To restore confidence and the normal operations of the interbank market (and lending by banks to firms and households), the ECB started to follow the following list of non-standard liquidity provisions:

[80] When financial assets and money are not perfect substitutes, excess liquidity in the financial market may affect the economy via portfolio rebalancing effects (Tobin, 1982; Meltzer, 1995; Szczerbowicz, 2015; Hausken and Ncube; 2013; Lim et al., 2014). In other words, excess liquidity induced by ECB's aggressive actions might force banks and other economic agents to purchase sovereign (and corporate) bonds in the Eurozone and substitute bonds elsewhere (e.g. South Africa), thereby raising the price of these bonds and depressing their yields.

- Unlimited provision of liquidity through 'fixed rate tenders with full allotment' (FRTPFA): Unlike traditional open market operations that are conducted via variable rate tenders, banks in Eurozone got the possibility to fulfill all their liquidity requirements at interest rates that was determined in advance by the ECB. This fixed interest rate refers to the rate on 'Main Refinancing Operations' (MROs). Szczerbowicz (2015) note that fixed rate tenders on MROs existed before - i.e. at the early days of the Eurosystem (Jan 1999 to June 2000) but were later taken away due to overbidding by banks. ECB started the FRTPFA around October 2008 for its open market operations and foreign liquidity swaps. By coordinating its efforts with the Fed, ECB also started to deliver 'unlimited' USD funding to the market. The ECB tried to reintroduce variable rate tenders in March 2010 but quickly resumed fixed rate tenders on May 2010 due to the Greek debt crisis.
- Extension of the maturity of 'long-term refinancing operations' (LTRO): ECB conducted maturity extensions of LTRO (up to 1 year) since 2007 and an exceptional liquidity measure of conducting 3 year LTROs. For instance, two packages of 3-year LTROs (one on 21 December 2011 and another on 29 February 2012) enabled Eurozone banks to borrow in excess of 1 trillion euros.
- Liquidity provision in foreign currencies to enhance 'foreign currency funding' (FOR): This was carried out via swap lines with other central banks. Under this instrument, ECB followed a policy of exchanging euros against US dollars. Although liquidity provisions in USD was the main part, it also exchanged euros against the pound sterling and also the Swiss franc. Apart from exchanging euros to foreign currencies, the ECB also followed the policy of directly lending in foreign currencies to financial institutions in the Eurozone.

**iii) Collateral easing:** Since late 2008 (the onset of the global financial crisis), the ECB started to comprehensively loosen its rules over collaterals. ECB started accepting debt instruments that are issued by credit institutions (e.g. deposit certificates from banks) as eligible collaterals. However, to limit its exposure to risky assets, ECB started to transition away to asset backed securities (ABS) with higher requirements from emergency collateral instruments. The ECB announced operational details of asset-backed securities (ABSPP) On October 2, 2014, alongside new covered bond purchase program (CBPP3).

# Annex 3 (Fed, ECB & SARB event dates)

Table A1: Fed UMP Event dates

| Event dates | Event detail | UMP Type | Source |
|---|---|---|---|
| 11/25/2008 | Large-scale asset purchase (LSAP) announced: Fed will purchase $100 billion in GSE debt and $500 billion in MBS. | QE1 | Fawley and Neely (2013); US Fed |
| 12/1/2008 | First suggestion of extending QE to Treasuries. | QE1 | Fawley and Neely (2013); US Fed |
| 1/28/2009 | Fed stands ready to expand QE and buy Treasuries. | QE1 | Fawley and Neely (2013); US Fed |
| 3/18/2009 | LSAPs expanded: Fed will purchase $300 billion in long-term Treasuries and Fed expects low rates for an additional $750 and $100 billion in MBS and GSE debt, respectively. | QE1 | Fawley and Neely (2013); US Fed |
| 8/12/2009 | LSAPs slowed: All purchases will finish by the end of October, not mid-September. | QE1 | Fawley and Neely (2013); US Fed |
| 8/27/2010 | Bernanke suggests role for additional QE "should further action prove necessary." | QE2 | Fawley and Neely (2013); US Fed |
| 9/21/2010 | FOMC emphasizes low inflation, which "is likely to remain subdued for some time before rising to levels the Committee considers consistent with its mandate. | QE2 | Fawley and Neely (2013); US Fed |
| 10/12/2010 | FOMC members' "sense" is that "[additional] accommodation may be appropriate before long." | QE2 | Fawley and Neely (2013); US Fed |
| 11/3/2010 | QE2 announced: Fed will purchase $600 billion in Treasuries | QE2 | Fawley and Neely (2013); US Fed |
| 9/21/2011 | Maturity Extension Program ("Operation Twist") announced: The Fed will purchase $400 billion of Treasuries with remaining maturities of 6 to 30 years and sell an equal amount with remaining maturities of 3 years or less; MBS and agency debt principal payments will no longer be reinvested in Treasuries, but instead in MBS. | "Twist" | Fawley and Neely (2013); US Fed |
| 6/20/2012 | Maturity Extension Program extended: The Fed will continue to purchase long-term securities and sell short-term securities through the end of 2012. Purchases/sales will continue at the current pace, about $45 billion/month. | "Twist" | Fawley and Neely (2013); US Fed |
| 8/22/2012 | FOMC members "judged that additional monetary accommodation would likely be warranted fairly soon…" | QE3 | Fawley and Neely (2013); US Fed |
| 9/13/2012 | QE3 announced: The Fed will purchase $40 billion of MBS per month as long as "the outlook for the labor market does not improve substantially…in the context of price stability. Fed expects low rates "at least through mid-2015." | QE3 | Fawley and Neely (2013); US Fed |
| 12/12/2012 | QE3 expanded: The Fed will continue to purchase $45 billion of long-term Treasuries per month but will no longer sterilize purchases through the sale of short-term Treasuries. The Fed expects low rates to be appropriate while unemployment is above 6.5 % and inflation is forecasted below 2.5%. | QE3 | Fawley and Neely (2013); US Fed |
| 5/22/2013 | (Ben Bernanke's, ex-Fed Chairman, testimony to Congress) "...In the next few meetings, we could take a step down in our pace of purchase..." | Tapering | Chen et al(2014); US Fed |
| 6/19/2013 | (Ben Bernanke press conference) "...The central bank may start dialing down its unprecedented bond-buying program this year and end it entirely in mid-2014 if the economy finally achieves the sustainable growth the Fed sought since the recession ended in 2009..." | Tapering | Chen et al(2014); US Fed |
| 12/18/2013 | FOMC Meeting, Tapering | Tapering | US Fed |
| 1/29/2014 | FOMC Meeting, Tapering | Tapering | US Fed |
| 2/11/2014 | Janet Yellen (Current Fed Chair) Testimony, Tapering | Tapering | US Fed |

Table A2: ECB UMP event dates

| Event date | Description | UMP type |
|---|---|---|
| 6/22/2016 | ECB reinstates waiver affecting the eligibility of Greek bonds used as collateral in Eurosystem monetary policy operations (PSPP). | PSPP |
| 6/2/2016 | Announcement of remaining details of the corporate sector purchase program (CSPP). "...Today the Governing Council of the European Central Bank (ECB) decided that purchases under its corporate sector purchase program (CSPP) will start on 8 June 2016. The Governing Council also took decisions on the remaining details of the CSPP. The CSPP is a new program added to the existing elements of the asset purchase program that will strengthen the pass-through of asset purchases to the real economy…" | CSPP |
| 4/21/2016 | Announcement of details for the corporate sector purchase program (CSPP). The CSPP aims to further strengthen the pass-through of the Eurosystem's asset purchases to the financing conditions of the real economy. The CSPP will be carried out by six national central banks acting on behalf of the Eurosystem, coordinated by the ECB. | CSPP |
| 3/10/2016 | Decision to add corporate sector purchase program (CSPP) to the asset purchase program (APP) and announces changes to APP). The monthly purchases under the asset purchase program will be expanded to €80 billion starting in April. Investment grade euro-denominated bonds issued by non-bank corporations established in the euro area will be included in the list of assets that are eligible for regular purchases. A new series of four targeted longer-term refinancing operations (TLTRO II), each with a maturity of four years, will be launched, starting in June 2016. | ABSPP |
| 3/10/2016 | ECB announces new series of targeted longer-term refinancing operations (TLTRO II) | TLTRO |
| 11/9/2015 | Increase in PSPP issue share limit enlarges purchasable universe (PSPP) | PSPP |
| 9/23/2015 | Eurosystem adjusts purchase process in ABS program (ABSPP) | ABSPP |

| | | |
|---|---|---|
| 6/18/2015 | ECB Governing Council takes note of ruling on OMT by the Court of Justice of the European Union (ECJ) | OMT |
| 1/22/2015 | Decision that the interest rate for the remaining six TLTROs would be equal to the rate on the Eurosystem's MROs prevailing at the time when each TLTRO is conducted | TLTRO |
| 1/22/2015 | Announcement of expanded asset purchase program | PSPP |
| 12/4/2014 | (Draghi's press conference) "...Evidently we are convinced that a QE program which could include sovereign bonds falls within our mandate..." | PSPP |
| 11/26/2014 | (Vitor Constancio, vice president of the ECB, London speech) "...we will have to consider buying other assets, including sovereign bonds in the secondary market..." | PSPP |
| 11/17/2014 | (Mario Draghi's speech at the European Parliament) "The ECB Governing Council is unanimous in its commitment to using additional unconventional instruments [...] Unconventional measures might entail the purchase of a variety of assets, one of which is sovereign bonds." | PSPP |
| 10/2/2014 | Announcement of operational details for covered bond purchase programs | CBPP |
| 10/2/2014 | Announcement of operational details for asset-backed securities | ABSPP |
| 9/18/2014 | Decision to allot €82.6 billion in first targeted longer-term refinancing operation | TLTRO |
| 9/4/2014 | Decision that the Eurosystem would purchase a broad portfolio of euro-denominated covered bonds issued by MFIs domiciled in the euro area under a new covered bond purchase program (CBPP3) | CBPP |
| 9/4/2014 | Decision on purchasing a broad portfolio of simple and transparent asset-backed securities (ABSs) with underlying assets consisting of claims against the euro area non-financial private sector under an ABS purchase program (ABSPP) | ABSPP |
| 7/29/2014 | Publication of legal act relating to targeted longer-term refinancing operations | TLTRO |
| 7/3/2014 | Decision on further technical details for the series of targeted longer-term refinancing operations (TLTROs) | TLTRO |
| 6/17/2014 | Decision to continue offering seven-day US dollar liquidity-providing operations | FOR |
| 6/5/2014 | Decision to conduct a series of targeted longer-term refinancing operations (TLTROs) aimed at improving bank lending to the euro area non-financial private sector, excluding loans to households for house purchase. | TLTRO |
| 6/5/2014 | Decision to continue conducting the Eurosystem's main and three-month longer-term refinancing operations as fixed rate tender procedures with full allotment for as long as necessary. | LTRO |
| 6/5/2014 | Decision to continue conducting the Eurosystem's main and three-month longer-term refinancing operations as fixed rate tender procedures with full allotment for as long as necessary. | FRTPFA |
| 6/5/2014 | Decision to extend the existing eligibility of additional assets as collateral, notably under the additional credit claims framework, at least until September 2018, and to intensify preparatory work related to outright purchases of asset-backed securities (ABS). | COLL |
| 6/5/2014 | Decision to extend the existing eligibility of additional assets as collateral, notably under the additional credit claims framework, at least until September 2018, and to intensify preparatory work related to outright purchases of asset-backed securities (ABS). | ABSPP |
| 11/7/2013 | Decision to conduct three-month longer-term refinancing operations (LTROs) as fixed rate tender procedures with full allotment | LTRO |
| 11/7/2013 | Decision on continuing the conduct of main refinancing operations (MROs) as fixed rate tender procedures with full allotment for as long as necessary (at least until the end of the 6th maintenance period of 2015 on 7 July 2015); Decision to conduct three-month longer-term refinancing operations (LTROs) as fixed rate tender procedures with full allotment. | FRTPFA |
| 10/31/2013 | Establishment of standing swap arrangements with other central banks | FOR |
| 9/16/2013 | Decision to extend the liquidity swap arrangement with the Bank of England | FOR |
| 7/4/2013 | The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time. (Mario Draghi's press conference) | FWG |
| 5/2/2013 | Decision to conduct the three-month longer-term refinancing operations (LTROs) as fixed rate tender procedures with full allotment | LTRO |
| 5/2/2013 | Decision on continuing the conduct of main refinancing operations (MROs) as fixed rate tender procedures with full allotment for as long as necessary, and at least until the end of the 6th maintenance period of 2014 on 8 July 2014 | FRTPFA |
| 3/22/2013 | Collateral rule changed for some uncovered government guaranteed bank bonds | COLL |
| 2/21/2013 | Decision to publish the Eurosystem's holdings of securities acquired under the Securities Markets Program (SMP) | SMP |
| 12/13/2012 | Decision on extending liquidity swap arrangements with the Fed | FOR |
| 12/6/2012 | Decision on the conduct of 3-month LTROs as FRTPFA | LTRO |
| 12/6/2012 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary, and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 9/12/2012 | Decision on extending liquidity swap arrangement with the Bank of England | FOR |
| 9/6/2012 | ECB Governing Council meeting. The ECB Governing Council announced the technical details of OMTs and decided on additional measures to preserve collateral availability | OMT |
| 9/6/2012 | Announcement of technical details for OMTs and decisions on additional measures to preserve collateral availability | COLL |
| 8/2/2012 | Decision to undertake outright open market operations (of a size adequate to reach ECB's objective) | OMT |
| 7/26/2012 | (Mario Draghi's, president of ECB, London speech) "... whatever it takes ..." | OMT |
| 6/22/2012 | increase of collateral availability for counterparties | COLL |
| 6/6/2012 | Decision on conducting 3-month LTROs as FRTPFA | LTRO |
| 6/6/2012 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary, and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 2/28/2012 | Results of second 3-year LTRO | LTRO |
| 2/9/2012 | Decision on additional credit claims as collateral in Eurosystem credit operations (specific national eligibility criteria and risk control measures) | COLL |
| 12/21/2011 | Results from first 3-year LTRO | LTRO |
| 12/8/2011 | Decision on conducting two LTROs with a maturity of 3 years and to increase collateral availability | LTRO |
| 12/8/2011 | Decision on conducting two LTROs with a maturity of 3 years and to increase collateral availability | COLL |

| | | |
|---|---|---|
| 11/30/2011 | Decision on the establishment of a temporary network of reciprocal swap lines (in cooperation with other central banks) | FOR |
| 11/3/2011 | Decision on technical modalities of CBPP2 | CBPP |
| 10/6/2011 | Decision on conducting 3-month LTROs as FRTPFA, conducting 2 liquidity-providing supplementary LTROs with a maturity of 12 and 13 months as FRTPFA | LTRO |
| 10/6/2011 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary, conducting 3-month LTROs as FRTPFA, conducting 2 liquidity-providing supplementary LTROs with a maturity of 12 and 13 months as FRTPFA | FRTPFA |
| 10/6/2011 | Decision on launching new covered bond purchase program (CBPP2) | CBPP |
| 9/15/2011 | Decision to conduct three operations on dollar liquidity-provision in coordination with other central banks | FOR |
| 8/25/2011 | Decision on extending liquidity swap arrangements with the BoE | FOR |
| 8/8/2011 | Decision on implementing SMP for Italy and Spain | SMP |
| 8/4/2011 | Decision on conducting 3-month LTROs as FRTPFA and conducting liquidity provision via supplementary LTRO with a maturity of 6 months as a FRTPFA | LTRO |
| 8/4/2011 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary and to conduct 3-month LTROs as FRTPFA and on conducting liquidity provision via supplementary LTRO with a maturity of 6 months as a FRTPFA | FRTPFA |
| 6/29/2011 | Decision on extending liquidity swap arrangements with the Fed | FOR |
| 6/9/2011 | Decision on conducting 3-month LTROs as FRTPFA | LTRO |
| 6/9/2011 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 3/3/2011 | Decision on conducting 3-month LTROs as FRTPFA | LTRO |
| 3/3/2011 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 12/21/2010 | Decision on extending liquidity swap arrangements with the Fed | FOR |
| 12/17/2010 | Announcement of temporary swap facility with the Bank of England | FOR |
| 12/2/2010 | Decision on conducting 3-month LTROs as FRTPFA | LTRO |
| 12/2/2010 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 9/2/2010 | Decision on conducting 3-month LTROs as FRTPFA | LTRO |
| 9/2/2010 | Decision on continuing the conduct of MROs as FRTPFA for as long as necessary and to conduct 3-month LTROs as FRTPFA | FRTPFA |
| 6/10/2010 | Decision on adopting FRTPFA in regular 3-month LTROs | LTRO |
| 5/10/2010 | Decision on proceeding with SMP | SMP |
| 5/10/2010 | Decision on adopting a FRTPFA in the regular 3-month LTROs and to conduct new special LTROs | LTRO |
| 5/10/2010 | Decision on reactivating the temporary liquidity swap lines with the Fed | FOR |
| 3/4/2010 | Decision on enhancing the provision of LTROs | LTRO |
| 3/4/2010 | Decision on continuing the conduct of MROs as FRTFA for as long as needed | FRTPFA |
| 12/3/2009 | Decision on enhancing the provision of LTROs | LTRO |
| 12/3/2009 | Decision on continuing the conduct of MROs as FRTFA for as long as needed | FRTPFA |
| 9/24/2009 | Decision on continuing dollar liquidity provisions | FOR |
| 6/25/2009 | Decision on extending liquidity swap arrangements with the Fed | FOR |
| 6/4/2009 | Decision on technical modalities of CBPP1 | CBPP |
| 5/7/2009 | Decision on liquidity providing LTROs with a maturity of one year | LTRO |
| 5/7/2009 | Decision on purchase of euro-denominated covered bonds issued in the euro area | CBPP |
| 4/6/2009 | Decision on establishing temporary reciprocal currency arrangement with the Fed | FOR |
| 3/19/2009 | Decision on continuing dollar liquidity provision operations | FOR |
| 3/5/2009 | Decision on continuing FRTFA for MROs and LTROs for as long as necessary | LTRO |
| 3/5/2009 | Decision on continuing FRTFA for MROs and LTROs for as long as necessary | FRTPFA |
| 2/3/2009 | Decision on extending temporary swap lines with the Fed | FOR |
| 12/19/2008 | Decision on continuing dollar liquidity provision operations | FOR |
| 12/18/2008 | Decision on continuing to carry out MROs via FRTFA for as long as necessary | FRTPFA |
| 10/15/2008 | Decision on enhancement of LTROs provisions | LTRO |
| 10/15/2008 | Decision on dollar liquidity provisions via forex swaps | FOR |
| 10/15/2008 | Decision on expansion of list of assets that could be eligible as collateral | COLL |
| 10/13/2008 | Decision on dollar liquidity provisions | FOR |
| 10/8/2008 | Decision on the adoption of fixed rate tender procedure with full allotment | FRTPFA |
| 10/7/2008 | Decisions on enhancing LTROs | LTRO |
| 10/7/2008 | Decisions on expanding dollar liquidity provisions | FOR |
| 9/29/2008 | Decision on doubling the temporary swap lines with the Fed | FOR |
| 9/26/2008 | Decision on dollar liquidity provision enhancements | FOR |
| 9/18/2008 | Decision on dollar liquidity provision enhancements | FOR |
| 9/4/2008 | Decision to renew two LTROs | LTRO |
| 7/31/2008 | Decision to renew two LTROs | LTRO |
| 7/30/2008 | Decision to renew two LTROs | FOR |
| 5/2/2008 | Decision on dollar liquidity provision enhancements | FOR |
| 3/28/2008 | Decision on conducting 6-month supplementary LTROs | LTRO |
| 3/11/2008 | Decision on dollar liquidity provisions | FOR |
| 2/7/2008 | Decision to renew two Supplementary LTROs | LTRO |
| 1/10/2008 | Decision on dollar liquidity provisions | FOR |
| 11/8/2007 | Decision on renewal of supplementary LTROs | LTRO |

| | | |
|---|---|---|
| 9/6/2007 | Decision on Supplementary LTROs | LTRO |
| 8/22/2007 | Decision on Supplementary LTROs | LTRO |

Sources: (ECB) https://www.ecb.europa.eu/press/pr/activities/mopo/html/index.en.html; Fallagiarda et al. (2015)

Table A3: Recent SARB MPC briefs regarding SA CMP changes

| | | | |
|---|---|---|---|
| 3/17/2016 | +.25 | 7.00 | "**Given the upside risks to the inflation forecast and the protracted period of the expected breach, the MPC decided that further tightening was required** to complement the previous moves. Accordingly, the MPC decided to increase the repurchase rate by 25 basis points to 7,00 per cent per annum , effective from 18 March 2016." |
| 1/28/2016 | +.50 | 6.75 | "**Given the deterioration in the inflation outlook, the MPC decided to increase the repurchase rate by 50 basis points to 6,75 per cent per annum**, effective from 29 January 2016. " |
| 11/19/2015 | +.25 | 6.25 | "...stability in the underlying of core inflation, ... **deteriorating economic growth outlook**...Against this difficult backdrop, the MPC decided to increase the repurchase rate by 25 basis points to 6,25 per cent per annum effective from 20 November 2015." |
| 7/24/2015 | +.25 | 6.00 | "MPC has therefore decided to continue on its **path of gradual policy normalization**. Accordingly, the repurchase rate will increase by 25 basis points to 6,0 per cent per annum with effect from Friday 24 July 2015. " |
| 7/18/2014 | +.25 | 5.75 | "The MPC has decided to **continue on its gradual normalisation path** and raise the repurchase rate by 25 basis points to 5,75 per cent per annum , effective from Friday 18 July. Given the expected inflation trajectory, the real repurchase rate remains slightly negative and well below its longer term neutral level. The monetary policy stance remains supportive of the domestic economy, and, as before, any future moves will be gradual and highly data dependent." |
| 1/29/2014 | +.50 | 5.50 | "**The primary responsibility of the Bank is to keep inflation under control and ensure that inflation expectations remain well anchored**. The depreciation experienced so far could improve our international competitiveness, provided that it is not eroded through higher wage and other input prices. In the light of these circumstances and taking account of policy trade-offs, the MPC has decided to increase the repurchase rate by 50 basis points to 5,5 per cent per annum as of 30 January 2014. The MPC is of the view that, notwithstanding this increase in the repo rate, monetary policy remains accommodative. " |
| 7/19/2012 | -.50 | 5.00 | "MPC views the prevailing conditions to be appropriate for **further monetary accommodation to the economy** that will not undermine the inflation outlook. The MPC has therefore decided to reduce the repurchase rate by 50 basis points to 5,0 per cent from Friday 20 July 2012. While it is recognised that **such a move on its own will not overcome the challenges facing the economy, it is felt that it can help alleviate some of the pressures faced by some sectors. A sustained increase in the potential output of the economy will require a concerted and coordinated effort from both government and the private sector**." |
| 11/18/2010 | -.50 | 5.50 | "… improved longer term inflation outlook and assesses the risks to this outlook to be fairly evenly balanced. The **domestic economic recovery remains fragile, and the adverse global developments make the growth outlook more uncertain**. The MPC believes that while monetary policy cannot determine the long term growth path of the economy, it can impact on cyclical deviations of output from potential output. The view of the MPC is that there is room for further stimulus, given the weakness in the supply side of the economy…The MPC has accordingly decided to reduce the repurchase rate by 50 basis points to 5,5 per cent per annum with effect from 19 November 2010. This action is viewed to be consistent with the continued attainment of the inflation target. The scope for further downward movement, however, is seen to be limited given the signs of recovery in household consumption expenditure and credit extension. " |
| 9/9/2010 | -.50 | 6.00 | "… improved inflation outlook creates sufficient room for monetary policy to provide additional stimulus to the somewhat **fragile recovery of the domestic economy which remains vulnerable to the uncertain global environment**…The MPC has decided to reduce the repurchase rate by 50 basis points to 6,0 per cent per annum with effect from 10 September 2010. The MPC views this action to be consistent with the continued attainment of the inflation target, having given due regard to the risks to the outlook. The scope for further downward movement is seen to be limited, but this will be assessed on an ongoing basis. Our approach remains forward-looking and is informed by close examination of the data and future developments." |
| 3/25/2010 | -.50 | 6.50 | "… **despite clear signs that the economy has emerged from the recession, the pace of recovery is expected to remain slow**. The improved inflation environment has provided some space for an additional monetary stimulus to reinforce the sustainability of the upswing without jeopardising the achievement of the inflation target. The MPC has therefore decided to reduce the repurchase rate by 50 basis points to 6,5 per cent per annum with effect from 26 March 2010. The MPC will continue to assess developments, and will adjust the monetary policy stance when necessary in order to achieve the inflation target. " |
| 8/13/2009 | -.50 | 7.00 | "… **adverse economic conditions appear to tilt the balance of risks to the inflation outlook towards the downside** over the medium term. The MPC has therefore decided to reduce the repurchase rate by 50 basis points to 7 per cent per annum with effect from 14 August 2009." |
| 5/28/2009 | -1.00 | 7.50 | "… **output gap has widened further**. **This is expected to contribute to an improved inflation outlook**, notwithstanding some current inflation inertia. Accordingly the MPC has decided to reduce the repurchase rate by 100 basis points to 7,5 per cent per annum with effect from 29 May 2009." |
| 5/4/2009 | -1.00 | 8.50 | "… **severe synchronised downturn in international and domestic economic conditions** … potential future downward impact on inflation, notwithstanding the higher-than-expected recent domestic inflation outcomes. The committee is of the view that the adverse economic conditions continue to tilt the balance of risks to the inflation outlook to the downside over the medium term and has therefore decided to reduce the repurchase rate by 100 basis points to 8,5 per cent per annum with effect from 4 May 2009." |

| | | | |
|---|---|---|---|
| 3/25/2009 | -1.00 | 9.50 | "Against the background of a **slowing global and domestic economy and an improved medium-term outlook for inflation**, the Monetary Policy Committee has decided to reduce the repurchase rate by 100 basis points to 9,5 per cent per annum with effect from 25 March 2009. " |
| 2/6/2009 | -1.00 | 10.50 | "The Monetary Policy Committee has decided to reduce the repurchase rate by 100 basis points to 10,5 per cent per annum with effect from 6 February 2009. The MPC will continue to monitor domestic and global developments in order to decide on the most appropriate monetary policy stance going forward." |
| 12/12/2008 | -.50 | 11.50 | "The Monetary Policy Committee considered recent developments in the South African economy and the risks to the inflation outlook against the backdrop of **conditions prevailing in the global economy and international financial markets.** The MPC has noted improvements in the inflation outlook in South Africa since its previous meeting in October 2008. However risks to the inflation outlook remain and will be monitored closely. The MPC has therefore decided to reduce the repurchase rate by 50 basis points to 11,5 per cent per annum with effect from 12 December 2008. " |
| 6/13/2008 | +.50 | 12.00 | "In the light of the further **deterioration in the inflation outlook, but mindful that the economy is responding to a less accommodative monetary policy stance**, the Monetary Policy Committee has decided that at this stage further tightening of monetary policy is warranted. Accordingly the repurchase rate will be increased by 50 basis points to 12 per cent per annum with effect from 13 June 2008. The MPC remains committed to bringing inflation back to within the target range over a reasonable time period. " |
| 4/11/2008 | +.50 | 11.50 | "In view of the **deteriorating inflation outlook** and especially evidence of **more generalised inflation pressures**, the MPC has decided to increase the repo rate by 50 basis points to 11,5 per cent per annum with effect from 11 April 2008. The MPC remains committed to bringing CPIX inflation back to within the inflation target range." |
| 12/7/2007 | +.50 | 11.00 | "The assessment of the MPC is that the balance of risks to the **inflation outlook continues to be on the upside**. Therefore the MPC has decided to adjust the repurchase rate by 50 basis points to 11,0 per cent per annum with effect from Friday, 7 December 2007. The MPC will continue to monitor relevant developments and take the necessary steps to ensure that inflation returns to within the target range." |
| 10/12/2007 | +.50 | 10.50 | "Having considered …developments and in particular **the risks which are on the upside**, the MPC has decided to adjust the repurchase rate by 50 basis points to 10,5 per cent per annum with effect from Friday, 12 October 2007. The MPC is determined to ensure that inflation returns to within the target range." |
| 8/17/2007 | +.50 | 10.00 | "Having considered recent developments, the MPC has decided that a further adjustment in the monetary policy stance is required in order to **ensure that CPIX inflation returns to within the target range**. Accordingly, the repo rate is adjusted by 50 basis points to 10,0 per cent per annum with effect from 17 August 2007. The MPC will continue to monitor the relevant economic and financial developments in order to ensure that its mandate is fulfilled." |
| 6/8/2007 | +.50 | 9.50 | "… in view of the **further deterioration in the inflation outlook**, the monetary policy stance needs to be adjusted to ensure that CPIX inflation returns to within the inflation target range over time. Accordingly, the repo rate will be increased by 50 basis points to 9,5 per cent per annum with effect from Friday 8 June 2007. The MPC will continue to monitor developments which have a bearing on inflation outcomes and will not hesitate to adjust the policy stance as may be appropriate." |
| 12/8/2006 | +.50 | 9.00 | "The Monetary Policy Committee has decided to **adjust the existing monetary policy stance** by increasing the repo rate by 50 basis points to 9,0 per cent per annum with effect from Friday, 8 December 2006. " |
| 10/13/2006 | +.50 | 8.50 | "Having **considered in detail all the recent economic data and other developments impacting on inflation**, the MPC remains **concerned about the outlook for inflation** and is of the view that the risks to the outlook are still on the upside. Accordingly the MPC has decided that a further upward adjustment in the repo rate is appropriate at this juncture. The repo rate is therefore increased by 50 basis points to 8,5 per cent per annum with effect from Friday, 13 October 2006." |
| 8/3/2006 | +.50 | 8.00 | "The MPC remains concerned about the **longer term threats to the inflation outlook** and has therefore decided that a further adjustment to the repo rate would be prudent. Accordingly, the repo rate is increased by 50 basis points to 8,0 per cent per annum with immediate effect." |
| 6/8/2006 | +.50 | 7.50 | "On the basis of the detailed analysis of the economy which is summarised above, the MPC has decided that a moderate adjustment in the repo rate is warranted at present. Accordingly the repo rate is increased by 50 basis points to 7,5 per cent per annum with immediate effect. " |

Table A4: News relating to SARB or its operations on Financial Times

| Event Date | Title of News item | Other details |
|---|---|---|
| 24-Aug-16 | South African inflation falls to year low | |
| 21-Jul-16 | South Africa keeps rates on hold | |
| 19-Jul-16 | Rand awaits central bank rate decision | Currency recovers from recent fall as Ankara's travails had little to do with Pretoria |
| 13-Jun-16 | South Africa: relief all round | Policymakers have won some time to fix the economy, but it is not clear how they will achieve this |
| 19-May-16 | Rand stumbles as South Africa holds interest rates | |
| 4-May-16 | Barclays to offload African stake | |
| 17-Mar-16 | South Africa raises rates and dampens growth outlook amid turmoil | Decision seen to reinforce central bank's credibility |
| 17-Mar-16 | Rand climbs further after South Africa raises key interest rate | |
| 17-Mar-16 | South African rates: in the shade of political soap opera | |
| 16-Mar-16 | Action could come from central banks in Norway and South Africa | |
| 4-Feb-16 | South Africa's central bank: out on its own | As other policymakers fail to step up, the reserve bank must do what it can |
| 28-Jan-16 | South Africa raises key interest rate to 6.75% | |

| | | |
|---|---|---|
| 22-Jan-16 | A wild week of two halves for EM FX | |
| 8-Jan-16 | RBS: South Africa's under-fire rand needs support | |
| 14-Dec-15 | AB InBev confirms South African listing plans | |
| 10-Dec-15 | You're fired: Analysts react to South African finmin shock | |
| 19-Nov-15 | South Africa raises rates amid inflation fears | Decision in line with central bank's focus on inflation targeting |
| 26-Aug-15 | South Africa's central bank chief rules out defence of rand | But governor fears for national economy amid emerging market turbulence over China |
| 23-Jul-15 | South Africa raises interest rates to curb inflationary pressures | Growth outlook has deteriorated amid a power crisis, bouts of labour unrest and weak confidence |
| 22-Jun-15 | South Africa in the grip of stagflation | Central bank stands firm on prices but little action on much-needed supply side reforms |
| 4-Jun-15 | How South Africa can fill its public service gap | |
| 6-Oct-14 | South African Reserve Bank names deputy as new governor | Kganyago seen as providing continuity within the institution |
| 18-Sep-14 | Gill Marcus to step down as South Africa's central bank chief | Rand falls after respected governor says she will quit |
| 10-Aug-14 | S African rescue plan will split Abil into 'good' and 'bad' banks | Lender has suffered a 9 per cent drop in its share price |
| 22-Jun-14 | South Africa: exports, please | Reserve Bank's current account problem |
| 22-May-14 | South Africa keeps interest rates on hold | |
| 25-Mar-14 | Rand benefits from calmer emerging market waters | Currencies less sensitive to shift in US rate expectations |
| 29-Jan-14 | South Africa hikes rates but rand weakens | |
| 24-Jan-14 | Rand at 11: how long before S Africa raises rates? | |
| 5-Nov-13 | South Africa to invest in China bonds | Central bank move aims to diversify currency exposure |
| 25-Aug-13 | South Africa stops short of rand intervention as EM crisis builds | Country has no plans to commit billions to prop up currency |
| 28-May-13 | South Africa: manufacturing slump dents GDP growth | |
| 15-May-13 | S Africa consumers reluctant to take brake off spending | |
| 19-Mar-13 | S Africa: weakening rand adds to list of economic woes | |
| 12-Mar-13 | Brics bank to focus on infrastructure | |
| 12-Mar-13 | South Africa: rand slumps on deficit | |
| 21-Dec-12 | S Africa FX: proceeding with caution | |
| 5-Oct-12 | Rand drops on latest mine death | |
| 20-Sep-12 | South Africa holds rates for now | |
| 11-Sep-12 | S Africa: investors jittery as current account deficit soars, labour unrest spreads | |
| 24-Jul-12 | World Bank cuts South Africa forecast | Risk of recession or stagnation from eurozone crisis |
| 19-Jul-12 | South Africa: inflation fades as economic woes loom larger | |
| 19-Jul-12 | South Africa cuts rates to 5 per cent | Surprise move to bolster flagging growth |
| 20-Jun-12 | S African inflation adds to pressure for interest rate cut | |
| 21-Nov-11 | Global financial crisis | |
| 21-Nov-11 | Rand falls victim to global concerns | South Africa's currency at six-week low against the dollar |
| 23-Aug-11 | Sarb's Marcus to world leaders: get a grip | |
| 21-Jul-11 | Global outlook weighs on Sarb | |
| 9-Dec-10 | Central bank mash-up, carry bash-up | |
| 7-Oct-10 | Strong rand puts South Africa under pressure | Currency's rise has been driven by foreign investors |
| 25-Apr-10 | Former S African central banker joins Goldman | Mboweni to serve as international adviser |
| 18-Feb-10 | South African unions win cenbank policy change | |
| 28-Jan-10 | Floating currency and falling inflation in South Africa | |
| 25-Jan-10 | Nationalisation plan for South African central bank | |
| 30-Apr-09 | S Africa sees no sign of quick recovery | Bank cuts interest rate to 8.5% |
| 14-Aug-08 | S Africa opts against further rate rise | |
| 12-Aug-08 | View of the day: Gloomy outlook for rand | |
| 16-Jul-08 | Bank attacks S Africa's inflation data | |
| 1-Feb-08 | Rand tumbles as SARB holds rates | |
| 25-Oct-07 | ICBC pays $5.5bn for Standard Bank stake | |
| 9-Aug-07 | Upheaval at Anglo American | |
| 29-Mar-07 | SA bank chief hits out at Barclays | |
| 23-Sep-04 | Barclays in talks over taking €3bn Absa stake | |

Source: Financial Times

# Annex 4 (Extra Analytics: Figures)

## 1. Historical trends in asset dynamics

Figure 1.1: Exchange rate (South African Rand vs. US dollar and the Euro)

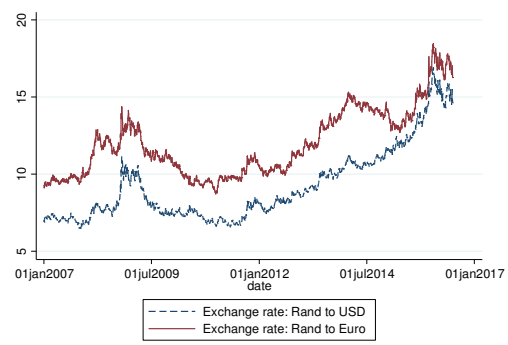



Figure 1.2: 5 and 10 year South African Sovereign Bond Yields

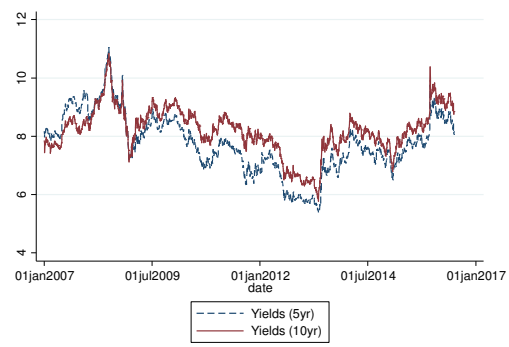



Figure 1.3: Volatility indices (for the domestic and international markets)

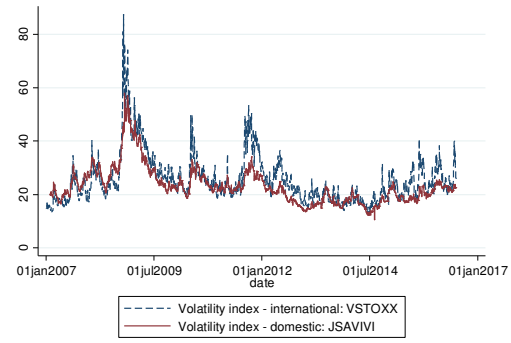



Figure 1.4: Stock market indices

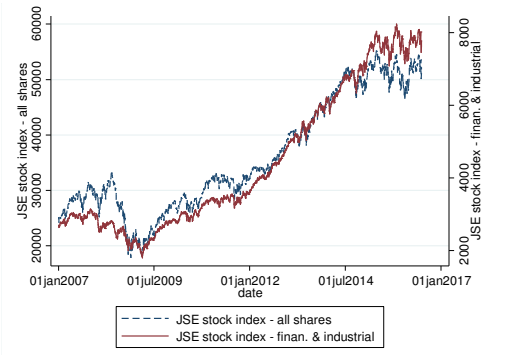



Figure 1.5: Interbank rate (3 month)

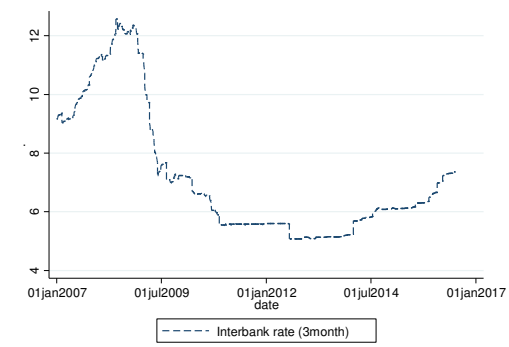
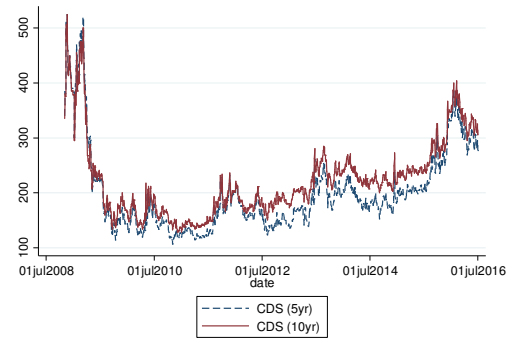



Figure 1.6: 5 and 10 year CDS




Sourse: using Datastream

## 2. Movements in daily asset returns

### 2.1 Fed UMP surprises & daily asset returns

Figure 2.1.1: Changes in Exchange rate (South African Rand vs. US dollar)

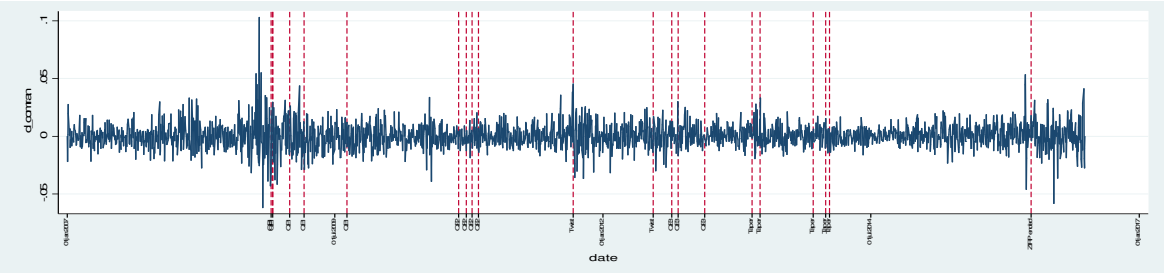



Figure 2.1.2: Changes in Exchange rate (South African Rand vs. Euro)

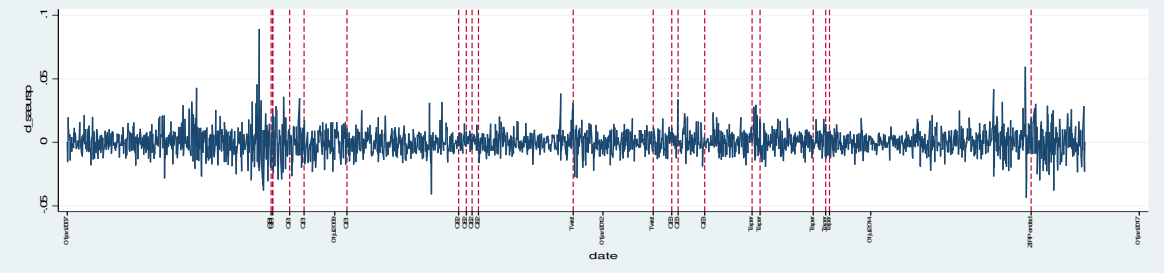



Figure 2.1.3: Changes in 5 year Yields

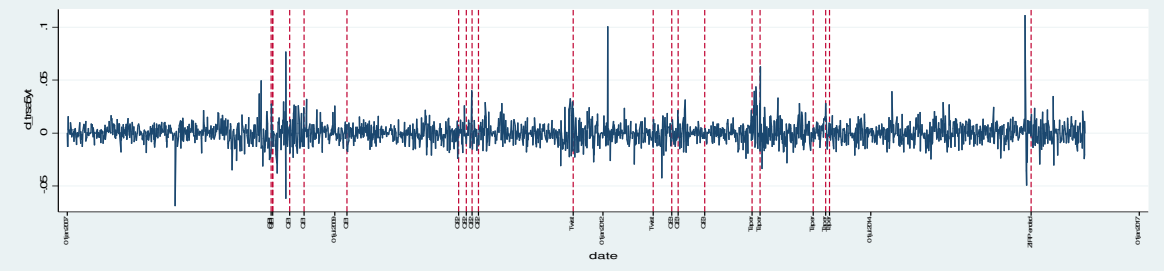



Figure 2.1.4: Changes in 10 year Yields

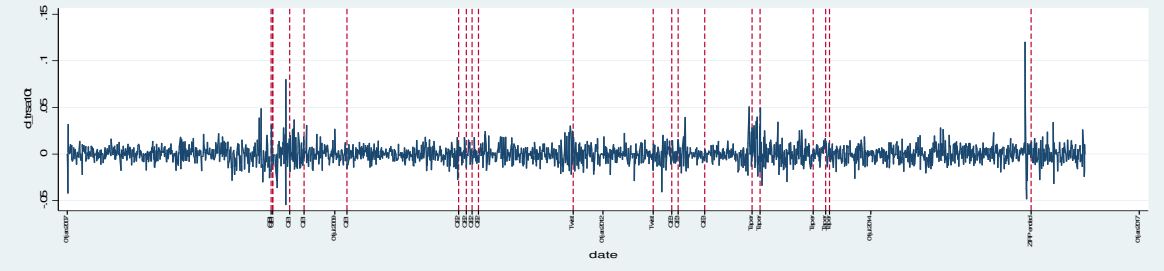


Figure 2.1.5: Changes in 5 year CDS

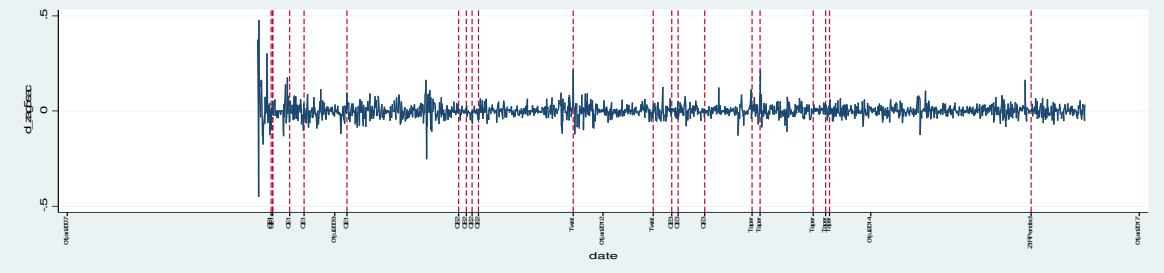



Figure 2.1.6: Changes in 10 year CDS

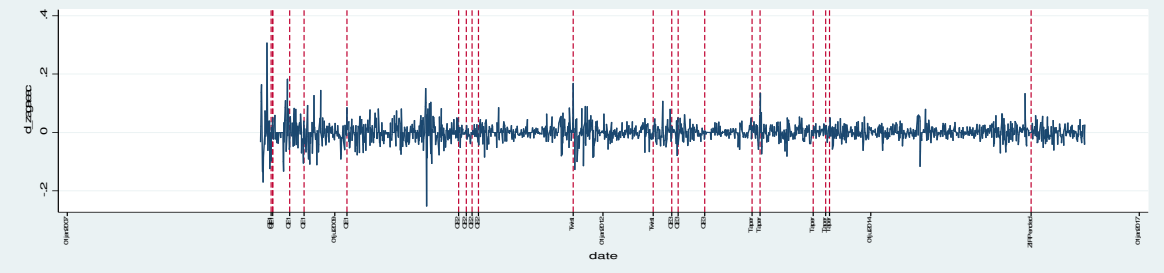



Figure 2.1.7: Changes in 3 month Interbank rate (IBK)

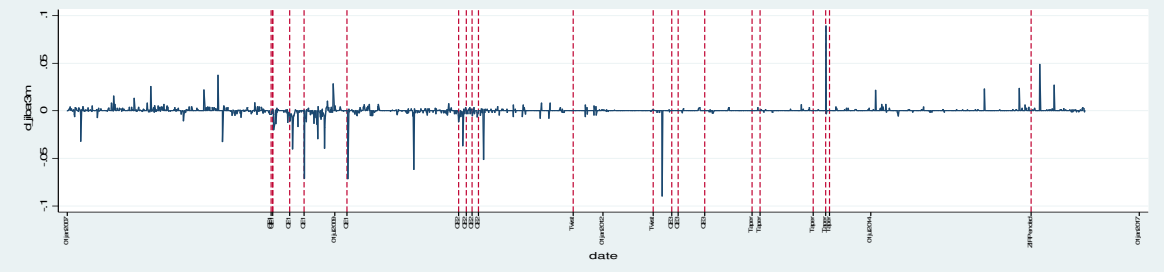



Figure 2.1.8: Changes in JSE Stock mkt. Indice - all shares

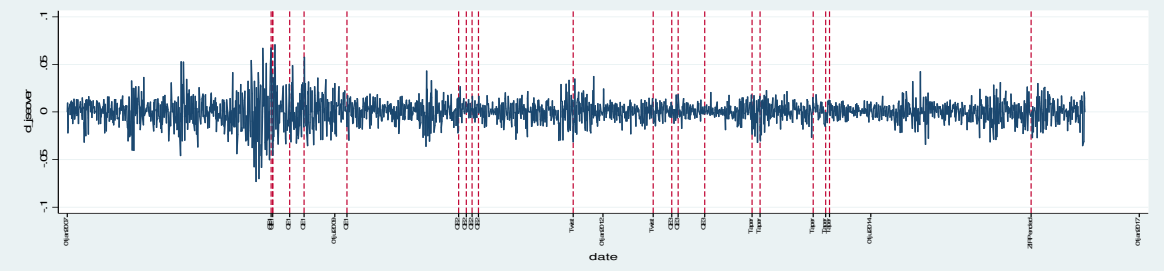
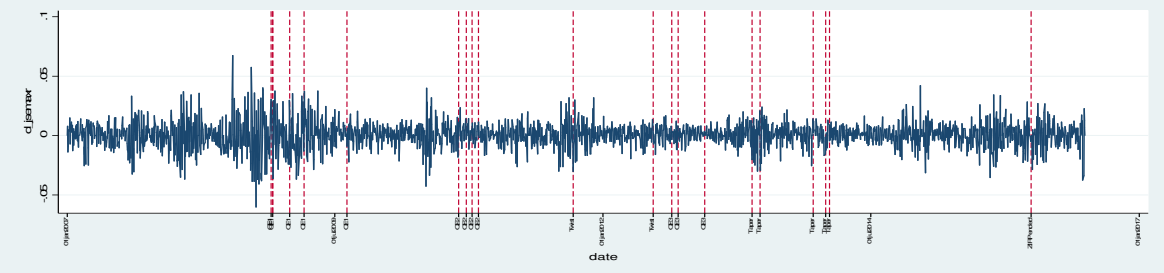



Figure 2.1.9: Changes in JSE Stock mkt. Indice - Financials & Industrials




Sourse: using Datastream

## 2.2 ECB UMP surprises & daily asset returns

Figure 2.2.1: Changes in Exchange rate (South African Rand vs. US dollar)

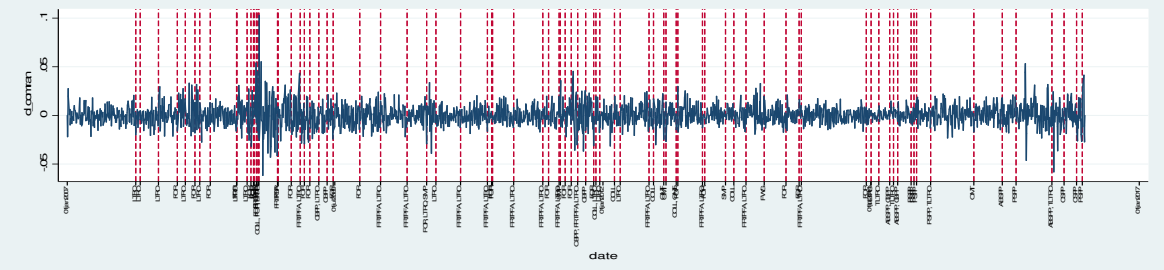



Figure 2.2.2: Changes in Exchange rate (South African Rand vs. Euro)

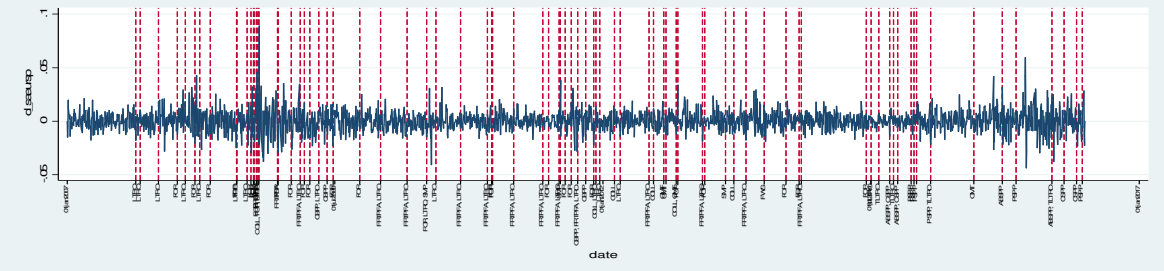



Figure 2.2.3: Changes in 5 year Yields

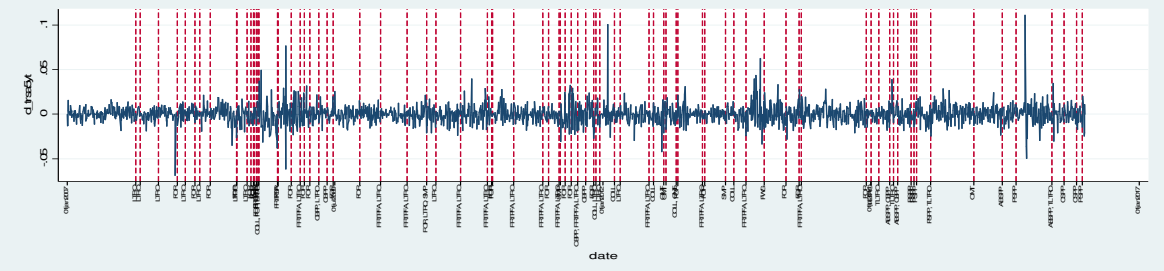



Figure 2.2.4: Changes in 10 year Yields

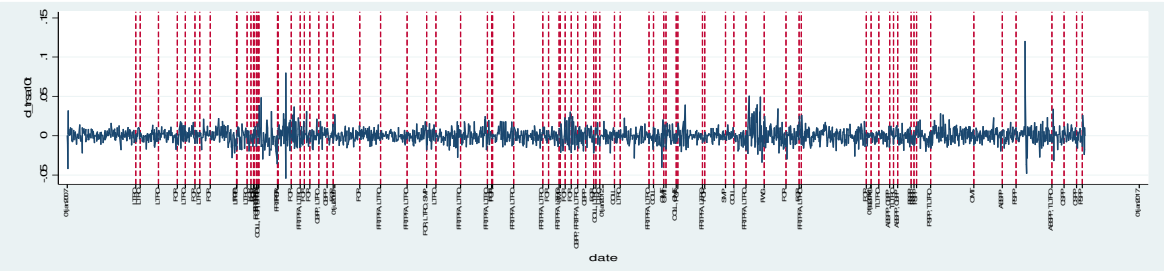


Figure 2.2.5: Changes in 5 year CDS

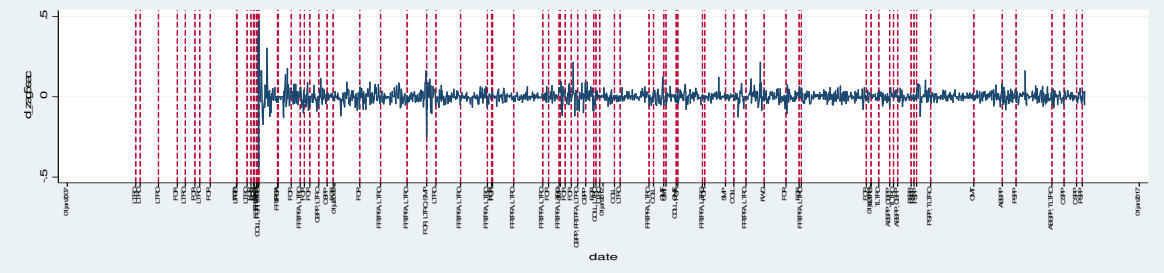



Figure 2.2.6: Changes in 10 year CDS

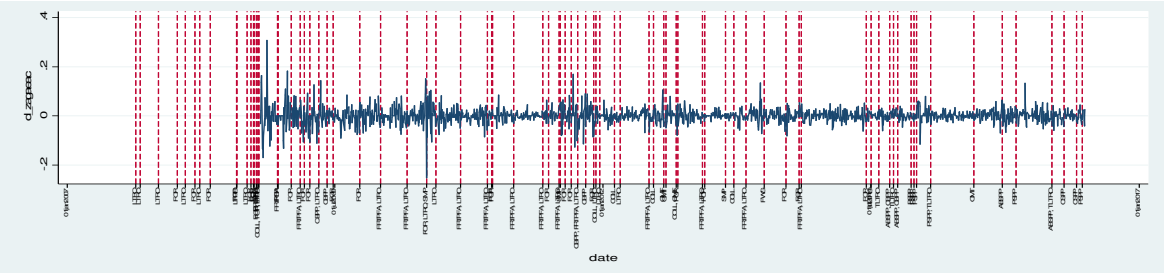



Figure 2.2.7: Changes in 3 month Interbank rate (IBK)

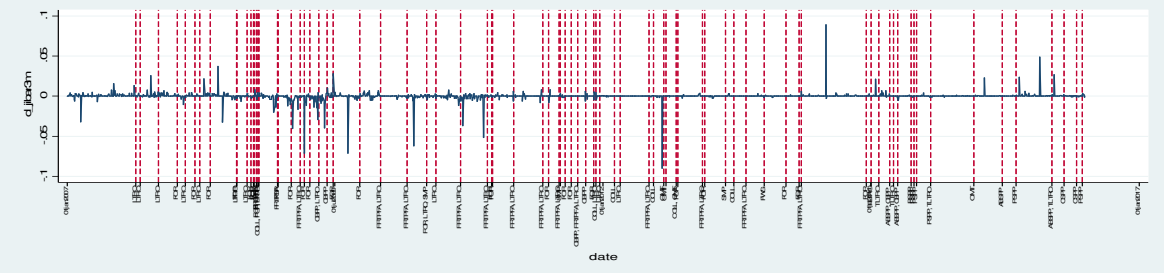



Figure 2.2.8: Changes in JSE Stock mkt. Indice - all shares

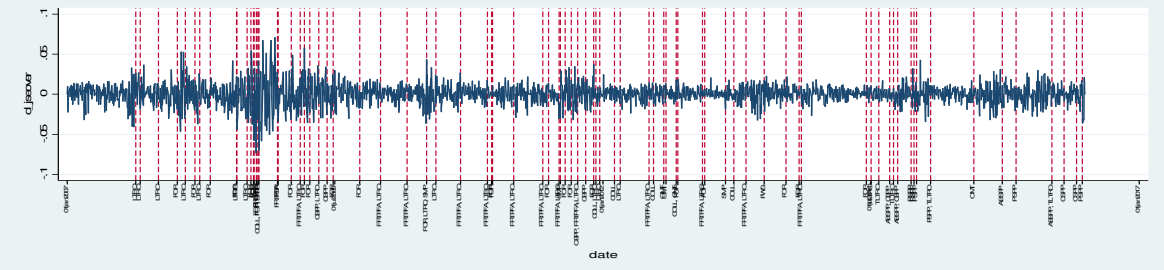
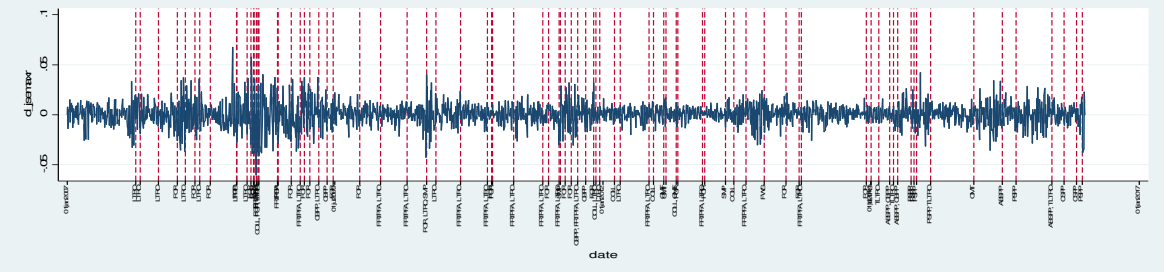



Figure 2.2.9: Changes in JSE Stock mkt. Indice - Financials & Industrials




Sourse: using Datastream

# Annex 5 (Extra Analytics: Tables)

## 1. Variable Summary Statistics

Table 1.1) Summary statistics of dependent variables (Source: Datastream)

| Dependent Variable | Measurement | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Net Investment flow to equities | Net purchase of SA equities by foreigners (as a percentage of liabilities to foreigners by SA financial corporations) | -.0001259 | .3201191 | -3.233232 | 3.361102 |
| Net Investment flow to bonds | Net purchase of SA bonds by foreigners (as a percentage of liabilities to foreigners by SA financial corporations) | .0002917 | .4068918 | -3.66752 | 3.375528 |
| SA All Stock/Equity Index | JSE all shares stock market returns (in percent) | .0376462 | 1.249416 | -7.300471 | 7.072902 |
| SA Financial & Industrial Stock/Equity Index | JSE Financial & Indust. stock market returns (in percent) | 0.048782 | 1.074176 | -6.02581 | 6.741214 |
| SA Volatility Index (SAVI) | Difference in volatility index (in percentage point) | .0010749 | .7333523 | -4.38 | 7.84 |
| International Volatility Index (VSTOXX) | Difference in volatility index (in percentage point) | 0.0045363 | 1.967674 | -13.98 | 22.64 |
| Sovereign yields | 5 year SA sovereign yields (difference in percentage point) | -8.06e-06 | .0773717 | -.6450005 | .9150009 |
| Sovereign yields | 10 year SA sovereign yields (difference in percentage point) | 0.0004 | 0.07733 | -0.48 | 1.06 |
| CDS | 5 Year SA sovereign CDS (difference in basis point) | -.022257 | 11.04794 | -204.9499 | 124 |
| CDS | 10 Year SA sovereign CDS (difference in basis point) | 0.034138 | 10.62126 | -195.534 | 124 |
| Interbank rate | 3 month SA interbank rate (difference in percentage point) | -.0007331 | .0373716 | -.691 | .467 |
| Exchange rate (Rand with USD) | Currency returns (in percent) | 0.02947 | 1.07494 | -6.39074 | 9.80761 |
| Exchange rate (Rand with Euro) | Currency returns (in percent) | 0.02706 | 0.95015 | -4.35166 | 8.87093 |

Table 1.2) Summary statistics of Explanatory Variables for additional robustness exercises (monthly series)

| Explanatory Variables | Source | Measurement | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| US long-term interest rate | Datastream | US 5 year sovereign yields (in percentage point) | 2.470186 | 1.174505 | 1.027636 | 5.42719 |
| Fiscal Deficit | Own computation using IMF IFS gov. revenue and expenditure data | Fiscal deficit (as percentage of expenditure) | -7.27791 | 27.89072 | -54.7345 | 64.57795 |
| SA short-term policy rate | IMF IFS | SA policy rate (in percentage point) | 6.98913 | 2.234202 | 5 | 12 |
| Inflation | IMF IFS | SA Consumer price Index | 107.4292 | 16.46291 | 77.21432 | 132.4826 |
| Output Gap | Own computation using IMF IFS indust. Prod. data | SA Output gap (in percentage point) | 4.57e-09 | 2.997164 | -7.538948 | 11.67769 |
| US short-term policy rate | Datastream | US Fed Funds rate (in percentage point) | .8429623 | 1.570774 | .067 | 5.2655 |
| SA foreign currency reserves | IMF IFS | Log (natural) of SA reserves | 23.88458 | .1782829 | 23.46206 | 24.07805 |

## 2. Release of Macroeconomic Data

Table 2.1) Macroeconomic data releases: summary of actual data and forecast

| | Actual data | | Forecast data | | Unit |
|---|---|---|---|---|---|
| **Data Type** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** | **unit** |
| Balance of Trade | -5.333 | 10.20631 | -5.685 | 5.079196 | ZAR Bl. |
| Barclays Manufacturing PMI | 48.86154 | 3.722352 | 48.88077 | 2.840603 | Index |
| Business Confidence | 42 | 5.363696 | 40.84071 | 6.789285 | Index |
| Consumer Confidence | -5.76923 | 5.761277 | -5.8541 | 3.765267 | % |
| Core Inflation Rate | 5.483333 | 0.197782 | 5.532778 | 0.191981 | % |
| Current Account | -190.057 | 34.01752 | -196.179 | 34.20387 | ZAR Bl. |
| Foreign Exchange Reserves | 47.916 | 1.635592 | 48.142 | 2.076289 | USD Bl. |
| GDP Growth Rate | 1.271429 | 1.293819 | 1.4175 | 1.002991 | % |
| Inflation Rate | 3.105128 | 2.641522 | 3.092692 | 2.615102 | % |
| Interest Rate Decision | 5.894737 | 0.647194 | 5.802632 | 0.63234 | % |
| KAGISO Manufacturing PMI | 49.44211 | 2.726478 | 49.73316 | 2.622376 | % |
| M3 Money Supply | 8.9375 | 1.935737 | 9.05 | 1.602676 | % |
| Manufacturing Prod | 0.291026 | 2.6944 | 0.360769 | 1.701639 | % |

| | | | | | |
|---|---|---|---|---|---|
| Mining Production | -0.79615 | 6.843536 | -0.39577 | 3.981202 | % |
| Prime Overdraft Rate | 10.16667 | 0.437798 | 10 | 0.474342 | % |
| Private Sector Credit | 8.692222 | 0.610425 | 8.084444 | 0.984666 | % |
| Producer Price Index | 4.433333 | 2.905559 | 4.336222 | 2.900433 | % |
| Retail Sales | 1.524051 | 1.832836 | 1.517848 | 1.344768 | % |
| Standard Bank PMI | 49.1375 | 1.113473 | 48.775 | 1.181706 | Index |
| Total New Vehicle Sales | 49310.86 | 4090.291 | 50055.46 | 4064.391 | No. |
| Unemployment | 25.35833 | 0.880556 | 25.25 | 0.403395 | % |

Note:

a) The data involves month-on-month, quarter-on-quarter as well as year-on-year releases.

b) The paper uses the dates of data releases as dummies to control for their effect. These dates are not reported here to save space - instead, we provide this summary table.

c) Using additional dichotomous variables, we also account for whether the data released is above or below forecast or market expectation.

e) Data comes from Tradingeconomies.

## 3. Impact of Initial announcements, policy updates & actual implementations

Table 3.1) Fed Unconventional Monetary Policy: Initial announcements, policy updates, and actual implementations

| | **Equities, flows** | **Equities, flows** | **Bonds, flows** | **Bonds, flows** | **Stocks, returns** | **Stocks, returns** |
|---|---|---|---|---|---|---|
| Implementation QE1 | 0.0857*** | | | | 0.0885 | |
| | (0.02) | | | | (0.08) | |
| Implementation QE2 | 0.0377* | | 0.3351*** | | 0.0064 | |
| | (0.02) | | (0.03) | | (0.10) | |
| Implementation QE3 | 0.0166 | | 0.0279 | | 0.0785 | |
| | (0.02) | | (0.03) | | (0.10) | |
| Implementation Taper | 0.0137 | | -0.1035*** | | 0.0366 | |
| | (0.02) | | (0.02) | | (0.07) | |
| Announcements (cumulated) QE1 | 0.7942*** | 1.2801*** | | | 1.3002 | 0.3269 |
| | (0.23) | (0.25) | | | (1.06) | (1.13) |
| Announcements (cumulated) QE2 | 0.0127 | -0.1197 | -0.3219 | -0.0692 | 0.9539 | 0.2240 |
| | (0.24) | (0.25) | (0.27) | (0.28) | (1.11) | (1.13) |
| Announcements (cumulated) QE3 | -0.2083 | -0.2491 | -0.0364 | 0.4522 | 0.0275 | 0.4488 |
| | (0.25) | (0.27) | (0.27) | (0.32) | (1.14) | (1.24) |
| Announcement (cumulated) Taper | -0.2529 | -1.1914*** | | -0.0847 | -3.6618*** | -4.9088*** |
| | (0.29) | (0.36) | | (0.45) | (1.34) | (1.68) |
| Announcement (Initial) QE1 | | -1.2518*** | | | | 6.3549*** |
| | | (0.31) | | | | (1.43) |
| Announcement (Initial) QE2 | | 1.4879*** | | 1.5053*** | | 4.1489** |
| | | (0.44) | | (0.57) | | (2.03) |
| Announcement (Initial) QE3 | | 0.1557 | | -0.6850 | | -1.1068 |
| | | (0.33) | | (0.42) | | (1.52) |
| Announcement (Initial) Taper | | -0.3608 | | -0.0009 | | 0.1689 |
| | | (0.38) | | (0.49) | | (1.76) |
| _cons | -0.0071 | 0.0107** | 0.1116*** | 0.0908*** | 0.0124 | 0.0366 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.03) | (0.03) |
| N | 2479 | 2479 | 1805 | 1805 | 2479 | 2479 |
| R-sq | 0.036 | 0.035 | 0.112 | 0.013 | 0.007 | 0.018 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) For initial announcement of QE1, we use 11/25/2008 Fed announcement for Large-scale asset purchase (LSAP). Fed announced that it will purchase $100 billion in GSE debt and $500 billion in MBS.

c) For initial announcement of QE2, we use 8/27/2010 announcement where Bernanke suggested role for additional QE "should further action prove necessary."

d) For initial announcement of QE3, we use 8/22/2012 announcement by Fed where FOMC members "judged that additional monetary accommodation would likely be warranted fairly soon…"

e) For initial announcement of QE taper, we use 5/22/2013 Ben Bernanke's testimony to US Congress "...In the next few meetings, we could take a step down in our pace of purchase..."'

f) The implementation dates (phases) of Fed's QE programs use: QE1 (Dec. 2008 to Mar. 2010), QE2 (Nov. 2010 to June 2011), QE3 (Sept. 2012 to May 21. 2013), while Tapering (May 22, 2013 to 29 October 2014). The Tapering dates span from end of qe3 (on Bernanke's May 22, 2013 'taper' announcement) to actual end of the asset purchase programs on Oct 29, 2014.

g) 'QE1', 'QE2', 'QE3' and 'Taper' coefficients relate to the series of announcements (updates/communication) made by Fed regarding these programs, as given in Annex 3.

Table 3.2) Fed Unconventional Monetary Policy: Initial announcements, policy updates, and actual implementations

| | Mkt. Volatility | Mkt. Volatility | Sovereign Yields | Sovereign Yields | Interbank | Interbank |
|---|---|---|---|---|---|---|
| Implementation QE1 | -0.0033* | | 0.0008 | | -0.0177*** | |
| | (0.00) | | (0.00) | | (0.00) | |
| Implementation QE2 | -0.0007 | | 0.0039 | | -0.0039 | |
| | (0.00) | | (0.01) | | (0.00) | |
| Implementation QE3 | -0.0021 | | -0.0005 | | -0.0019 | |
| | (0.00) | | (0.01) | | (0.00) | |
| Implementation Taper | -0.0006 | | 0.0050 | | 0.0004 | |
| | (0.00) | | (0.00) | | (0.00) | |
| Announcements (cumulated) QE1 | 0.0206 | 0.0231 | -0.0584 | -0.0550 | -0.0036 | -0.0183 |
| | (0.03) | (0.03) | (0.07) | (0.07) | (0.03) | (0.03) |
| Announcements (cumulated) QE2 | 0.0353 | 0.0445 | -0.0009 | 0.0100 | -0.0211 | -0.0100 |
| | (0.03) | (0.03) | (0.07) | (0.07) | (0.03) | (0.03) |
| Announcements (cumulated) QE3 | 0.0405 | 0.0336 | 0.0153 | 0.0250 | 0.0013 | -0.0000 |
| | (0.03) | (0.03) | (0.07) | (0.08) | (0.03) | (0.04) |
| Announcements (cumulated) Taper | 0.0021 | 0.0287 | 0.0105 | 0.0347 | -0.0188 | 0.0360 |
| | (0.03) | (0.04) | (0.08) | (0.10) | (0.04) | (0.05) |
| Announcement (Initial) QE1 | | -0.0484 | | -0.0400 | | -0.0317 |
| | | (0.03) | | (0.09) | | (0.04) |
| Announcement (Initial) QE2 | | -0.0634 | | -0.0650 | | -0.1003 |
| | | (0.05) | | (0.13) | | (0.06) |
| Announcement (Initial) QE3 | | 0.0168 | | -0.0300 | | -0.0000 |
| | | (0.04) | | (0.09) | | (0.05) |
| Announcement (Initial) Taper | | 0.0604 | | -0.0200 | | 0.0000 |
| | | (0.04) | | (0.11) | | (0.05) |
| _cons | 0.0008 | 0.0000 | -0.0009 | 0.0002 | 0.0022** | -0.0007 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| N | 2456 | 2456 | 2480 | 2480 | 2480 | 2480 |
| R-sq | 0.005 | 0.006 | 0.005 | 0.004 | 0.028 | 0.003 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) For initial announcement of QE1, we use 11/25/2008 Fed announcement for Large-scale asset purchase (LSAP). Fed announced that it will purchase $100 billion in GSE debt and $500 billion in MBS.

c) For initial announcement of QE2, we use 8/27/2010 announcement where Bernanke suggested role for additional QE "should further action prove necessary."

d) For initial announcement of QE3, we use 8/22/2012 announcement by Fed where FOMC members "judged that additional monetary accommodation would likely be warranted fairly soon…"

e) For initial announcement of QE taper, we use 5/22/2013 Ben Bernanke's testimony to US Congress "...In the next few meetings, we could take a step down in our pace of purchase..."'

f) The implementation dates (phases) of Fed's QE programs use: QE1 (Dec. 2008 to Mar. 2010), QE2 (Nov. 2010 to June 2011), QE3 (Sept. 2012 to May 21. 2013), while Tapering (May 22, 2013 to 29 October 2014). The Tapering dates span from end of qe3 (on Bernanke's May 22, 2013 'taper' announcement) to actual end of the asset purchase programs on Oct 29, 2014.

g) 'QE1', 'QE2', 'QE3' and 'Taper' coefficients relate to the series of announcements (updates/communication) made by Fed regarding these programs, as given in Annex 3.

Table 3.3) ECB Unconventional Monetary Policy: Initial announcements, policy updates, and actual implementations

| | Equities, flows | Equities, flows | Bonds, flows | Bonds, flows | Stocks, returns | Stocks, returns |
|---|---|---|---|---|---|---|
| Implementation Asset Purchase | -0.0342*** | | -0.3338*** | | 0.0368 | |
| | (0.01) | | (0.02) | | (0.06) | |
| Implementation Liquidity Provision | 0.0120 | | 0.0056 | | 0.0437 | |
| | (0.01) | | (0.02) | | (0.06) | |
| Announcements (cumulated) Asset Purchase | 0.1674 | 0.1645 | 0.4438** | 0.5597*** | 1.0376* | 0.9650* |
| | (0.11) | (0.12) | (0.19) | (0.21) | (0.57) | (0.58) |
| Announcements (cumulated) Liquidity Provision | -0.0301 | -0.0166 | 0.2213*** | 0.2123*** | 0.2095 | 0.1913 |
| | (0.04) | (0.04) | (0.07) | (0.07) | (0.18) | (0.18) |
| Announcements (cumulated) Collateral Easing | 0.0495 | 0.0584 | -0.1228 | -0.1858 | -0.2618 | -0.2268 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.07) | (0.08) | (0.11) | (0.13) | (0.37) | (0.40) |
| Announcements (Initial) Forward Guidance | -0.1135 | -0.1232 | 0.0640 | 0.0182 | 1.4289** | 1.4409** |
| | (0.12) | (0.12) | (0.18) | (0.20) | (0.61) | (0.61) |
| Announcements (Initial) Asset Purchase | | -0.1102 | | 0.3607 | | 0.2699 |
| | | (0.21) | | (0.35) | | (1.07) |
| Announcements (Initial) Liquidity Provision | | -0.2794 | | | | 0.2092 |
| | | (0.21) | | | | (1.06) |
| Announcements (Initial) Collateral Easing | | -0.1853 | | -0.0610 | | 0.1274 |
| | | (0.23) | | (0.37) | | (1.13) |
| _cons | 0.0189*** | 0.0064 | 0.3658*** | 0.0833*** | 0.0048 | 0.0524** |
| | (0.01) | (0.00) | (0.01) | (0.01) | (0.03) | (0.02) |
| N | 2479 | 2479 | 1805 | 1805 | 2479 | 2479 |
| R-sq | 0.006 | 0.003 | 0.192 | 0.011 | 0.005 | 0.004 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) For initial announcement of asset purchases, we use Draghi's speech, 7/26/2012 "… whatever it takes …" (OMT)

c) For initial announcement of liquidity provision, we use ECB's decision, 3/11/2008, on US dollar liquidity provisions (FOR)

d) For initial announcement of collateral provision, we use 10/15/2008 Decision on expansion of list of assets that could be eligible as collateral (COLL). This also includes enhanced provision of LTROs and provision of US dollar liquidity through foreign-exchange swaps.

e) The Implementation of Asset Purchase programs refers to dates where ECB conducted market purchases under SMP program. Data on this is taken from Fratzscher et al. (2016).

f) The implementation of ECB's Liquidity Provision program refers to dates where liquidity auctions were conducted under the LTRO program. Data on this is taken from Fratzscher et al. (2016).

g) 'Asset Purchase', 'Liquidity Provision' and 'Collateral Easing' coefficients relate to the series of announcements (updates/communication) made by ECB regarding these programs, as given in Annex 3.

## Table 3.4) ECB Unconventional Monetary Policy: Initial announcements, policy updates, and actual implementations

| | Mkt. Volatility | Mkt. Volatility | Sovereign Yields | Sovereign Yields | Interbank | Interbank |
|---|---|---|---|---|---|---|
| Implementation Asset Purchase | 0.0017 | | -0.0001 | | 0.0045** | |
| | (0.00) | | (0.00) | | (0.00) | |
| Implementation Liquidity Provision | -0.0013 | | -0.0001 | | -0.0013 | |
| | (0.00) | | (0.00) | | (0.00) | |
| Announcements (cumulated) Asset Purchase | -0.0356*** | -0.0365*** | -0.0627* | -0.0553 | 0.0108 | 0.0117 |
| | (0.01) | (0.01) | (0.03) | (0.03) | (0.02) | (0.02) |
| Announcements (cumulated) Liquidity Provision | -0.0002 | -0.0006 | 0.0056 | 0.0069 | -0.0033 | -0.0049 |
| | (0.00) | (0.00) | (0.01) | (0.01) | (0.01) | (0.01) |
| Announcements (cumulated) Collateral Easing | 0.0072 | 0.0087 | -0.0079 | -0.0050 | -0.0071 | -0.0067 |
| | (0.01) | (0.01) | (0.02) | (0.02) | (0.01) | (0.01) |
| Announcements (Initial) Forward Guidance | -0.0097 | -0.0095 | -0.0306 | -0.0311 | -0.0008 | 0.0006 |
| | (0.01) | (0.01) | (0.04) | (0.04) | (0.02) | (0.02) |
| Announcements (Initial) Asset Purchase | | -0.0024 | | -0.1054* | | -0.0033 |
| | | (0.02) | | (0.06) | | (0.04) |
| Announcements (Initial) Liquidity Provision | | 0.0142 | | -0.0861 | | 0.0023 |
| | | (0.02) | | (0.06) | | (0.04) |
| Announcements (Initial) Collateral Easing | | -0.0069 | | -0.0284 | | 0.0106 |
| | | (0.02) | | (0.07) | | (0.04) |
| _cons | -0.0017** | -0.0014*** | -0.0011 | -0.0012 | -0.0024** | -0.0006 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| N | 2456 | 2456 | 2480 | 2480 | 2480 | 2480 |
| R-sq | 0.005 | 0.004 | 0.002 | 0.004 | 0.003 | 0.000 |

Notes:

a) Standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.

b) For initial announcement of asset purchases, we use Draghi's speech, 7/26/2012 "… whatever it takes …" (OMT)

c) For initial announcement of liquidity provision, we use ECB's decision, 3/11/2008, on US dollar liquidity provisions (FOR)

d) For initial announcement of collateral provision, we use 10/15/2008 Decision on expansion of list of assets that could be eligible as collateral (COLL). This also includes enhanced provision of LTROs and provision of US dollar liquidity through foreign-exchange swaps.

e) The Implementation of Asset Purchase programs refers to dates where ECB conducted market purchases under SMP program. Data on this is taken from Fratzscher et al. (2016).

f) The implementation of ECB's Liquidity Provision program refers to dates where liquidity auctions were conducted under the LTRO program. Data on this is taken from Fratzscher et al. (2016).

g) 'Asset Purchase', 'Liquidity Provision' and 'Collateral Easing' coefficients relate to the series of announcements (updates/communication) made by ECB regarding these programs, as given in Annex 3.

## 4. 'Financial Cycle Theory': The impact of US Short-term and long-term rates

Table 4.1) Impact on Short-term policy rates (Dep. Var.: SA short-term policy rate)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Inflation rate | -0.0730*** | | -0.0729*** | 0.0035 | 0.0033 | -0.0738*** | 0.0033 |
| | (0.01) | | (0.01) | (0.00) | (0.00) | (0.01) | (0.00) |
| Output gap | 0.0662 | | 0.0609 | 0.0346*** | 0.0334*** | 0.0621 | 0.0347*** |
| | (0.05) | | (0.05) | (0.01) | (0.01) | (0.05) | (0.01) |
| US short-term policy rate | 0.3632*** | 0.3948*** | 0.3919*** | 0.1032*** | 0.1013*** | 0.3982*** | 0.1042*** |
| | (0.12) | (0.12) | (0.13) | (0.02) | (0.02) | (0.13) | (0.02) |
| Inflation rate (Lagged) | | -0.0724*** | | | | | |
| | | (0.01) | | | | | |
| Output gap (Lagged) | | 0.0965** | | | | | |
| | | (0.05) | | | | | |
| Exchange rate (Change) | | | -0.0053 | | -0.0086 | | |
| | | | (0.06) | | (0.01) | | |
| SA short-term policy rate (Lagged) | | | | 0.9608*** | 0.9609*** | | 0.9602*** |
| | | | | (0.02) | (0.02) | | (0.02) |
| Reserves (change) | | | | | | -5.9492 | -1.0107 |
| | | | | | | (8.53) | (1.56) |
| _cons | 14.5213*** | 14.4190*** | 14.5068*** | -0.2093 | -0.1869 | 14.6280*** | -0.1767 |
| | (1.34) | (1.32) | (1.36) | (0.36) | (0.36) | (1.36) | (0.36) |
| N | 115 | 114 | 114 | 114 | 114 | 114 | 114 |
| R-sq | 0.551 | 0.562 | 0.553 | 0.985 | 0.985 | 0.555 | 0.985 |

Note:

a) The inflation rate uses consumer price index

b) Output gap is computed from monthly industrial production using HP filter.

c) Exchange rate is REER.

d) Short term policy rates represent Federal Funds rate for US and the monetary policy rate for South Africa.

e) Reserves represent South African official foreign currency reserve assets.

f) Lags and changes represent month-to-month dynamics

g) Table uses monthly series coming from IMF's IFS database.

Table 4.2) Impact on Long-term interest rates (Dep. Var.: SA long-term interest rate)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| US long-term interest rate | 0.3052*** | 0.1323*** | 0.7181*** | 0.2857*** | 0.3218*** | 0.1288** |
| | (0.09) | (0.05) | (0.10) | (0.06) | (0.10) | (0.05) |
| SA short-term policy rate | 0.2006*** | -0.0226 | 0.1998*** | -0.0056 | 0.1947*** | -0.0214 |
| | (0.05) | (0.03) | (0.04) | (0.03) | (0.05) | (0.03) |
| SA long-term interest rate (Lagged) | | 0.8790*** | | 0.7865*** | | 0.8786*** |
| | | (0.05) | | (0.05) | | (0.05) |
| Deficit | | | 0.0041** | 0.0022** | | |
| | | | (0.00) | (0.00) | | |
| Inflation rate | | | 0.0354*** | 0.0106*** | | |
| | | | (0.01) | (0.00) | | |
| Reserves (change) | | | | | 1.6178 | 0.4402 |
| | | | | | (3.80) | (1.82) |
| _cons | 5.6032*** | 0.7718*** | 0.8158 | -0.1258 | 5.6021*** | 0.7725*** |
| | (0.21) | (0.27) | (0.81) | (0.44) | (0.21) | (0.27) |
| N | 115 | 114 | 115 | 114 | 114 | 114 |
| R-sq | 0.585 | 0.907 | 0.720 | 0.920 | 0.590 | 0.907 |

Note:

a) The inflation rate uses consumer price index

b) Short term policy rates represent Federal Funds rate for US and the monetary policy rate for South Africa.

c) Long term interest rates represent five-year interest rates for US and South Africa.

d) Deficit represents total/fiscal deficit.

e) Reserves represent South African official foreign currency reserve assets.

f) Lags and changes represent month-to-month dynamics

g) Table uses monthly series coming from IMF's IFS database, except for long term (5 Year) interest rates that come from Datastream.

## 5. Largest gains and losses on daily asset returns

Table 5.1: 20 largest gains and losses on daily asset returns (Jan 01, 2000-Jun 30, 2016)

| date | ER Rand to USD | date | ER Rand to Euro | date | Yields 5YR | date | Yields 10YR | date | IBK 3M |
|---|---|---|---|---|---|---|---|---|---|
| 16-Oct-08 | 10.3% | 21-Dec-01 | -9.2% | 11-Jun-13 | 27.9% | 11-Jun-13 | 25.2% | 20-Jul-12 | -9.0% |
| 21-Dec-01 | -8.2% | 16-Oct-08 | 8.9% | 22-Jan-16 | 15.0% | 22-Jan-16 | 13.6% | 30-Jan-14 | 8.9% |
| 20-Dec-01 | 7.5% | 20-Dec-01 | 7.3% | 21-Jan-16 | -14.4% | 21-Jan-16 | -13.1% | 13-Aug-04 | -8.5% |
| 29-Oct-08 | -6.2% | 14-Dec-01 | 6.5% | 10-Dec-15 | 12.1% | 10-Dec-15 | 12.1% | 15-Jun-01 | -8.0% |
| 14-Dec-01 | 5.9% | 11-Dec-15 | 5.9% | 6-Nov-08 | -10.3% | 6-Nov-08 | -8.6% | 15-Apr-05 | -7.8% |
| 17-Mar-16 | -5.8% | 8-Oct-08 | 4.5% | 22-Apr-10 | 9.2% | 23-Jul-12 | -8.1% | 17-Oct-03 | -7.2% |
| 22-Oct-08 | 5.5% | 15-Oct-08 | 4.5% | 23-Jul-12 | -8.9% | 22-Apr-10 | 5.8% | 14-Aug-09 | -7.1% |
| 6-Oct-08 | 5.4% | 14-Dec-15 | -4.4% | 21-Apr-10 | -8.4% | 14-Dec-15 | -5.5% | 19-Mar-09 | -7.1% |
| 11-Dec-15 | 5.3% | 15-May-03 | 4.3% | 19-Apr-10 | 8.4% | 21-Apr-10 | -5.5% | 26-Mar-10 | -6.2% |
| 15-Oct-08 | 4.9% | 17-Dec-02 | 4.3% | 16-Apr-10 | -7.7% | 20-Jun-13 | 5.4% | 9-Jun-06 | 5.7% |
| 14-Dec-15 | -4.6% | 17-Mar-08 | 4.3% | 8-Apr-10 | 7.1% | 11-Dec-15 | 5.1% | 13-Jun-03 | -5.2% |
| 15-May-03 | 4.6% | 10-Dec-15 | 4.2% | 29-Apr-10 | -6.9% | 8-Apr-10 | 5.1% | 19-Nov-10 | -5.1% |
| 22-Sep-11 | 4.5% | 24-Aug-15 | 4.2% | 4-Nov-08 | 6.6% | 6-Apr-10 | -4.9% | 12-Dec-03 | 4.9% |
| 8-Oct-08 | 4.5% | 26-May-10 | -4.1% | 6-Apr-10 | -6.6% | 19-Apr-10 | 4.9% | 29-Jan-16 | 4.9% |
| 10-Dec-15 | 4.4% | 24-Dec-01 | -4.1% | 3-May-12 | 6.5% | 3-May-12 | 4.7% | 16-Jan-02 | 4.8% |
| 2-Mar-09 | 4.4% | 2-Jan-02 | 4.0% | 15-Apr-10 | 6.3% | 4-Nov-08 | 4.7% | 21-Sep-01 | -4.5% |
| 24-Nov-08 | -4.3% | 12-Aug-04 | 3.8% | 14-Apr-10 | -6.0% | 16-Apr-10 | -4.6% | 6-Feb-09 | -4.0% |
| 17-Dec-08 | -4.2% | 9-Aug-11 | 3.8% | 20-Jun-13 | 6.0% | 23-Oct-08 | 4.6% | 27-May-09 | -4.0% |
| 27-Jun-16 | 4.1% | 13-Dec-01 | 3.8% | 12-Apr-10 | 5.9% | 30-Apr-10 | 4.3% | 29-May-08 | 3.7% |

Table 5.2: 20 largest gains and losses on daily asset returns (Jan 01, 2000-Jun 30, 2016)

| date | CDS 5YR | date | CDS 10YR | date | Stocks-Fin&Indust | date | Stocks-all |
|---|---|---|---|---|---|---|---|
| 15-Oct-08 | 47.7% | 8-Oct-08 | 51.2% | 17-Apr-00 | -7.6% | 17-Apr-00 | -7.6% |
| 14-Oct-08 | -45.0% | 14-Oct-08 | -41.1% | 17-Jul-08 | 6.7% | 6-Oct-08 | -7.3% |
| 10-Oct-08 | 37.4% | 15-Oct-08 | 39.3% | 8-Jun-06 | -6.3% | 8-Dec-08 | 7.1% |
| 12-Nov-08 | 30.3% | 10-Oct-08 | 35.3% | 6-Oct-08 | -6.0% | 15-Oct-08 | -7.0% |
| 10-May-10 | -25.0% | 12-Nov-08 | 30.7% | 25-Sep-01 | 5.8% | 25-Nov-08 | 6.7% |
| 22-Sep-11 | 21.4% | 10-May-10 | -25.2% | 19-Sep-08 | 5.7% | 29-Oct-08 | 6.7% |
| 20-Jun-13 | 21.4% | 9-Oct-08 | 25.0% | 18-Apr-00 | 5.2% | 8-Jun-06 | -6.5% |
| 20-Jan-09 | 17.6% | 20-Jan-09 | 18.3% | 9-Jun-06 | 4.6% | 25-Sep-01 | 6.1% |
| 30-Oct-08 | -17.4% | 30-Oct-08 | -17.0% | 10-Jan-00 | 4.5% | 24-Oct-08 | -5.8% |
| 22-Oct-08 | 16.3% | 22-Sep-11 | 16.9% | 11-Sep-01 | -4.3% | 29-Sep-08 | -5.8% |
| 10-Dec-15 | 16.2% | 24-Oct-08 | 16.4% | 7-May-10 | -4.3% | 19-Mar-09 | 5.8% |
| 7-May-10 | 16.2% | 6-May-10 | 15.1% | 15-Jun-06 | 4.2% | 19-Sep-08 | 5.4% |
| 24-Oct-08 | 15.9% | 13-May-09 | 14.4% | 18-Dec-14 | 4.2% | 30-Oct-08 | 5.4% |
| 13-Jan-09 | 13.8% | 23-Oct-08 | 13.6% | 15-Oct-08 | -4.1% | 21-Dec-01 | -5.4% |
| 16-Oct-08 | 13.5% | 28-Oct-08 | -13.5% | 5-Apr-00 | -4.0% | 24-Jan-08 | 5.3% |
| 28-Oct-08 | -13.1% | 20-Jun-13 | 13.5% | 29-Oct-08 | 4.0% | 1-Feb-08 | 5.3% |
| 23-Oct-08 | 13.1% | 10-Dec-15 | 13.3% | 10-May-10 | 4.0% | 10-Nov-08 | 5.1% |
| 7-Jan-09 | -13.0% | 7-Jan-09 | -13.2% | 20-Sep-01 | -3.9% | 24-Nov-08 | 5.1% |
| 27-Oct-08 | -12.8% | 27-Oct-08 | -13.2% | 29-Sep-08 | -3.9% | 15-Jun-06 | 5.0% |

Table 5.3: gains and losses on daily asset returns (selected Fed UMP events)

| Fed UMP event | date | ER Rand to USD | Percentile rank | ER Rand to Euro | Percentile rank | Yields 5YR | Percentile rank | Yields 10YR | Percentile rank |
|---|---|---|---|---|---|---|---|---|---|
| | 21-Nov-08 | -0.1% | 7.8% | -0.2% | 19.0% | -2.2% | **97.2%** | -2.1% | **97.5%** |
| | 24-Nov-08 | -4.3% | **99.6%** | -1.9% | **94.1%** | -2.7% | **98.3%** | -2.1% | **97.5%** |
| QE1 | 25-Nov-08 | **-3.2%** | **98.8%** | **-2.0%** | **95.6%** | **-1.9%** | **96.3%** | **-1.5%** | **94.4%** |
| | 26-Nov-08 | 1.1% | **76.0%** | 0.3% | 33.5% | -2.3% | **97.4%** | -2.2% | **97.9%** |
| | 27-Nov-08 | -0.5% | 41.7% | -0.6% | 53.7% | 2.6% | **98.1%** | 3.0% | **99.0%** |
| | 24-Jan-14 | 1.2% | 80.3% | 1.2% | **84.1%** | 1.2% | **89.3%** | 0.8% | **79.4%** |
| | 27-Jan-14 | 0.5% | 45.5% | 0.4% | 40.6% | 0.0% | 0.0% | 0.0% | 0.0% |
| | 28-Jan-14 | -1.0% | **74.5%** | -1.1% | **80.1%** | 2.8% | **98.6%** | 2.4% | **98.2%** |
| Taper | 29-Jan-14 | **1.6%** | **88.0%** | **1.4%** | **88.1%** | **2.7%** | **98.3%** | **1.0%** | **86.0%** |
| | 30-Jan-14 | -0.7% | 56.8% | -1.3% | **84.7%** | 1.5% | **93.4%** | 0.8% | **79.8%** |
| | 31-Jan-14 | 0.2% | 18.2% | -0.4% | 39.9% | 1.3% | **89.7%** | 1.1% | **88.1%** |
| | 3-Feb-14 | 0.6% | 50.8% | 0.8% | 67.4% | -0.9% | **81.2%** | -0.5% | 65.8% |

Table 5.4: gains and losses on daily asset returns (selected Fed UMP policies)

| Fed UMP event | date | IBK 3M | Percentile rank | CDS 5YR | Percentile rank | CDS 10YR | Percentile rank | Stocks-Fin&Indust | Percentile rank | Stocks-all | Percentile rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 21-Nov-08 | -0.4% | **93.4%** | -12.4% | **99.5%** | -12.4% | **99.5%** | -0.7% | 56.9% | 1.4% | **81.4%** |
| | 24-Nov-08 | -0.4% | **93.5%** | 0.0% | 0.0% | 0.0% | 0.0% | 1.8% | **91.9%** | 5.1% | **99.6%** |
| QE1 | 25-Nov-08 | **-0.4%** | **93.6%** | **-9.8%** | **99.1%** | **-9.8%** | **99.1%** | **3.1%** | **98.1%** | **6.7%** | **99.9%** |
| | 26-Nov-08 | -0.4% | **93.7%** | 1.7% | **78.5%** | 1.7% | **81.0%** | 1.1% | **76.9%** | 1.0% | 69.8% |
| | 27-Nov-08 | 0.0% | 64.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.8% | **91.5%** | 4.0% | **99.0%** |
| | 24-Jan-14 | 0.0% | 0.0% | 3.7% | **91.6%** | 2.8% | **89.1%** | -1.7% | **90.9%** | -1.2% | **76.8%** |
| | 27-Jan-14 | 0.0% | 0.0% | -1.9% | **80.2%** | -0.7% | 69.3% | -1.5% | **88.5%** | -1.5% | **84.2%** |
| | 28-Jan-14 | 0.0% | 0.0% | -0.4% | 62.0% | 2.1% | **84.7%** | -0.1% | 15.2% | -0.1% | 8.6% |
| Taper | 29-Jan-14 | **0.0%** | **0.0%** | **3.2%** | **88.9%** | **-0.3%** | **61.6%** | **-1.0%** | **73.0%** | **-0.4%** | **30.4%** |
| | 30-Jan-14 | 8.9% | **100.0%** | -1.0% | **71.0%** | -0.6% | 66.4% | -1.2% | **81.6%** | -0.8% | 60.7% |
| | 31-Jan-14 | -0.3% | **90.6%** | 2.7% | **86.7%** | 2.3% | **86.5%** | 0.2% | 22.4% | -0.1% | 11.9% |
| | 3-Feb-14 | 0.0% | 0.0% | 0.0% | 55.8% | -0.3% | 63.1% | -0.4% | 40.0% | -0.4% | 32.9% |

Table 5.5: gains and losses on daily asset returns (selected ECB UMP policies)

| date | ER Rand to USD | perc ER Rand to USD | ER Rand to Euro | perc ER Rand to Euro | Yields 5YR | perc Yields 5YR | Yields 10YR | perc Yields 10YR | ECB UMP event |
|---|---|---|---|---|---|---|---|---|---|
| 6-Oct-08 | 5.4% | **99.8%** | 3.1% | **99.0%** | 0.3% | 54.2% | 0.1% | 45.1% | |
| **7-Oct-08** | **-0.8%** | **61.1%** | **0.3%** | **27.7%** | **0.1%** | **45.8%** | **0.2%** | **48.0%** | FOR, LTRO |
| **8-Oct-08** | **4.5%** | **99.7%** | **4.5%** | **99.9%** | **-2.0%** | **96.7%** | **-1.9%** | **96.6%** | FRTPFA |
| 9-Oct-08 | -1.6% | **88.5%** | -1.5% | **90.4%** | 0.3% | 55.8% | 0.3% | 55.2% | |
| 10-Oct-08 | 3.2% | **98.7%** | 2.1% | **95.9%** | 0.9% | **82.1%** | 1.0% | **84.8%** | |
| **13-Oct-08** | **-1.9%** | **92.9%** | **-1.3%** | **85.7%** | **1.2%** | **88.0%** | **1.3%** | **91.8%** | FOR |
| 14-Oct-08 | -2.3% | **96.2%** | -2.0% | **95.4%** | 0.2% | 50.2% | 0.4% | 60.8% | |
| **15-Oct-08** | **4.9%** | **99.8%** | **4.5%** | **99.9%** | **-0.2%** | **50.7%** | **-0.2%** | **47.2%** | COLL, FOR, LTRO |
| 16-Oct-08 | 10.3% | **100.0%** | 8.9% | **100.0%** | 0.2% | 51.4% | 0.1% | 46.4% | |
| 17-Oct-08 | -2.6% | **97.3%** | -2.2% | **96.7%** | 3.8% | **99.3%** | 3.8% | **99.4%** | |
| 20-Oct-08 | 0.9% | 67.1% | -0.2% | 22.3% | -0.6% | 69.6% | -0.7% | **75.0%** | |
| 29-Jan-09 | 0.5% | 47.8% | -0.6% | 52.7% | -0.8% | **77.2%** | -1.2% | **90.1%** | |
| 30-Jan-09 | 2.6% | **97.4%** | 0.5% | 50.5% | -1.2% | **89.4%** | -1.6% | **95.0%** | |
| 2-Feb-09 | 0.0% | 3.7% | 0.0% | 5.8% | 0.7% | **76.5%** | 1.2% | **89.7%** | |
| **3-Feb-09** | **-0.8%** | **61.5%** | **0.5%** | **48.0%** | **0.2%** | **51.8%** | **0.4%** | **61.6%** | FOR |
| 4-Feb-09 | -2.0% | **94.1%** | -2.6% | **98.0%** | -0.4% | 59.5% | -0.1% | 44.4% | |
| 5-Feb-09 | -0.6% | 50.0% | -0.9% | **71.9%** | 0.0% | 38.8% | 0.3% | 56.1% | |
| 6-Feb-09 | -1.7% | **90.4%** | -1.6% | **91.0%** | -1.7% | **95.4%** | -1.2% | **89.3%** | |
| 2-Mar-09 | 4.4% | **99.7%** | 3.4% | **99.4%** | 2.6% | **98.1%** | 2.4% | **98.1%** | |
| 3-Mar-09 | 0.1% | 6.3% | -0.1% | 15.7% | 0.5% | 67.9% | 0.5% | 68.6% | |
| 4-Mar-09 | -1.0% | **71.4%** | -1.0% | **77.1%** | -0.5% | 68.7% | -0.4% | 63.5% | |
| **5-Mar-09** | **1.2%** | **79.6%** | **1.1%** | **79.7%** | **-1.6%** | **94.5%** | **-1.5%** | **93.7%** | FRTPFA, LTRO |
| 6-Mar-09 | 0.2% | 23.4% | 1.1% | **81.4%** | -0.3% | 55.9% | -0.3% | 59.5% | |
| 9-Mar-09 | 0.6% | 51.5% | 0.4% | 38.8% | -1.2% | **88.2%** | -1.4% | **92.8%** | |
| 10-Mar-09 | -2.9% | **98.0%** | -2.0% | **95.5%** | 1.5% | **93.4%** | 1.2% | **89.8%** | |
| 5-May-10 | 0.6% | 52.3% | -0.7% | 60.6% | 2.1% | **96.8%** | 1.8% | **96.5%** | |
| 6-May-10 | 0.6% | 54.0% | -0.6% | 54.5% | 0.5% | 68.8% | 0.4% | 61.9% | |
| 7-May-10 | 0.5% | 46.3% | 0.0% | 5.0% | 2.5% | **98.0%** | 1.9% | **96.6%** | |
| **10-May-10** | **-2.9%** | **98.1%** | **-1.5%** | **89.1%** | **-2.4%** | **97.6%** | **-2.0%** | **97.1%** | FOR, LTRO, SMP |
| 11-May-10 | 1.0% | **72.6%** | -0.2% | 19.4% | 3.2% | **99.0%** | 1.3% | **91.5%** | |
| 12-May-10 | -1.0% | **74.7%** | -1.1% | **80.6%** | 0.0% | 0.0% | 0.0% | 0.0% | |
| 13-May-10 | 0.0% | 1.6% | -0.9% | **72.6%** | 0.0% | 0.0% | 0.0% | 0.0% | |
| 1-Nov-11 | 2.6% | **97.3%** | 0.6% | 53.0% | 0.7% | **73.6%** | 0.6% | **71.0%** | |
| 2-Nov-11 | -1.6% | **88.6%** | -0.7% | 59.7% | 0.2% | 51.9% | 0.9% | **82.2%** | |
| **3-Nov-11** | **-1.4%** | **85.5%** | **-1.8%** | **93.5%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | CBPP |
| 4-Nov-11 | 0.3% | 26.8% | 0.4% | 39.7% | 0.0% | 0.0% | 0.0% | 0.0% | |
| 7-Nov-11 | 1.0% | **72.3%** | 0.9% | **73.5%** | -2.6% | **98.0%** | -1.5% | **93.6%** | |
| 8-Nov-11 | -1.2% | **79.0%** | -0.8% | 63.9% | -0.9% | **80.8%** | -1.1% | **87.5%** | |

Table 5.6: gains and losses on daily asset returns (selected ECB UMP policies)

| date | IBK 3M | perc IBK 3M | CDS 5YR | perc CDS 5YR | CDS 10YR | perc CDS 10YR | Stocks-Fin&Indust | perc Stocks-Fin&Indust | Stocks-all | perc Stocks-all | ECB UMP event |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Oct-08 | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% | -6.0% | 99.9% | -7.3% | 100.0% | |
| 7-Oct-08 | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% | 2.1% | 94.1% | 2.6% | 95.4% | FOR, LTRO |
| 8-Oct-08 | -0.4% | 93.5% | | 0.0% | 51.2% | 100.0% | -1.8% | 92.3% | -2.8% | 96.4% | FRTPFA |
| 9-Oct-08 | 0.1% | 71.5% | | 0.0% | 25.0% | 99.9% | 0.4% | 37.9% | 1.4% | 81.6% | |
| 10-Oct-08 | 0.5% | 94.6% | 37.4% | 100.0% | 35.3% | 99.9% | -3.7% | 99.3% | -3.1% | 97.7% | |
| 13-Oct-08 | 0.1% | 80.8% | 0.0% | 0.0% | 0.0% | 0.0% | 3.0% | 98.0% | 4.2% | 99.2% | FOR |
| 14-Oct-08 | 0.0% | 63.8% | -45.0% | 100.0% | -41.1% | 100.0% | 2.9% | 97.6% | 3.1% | 97.7% | |
| 15-Oct-08 | 0.0% | 63.8% | 47.7% | 100.0% | 39.3% | 100.0% | -4.1% | 99.7% | -7.0% | 99.9% | COLL, FOR, LTRO |
| 16-Oct-08 | 0.4% | 94.4% | 13.5% | 99.7% | 10.3% | 99.2% | -1.5% | 87.9% | -2.3% | 94.1% | |
| 17-Oct-08 | 0.0% | 0.0% | 10.7% | 99.3% | 9.3% | 99.1% | -2.1% | 94.3% | 0.2% | 20.9% | |
| 20-Oct-08 | 0.0% | 0.0% | -3.2% | 89.2% | -3.2% | 91.1% | 1.3% | 84.1% | 2.8% | 96.6% | |
| 29-Jan-09 | -0.3% | 91.7% | 0.0% | 0.0% | 0.0% | 0.0% | -2.4% | 96.3% | -2.1% | 92.6% | |
| 30-Jan-09 | -1.1% | 98.4% | 5.3% | 95.7% | 5.5% | 96.7% | 0.1% | 11.3% | -0.1% | 8.6% | |
| 2-Feb-09 | -0.5% | 94.7% | 0.0% | 0.0% | 0.0% | 0.0% | -2.7% | 97.2% | -3.1% | 97.8% | |
| 3-Feb-09 | -0.3% | 90.9% | -1.0% | 70.5% | -1.0% | 73.0% | 1.3% | 83.6% | 0.5% | 37.1% | FOR |
| 4-Feb-09 | -0.6% | 96.1% | -1.2% | 73.7% | -1.2% | 76.1% | 1.5% | 87.6% | 3.1% | 97.8% | |
| 5-Feb-09 | -0.7% | 96.8% | 3.2% | 88.8% | 3.3% | 91.3% | -1.1% | 78.1% | -1.0% | 66.9% | |
| 6-Feb-09 | -4.0% | 99.6% | 2.4% | 84.2% | 2.4% | 87.3% | 3.5% | 99.0% | 4.9% | 99.5% | |
| 2-Mar-09 | -0.2% | 85.3% | 3.3% | 89.5% | 3.4% | 92.0% | -1.3% | 83.2% | -0.4% | 35.8% | |
| 3-Mar-09 | 0.0% | 0.0% | 3.2% | 88.8% | 3.3% | 91.4% | -1.7% | 91.3% | -1.4% | 82.2% | |
| 4-Mar-09 | 0.0% | 0.0% | 0.6% | 65.9% | 0.6% | 67.7% | -0.2% | 19.4% | 2.0% | 90.8% | |
| 5-Mar-09 | 0.0% | 0.0% | -0.6% | 65.8% | -0.6% | 67.7% | -0.5% | 44.5% | -0.3% | 26.6% | FRTPFA, LTRO |
| 6-Mar-09 | 0.0% | 0.0% | 6.1% | 96.9% | 6.4% | 97.7% | -0.7% | 58.4% | 1.2% | 75.6% | |
| 9-Mar-09 | -0.1% | 80.0% | 0.0% | 0.0% | 0.0% | 0.0% | -1.9% | 93.0% | -2.6% | 95.7% | |
| 10-Mar-09 | 0.0% | 65.7% | -6.7% | 97.4% | -7.0% | 98.1% | 2.0% | 93.6% | 2.4% | 94.5% | |
| 5-May-10 | 0.0% | 0.0% | 9.0% | 98.9% | 8.9% | 98.9% | -1.6% | 89.9% | -1.1% | 73.5% | |
| 6-May-10 | 0.2% | 87.9% | 10.8% | 99.3% | 15.1% | 99.7% | 0.0% | 6.4% | -0.4% | 32.3% | |
| 7-May-10 | 0.0% | 0.0% | 16.2% | 99.7% | 10.1% | 99.2% | -4.3% | 99.8% | -3.6% | 98.8% | |
| 10-May-10 | -0.2% | 87.8% | -25.0% | 99.9% | -25.2% | 99.9% | 4.0% | 99.6% | 4.3% | 99.3% | FOR, LTRO, SMP |
| 11-May-10 | 0.0% | 0.0% | 2.5% | 85.3% | 6.1% | 97.5% | 0.1% | 10.1% | -0.5% | 42.5% | |
| 12-May-10 | 0.0% | 0.0% | -7.9% | 98.2% | -8.7% | 98.9% | 2.8% | 97.4% | 2.4% | 94.6% | |
| 13-May-10 | -0.5% | 94.6% | 0.7% | 67.3% | 1.3% | 76.5% | -0.9% | 70.2% | -0.5% | 39.5% | |
| 1-Nov-11 | -0.6% | 96.5% | 8.9% | 98.9% | 9.0% | 99.0% | -1.7% | 90.7% | -1.9% | 90.7% | |
| 2-Nov-11 | 0.6% | 96.6% | -1.5% | 77.3% | -3.6% | 92.7% | 0.9% | 70.3% | 1.5% | 83.3% | |
| 3-Nov-11 | 0.0% | 0.0% | -3.1% | 88.3% | -4.3% | 94.7% | -0.1% | 11.7% | 0.0% | 7.6% | CBPP |
| 4-Nov-11 | 0.0% | 0.0% | -1.3% | 75.2% | 0.7% | 69.5% | -1.3% | 83.5% | -0.9% | 64.0% | |
| 7-Nov-11 | 0.0% | 0.0% | 4.8% | 94.5% | 3.2% | 91.1% | 1.5% | 87.0% | 1.9% | 90.0% | |
| 8-Nov-11 | 0.4% | 92.4% | -0.3% | 60.4% | -0.5% | 65.2% | 0.3% | 31.8% | 0.5% | 39.3% | |

## 6. Spillovers from Fed & ECB UMP: IH regressions

Table 6.1: IH Regressions (IV & GMM); Impact of SARB Monetary Policy on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | 0.0977** | (0.05) | 0.1006** | (0.05) |
| Yields 5YR | 0.0525** | (0.02) | 0.0537** | (0.02) |
| Yields 10YR | 0.0446* | (0.02) | 0.0457** | (0.02) |
| CDS 5YR | 0.1718** | (0.08) | 0.1788** | (0.08) |
| CDS 10YR | 0.1463** | (0.07) | 0.1524** | (0.07) |
| IBK 3M | 0.0202*** | (0.00) | 0.0201*** | (0.00) |
| Stocks-all | -0.0535*** | (0.02) | -0.0554*** | (0.02) |
| Stocks-Fin&Indust | -0.0408*** | (0.01) | -0.0423*** | (0.01) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the pass-through of domestic monetary policy to the (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.2: IH Regressions (IV & GMM); Impact of Fed UMP (QE1) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.2064*** | (0.07) | -0.2095*** | (0.07) |
| Yields 5YR | -0.1144*** | (0.04) | -0.1134*** | (0.04) |
| Yields 10YR | -0.1079*** | (0.03) | -0.1078*** | (0.04) |
| CDS 5YR | -0.3788*** | (0.13) | -0.3851*** | (0.13) |
| CDS 10YR | -0.3302*** | (0.11) | -0.3362*** | (0.11) |
| IBK 3M | -0.0028 | (0.00) | -0.0027 | (0.00) |
| Stocks-all | 0.0912*** | (0.03) | 0.0919*** | (0.03) |
| Stocks-Fin&Indust | 0.0664*** | (0.02) | 0.0676*** | (0.02) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of Fed QE1 on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.3: IH Regressions (IV & GMM); Impact of Fed UMP (QE Tapering) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | 0.0094* | (0.01) | 0.0313*** | (0.01) |
| Yields 5YR | 0.0173*** | (0.00) | 0.0297*** | (0.01) |
| Yields 10YR | 0.0161*** | (0.00) | 0.0288*** | (0.01) |
| CDS 5YR | 0.0442** | (0.02) | 0.0950** | (0.04) |
| CDS 10YR | 0.0286* | (0.02) | 0.0706*** | (0.02) |
| IBK 3M | 0.0178*** | (0.00) | 0.0056 | (0.02) |
| Stocks-all | -0.0093* | (0.01) | -0.0186** | (0.01) |
| Stocks-Fin&Indust | -0.0096** | (0.00) | -0.0188*** | (0.01) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of Fed Tapering on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.4: IH Regressions (IV & GMM); Impact of ECB UMP (all policies) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0151** | (0.01) | -0.0134* | (0.01) |
| Yields 5YR | -0.0089** | (0.00) | -0.0082** | (0.00) |
| Yields 10YR | -0.0089** | (0.00) | -0.0083** | (0.00) |
| CDS 5YR | -0.0365** | (0.02) | -0.0337** | (0.02) |
| CDS 10YR | -0.0316** | (0.01) | -0.0292** | (0.01) |
| IBK 3M | -0.0006 | (0.00) | -0.0006 | (0.00) |
| Stocks-all | 0.0071** | (0.00) | 0.0065* | (0.00) |
| Stocks-Fin&Indust | 0.0055** | (0.00) | 0.0051** | (0.00) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of all unconventional ECB policies on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.5: IH Regressions (IV & GMM); Impact of ECB UMP (Asset Purchases) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.1470** | (0.07) | -0.1449** | (0.07) |
| Yields 5YR | -0.0850** | (0.03) | -0.0833** | (0.04) |
| Yields 10YR | -0.0774** | (0.03) | -0.0760** | (0.04) |
| CDS 5YR | -0.3039** | (0.12) | -0.2987** | (0.14) |
| CDS 10YR | -0.2649** | (0.11) | -0.2606** | (0.12) |
| IBK 3M | -0.0001 | (0.00) | -0.0001 | (0.00) |
| Stocks-all | 0.0723** | (0.03) | 0.0710** | (0.03) |
| Stocks-Fin&Indust | 0.0526** | (0.02) | 0.0517** | (0.02) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's Asset Purchases program on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.6: IH Regressions (IV & GMM); Impact of ECB UMP (Liquidity Provisions) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.1470** | (0.07) | -0.1449** | (0.07) |
| Yields 5YR | -0.0850** | (0.03) | -0.0833** | (0.04) |
| Yields 10YR | -0.0774** | (0.03) | -0.0760** | (0.04) |
| CDS 5YR | -0.3039** | (0.12) | -0.2987** | (0.14) |
| CDS 10YR | -0.2649** | (0.11) | -0.2606** | (0.12) |
| IBK 3M | -0.0001 | (0.00) | -0.0001 | (0.00) |
| Stocks-all | 0.0723** | (0.03) | 0.0710** | (0.03) |
| Stocks-Fin&Indust | 0.0526** | (0.02) | 0.0517** | (0.02) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's Liquidity Provision program on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.7: IH Regressions (IV & GMM); Impact of ECB UMP (Collateral Easing) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.1470** | (0.07) | -0.1449** | (0.07) |
| Yields 5YR | -0.0850** | (0.03) | -0.0833** | (0.04) |
| Yields 10YR | -0.0774** | (0.03) | -0.0760** | (0.04) |
| CDS 5YR | -0.3039** | (0.12) | -0.2987** | (0.14) |
| CDS 10YR | -0.2649** | (0.11) | -0.2606** | (0.12) |
| IBK 3M | -0.0001 | (0.00) | -0.0001 | (0.00) |
| Stocks-all | 0.0723** | (0.03) | 0.0710** | (0.03) |
| Stocks-Fin&Indust | 0.0526** | (0.02) | 0.0517** | (0.02) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's Collateral Easing program on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.8: IH Regressions (IV & GMM); Impact of ECB UMP (FWG) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0203*** | (0.00) | -0.0178 | (0.03) |
| Yields 5YR | -0.0217** | (0.01) | -0.0314 | (0.03) |
| Yields 10YR | -0.0087 | (0.01) | -0.0181 | (0.03) |
| CDS 5YR | -0.0275 | (0.03) | -0.0183 | (0.08) |
| CDS 10YR | -0.0146 | (0.03) | 0.0008 | (0.05) |
| IBK 3M | -0.0002 | (0.00) | 0.0000 | (0.00) |
| Stocks-all | 0.0217* | (0.01) | 0.0351 | (0.04) |
| Stocks-Fin&Indust | 0.0199** | (0.01) | 0.0314 | (0.04) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's Forward Guidance policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.9: IH Regressions (IV & GMM); Impact of ECB UMP (OMT) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0216*** | (0.00) | -0.0137* | (0.01) |
| Yields 5YR | -0.0127*** | (0.00) | -0.0083 | (0.01) |
| Yields 10YR | -0.0103** | (0.00) | -0.0060 | (0.00) |
| CDS 5YR | -0.0409** | (0.02) | -0.0199 | (0.01) |
| CDS 10YR | -0.0360** | (0.02) | -0.0191 | (0.01) |
| IBK 3M | 0.0000 | (0.00) | 0.0000 | (0.00) |
| Stocks-all | 0.0119** | (0.01) | 0.0084*** | (0.00) |
| Stocks-Fin&Indust | 0.0086* | (0.00) | 0.0059*** | (0.00) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's OMT policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.10: IH Regressions (IV & GMM); Impact of ECB UMP (FOR) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0338*** | (0.01) | -0.0314*** | (0.01) |
| Yields 5YR | -0.0164*** | (0.01) | -0.0154** | (0.01) |
| Yields 10YR | -0.0163*** | (0.01) | -0.0154*** | (0.01) |
| CDS 5YR | -0.0829*** | (0.03) | -0.0788*** | (0.03) |
| CDS 10YR | -0.0760*** | (0.02) | -0.0725*** | (0.02) |
| IBK 3M | -0.0028** | (0.00) | -0.0028** | (0.00) |
| Stocks-all | 0.0190*** | (0.01) | 0.0182*** | (0.01) |
| Stocks-Fin&Indust | 0.0150*** | (0.00) | 0.0144*** | (0.00) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's FOR policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.11: IH Regressions (IV & GMM); Impact of ECB UMP (SMP) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.1001 | (0.07) | -0.1018 | (0.07) |
| Yields 5YR | -0.0586* | (0.04) | -0.0592* | (0.03) |
| Yields 10YR | -0.0523 | (0.03) | -0.0529 | (0.03) |
| CDS 5YR | -0.2457** | (0.12) | -0.2489** | (0.12) |
| CDS 10YR | -0.2221** | (0.11) | -0.2247** | (0.11) |
| IBK 3M | -0.0002 | (0.00) | -0.0002 | (0.00) |
| Stocks-all | 0.0413 | (0.03) | 0.0421 | (0.03) |
| Stocks-Fin&Indust | 0.0310 | (0.02) | 0.0317 | (0.02) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's SMP policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.12: IH Regressions (IV & GMM); Impact of ECB UMP (CBPP) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0174*** | (0.00) | -0.0239** | (0.01) |
| Yields 5YR | -0.0084** | (0.00) | -0.0108* | (0.01) |
| Yields 10YR | -0.0075** | (0.00) | -0.0099** | (0.00) |
| CDS 5YR | -0.0525*** | (0.01) | -0.0822* | (0.04) |
| CDS 10YR | -0.0445*** | (0.01) | -0.0702* | (0.04) |
| IBK 3M | 0.0006 | (0.00) | 0.0002 | (0.00) |
| Stocks-all | 0.0027 | (0.00) | 0.0132 | (0.01) |
| Stocks-Fin&Indust | 0.0029 | (0.00) | 0.0126 | (0.01) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's CBPP policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.13: IH Regressions (IV & GMM); Impact of ECB UMP (LTRO) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0112*** | (0.00) | -0.0086*** | (0.00) |
| Yields 5YR | -0.0078*** | (0.00) | -0.0065*** | (0.00) |
| Yields 10YR | -0.0082*** | (0.00) | -0.0076*** | (0.00) |
| CDS 5YR | -0.0208*** | (0.01) | -0.0177 | (0.02) |
| CDS 10YR | -0.0189*** | (0.01) | -0.0159 | (0.02) |
| IBK 3M | 0.0004 | (0.00) | 0.0004 | (0.00) |
| Stocks-all | 0.0069*** | (0.00) | 0.0095* | (0.01) |
| Stocks-Fin&Indust | 0.0042** | (0.00) | 0.0075* | (0.00) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's LTRO policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

Table 6.14: IH Regressions (IV & GMM); Impact of ECB UMP (PSPP) on various asset returns

| | IV | | GMM | |
|---|---|---|---|---|
| ER Rand to USD | -0.0122*** | (0.00) | -0.0002 | (0.01) |
| Yields 5YR | -0.0081** | (0.00) | -0.0037 | (0.01) |
| Yields 10YR | -0.0095*** | (0.00) | -0.0061 | (0.01) |
| CDS 5YR | -0.0210 | (0.01) | 0.0053 | (0.03) |
| CDS 10YR | -0.0174 | (0.01) | 0.0047 | (0.03) |
| IBK 3M | 0.0005 | (0.00) | 0.0006 | (0.00) |
| Stocks-all | 0.0062 | (0.00) | -0.0027 | (0.01) |
| Stocks-Fin&Indust | 0.0042 | (0.00) | -0.0029 | (0.01) |

Notes:
a) Heteroscedasticity-robust standard errors in parentheses; significance levels:*p<0.10, **p<0.05, ***p<0.01.
b) The table shows the impact of ECB's PSPP policy on (Rand/USD) exchange rate, 5 and 10 year sovereign yields, 5 and 10 year CDS, 3 month interbank rate, JSE all shares index, and JSE Financial & Industrial shares index.

## 7. Variance ratios: Fed & ECB event dates vs. non-event dates

Table 7.1: Standard Deviation and Variance Ratio for various assets - GFC

| period | GFC | Non-GFC | Variance Ratio (GFC to Non-GFC) |
|---|---|---|---|
| ER Rand to USD | 0.011 | 0.010 | 1.04* |
| ER Rand to Euro | 0.010 | 0.010 | 0.94*** |
| Yields 5YR | 0.013 | 0.008 | 1.61*** |
| Yields 10YR | 0.012 | 0.007 | 1.56*** |
| IBK 3M | 0.005 | 0.005 | 0.90*** |
| Stocks-all | 0.012 | 0.012 | 1.08*** |
| Stocks-Fin&Indust | 0.011 | 0.010 | 1.04* |

Note: The table compares daily returns on various South African assets during the period of Global financial crisis (Jan 2007 onwards) with period before (Jan 2000 to Dec-2006)

Table 7.2: Standard Deviation and Variance Ratio for various assets - Fed QE

| period | QE1 | Non-QE1 | Variance Ratio (QE1 to Non-QE1) |
|---|---|---|---|
| ER Rand to USD | 0.023 | 0.011 | 2.09*** |
| ER Rand to Euro | 0.016 | 0.009 | 1.69** |
| Yields 5YR | 0.015 | 0.013 | 1.180 |
| Yields 10YR | 0.013 | 0.012 | 1.082 |
| CDS 5YR | 0.058 | 0.038 | 1.54* |
| CDS 10YR | 0.058 | 0.035 | 1.66* |
| IBK 3M | 0.003 | 0.005 | 0.662 |
| Stocks-all | 0.041 | 0.012 | 3.32*** |
| Stocks-Fin&Indust | 0.019 | 0.011 | 1.80** |

Note: The table compares daily returns on various South African assets during the Fed QE1 announcement days with Non-Announcement days; this includes days post jan-1, 2007

Table 7.3: Standard Deviation and Variance Ratio for various assets - Tapering

| period | Taper | Non-Taper | Variance Ratio (Taper to Non-Taper) |
|---|---|---|---|
| ER Rand to USD | 0.011 | 0.011 | 1.020 |
| ER Rand to Euro | 0.010 | 0.010 | 1.028 |
| Yields 5YR | 0.016 | 0.013 | 1.219 |
| Yields 10YR | 0.011 | 0.012 | 0.979 |
| CDS 5YR | 0.026 | 0.038 | 0.70 |
| CDS 10YR | 0.011 | 0.035 | 0.31** |
| Stocks-all | 0.003 | 0.013 | 0.23*** |
| Stocks-Fin&Indust | 0.004 | 0.011 | 0.41* |

Note: The table compares daily returns on various South African assets during the Fed QE Tapering announcement days with Non-Announcement days.

Table 7.4: Standard Deviation and Variance Ratio for various assets - Fed CMP

| period | Fed CMP | Non-Fed CMP | Variance Ratio (Fed CMP to Non-Fed CMP) |
|---|---|---|---|
| ER Rand to USD | 0.026 | 0.011 | 2.41*** |
| ER Rand to Euro | 0.020 | 0.009 | 2.11*** |
| Yields 5YR | 0.010 | 0.013 | 0.787 |
| Yields 10YR | 0.010 | 0.012 | 0.894 |
| CDS 5YR | 0.055 | 0.038 | 1.444 |
| CDS 10YR | 0.225 | 0.033 | 6.73*** |
| IBK 3M | 0.002 | 0.005 | 0.42*** |
| Stocks-all | 0.023 | 0.012 | 1.86*** |
| Stocks-Fin&Indust | 0.014 | 0.011 | 1.318 |

Note: The table compares daily returns on various South African assets during the Fed conventional monetary policy, CMP, announcement days with Non-Announcement days.

Table 7.5: Standard Deviation and Variance Ratio for various assets - Fed UMP

| period | Fed UMP | Non-Fed UMP | Variance Ratio (Fed UMP to Non-Fed UMP) |
|---|---|---|---|
| ER Rand to USD | 0.011 | 0.011 | 1.021 |
| ER Rand to Euro | 0.010 | 0.010 | 1.028 |
| Yields 5YR | 0.016 | 0.013 | 1.219 |
| Yields 10YR | 0.011 | 0.012 | 0.979 |
| CDS 5YR | 0.026 | 0.038 | 0.696 |
| CDS 10YR | 0.011 | 0.035 | 0.31** |
| Stocks-all | 0.003 | 0.013 | 0.23*** |
| Stocks-Fin&Indust | 0.004 | 0.011 | 0.41* |

Note: The table compares daily returns on various South African assets during the Fed unconventional monetary policy, UMP, announcement days with Non-Announcement days

Table 7.6: Standard Deviation and Variance Ratio for various assets - Fed FOMC

| period | Fed FOMC | Non-Fed FOMC | Variance Ratio (Fed FOMC to Non-Fed FOMC) |
|---|---|---|---|
| ER Rand to USD | 0.014 | 0.011 | 1.32* |
| ER Rand to Euro | 0.012 | 0.009 | 1.231 |
| Yields 5YR | 0.014 | 0.013 | 1.107 |
| Yields 10YR | 0.012 | 0.012 | 1.029 |
| CDS 5YR | 0.033 | 0.038 | 0.87 |
| CDS 10YR | 0.031 | 0.035 | 0.88 |
| IBK 3M | 0.002 | 0.005 | 0.395 |
| Stocks-all | 0.018 | 0.012 | 1.46*** |
| Stocks-Fin&Indust | 0.011 | 0.011 | 0.984 |

Note: The table compares daily returns on various South African assets during the Fed Federal Open Market Committee, FOMC, meeting days with Non-meeting days

Table 7.7: Standard Deviation and Variance Ratio for various assets - ECB CMP

| period | ECB CMP | Non-ECB CMP | Variance Ratio (ECB CMP to Non-ECB CMP) |
|---|---|---|---|
| ER Rand to USD | 0.017 | 0.011 | 1.55*** |
| ER Rand to Euro | 0.016 | 0.009 | 1.71*** |
| Yields 5YR | 0.024 | 0.013 | 1.875 |
| Yields 10YR | 0.021 | 0.011 | 1.84*** |
| CDS 5YR | 0.031 | 0.035 | 0.88 |
| CDS 10YR | 0.127 | 0.034 | 3.80*** |
| IBK 3M | 0.002 | 0.005 | 0.47*** |
| Stocks-all | 0.019 | 0.012 | 1.50*** |
| Stocks-Fin&Indust | 0.014 | 0.011 | 1.30* |

Note: The table compares daily returns on various South African assets during the ECB conventional monetary policy, CMP, announcement days with Non-Announcement days.

Table 7.8: Standard Deviation and Variance Ratio for various assets - ECB UMP

| period | ECB UMP | Non-ECB UMP | Variance Ratio (ECB UMP to Non-ECB UMP) |
|---|---|---|---|
| ER Rand to USD | 0.014 | 0.011 | 1.34*** |
| ER Rand to Euro | 0.013 | 0.009 | 1.44*** |
| Yields 5YR | 0.009 | 0.013 | 0.72*** |
| Yields 10YR | 0.009 | 0.012 | 0.73*** |
| CDS 5YR | 0.076 | 0.036 | 2.13*** |
| CDS 10YR | 0.087 | 0.035 | 2.73*** |
| IBK 3M | 0.008 | 0.005 | 1.79*** |
| Stocks-all | 0.019 | 0.012 | 1.58*** |
| Stocks-Fin&Indust | 0.015 | 0.011 | 1.44*** |

Note: The table compares daily returns on various South African assets during the ECB unconventional monetary policy, UMP, announcement days with Non-Announcement days.

Table 7.9: Stand. Dev. and Variance Ratio for various assets - ECB Gov.Council.

| period | ECB Gov. Council Meeting | Non-ECB Gov. Council Meeting | Variance Ratio (ECB Gov. Council Meeting to Non-ECB Gov. Council Meeting) |
|---|---|---|---|
| ER Rand to USD | 0.011 | 0.011 | 0.981 |
| ER Rand to Euro | 0.011 | 0.009 | 1.61* |
| Yields 5YR | 0.023 | 0.013 | 1.85*** |
| Yields 10YR | 0.021 | 0.011 | 1.88*** |
| CDS 5YR | 0.030 | 0.038 | 0.79** |
| CDS 10YR | 0.026 | 0.035 | 0.724*** |
| IBK 3M | 0.001 | 0.005 | 0.30*** |
| Stocks-all | 0.013 | 0.012 | 1.053 |
| Stocks-Fin&Indust | 0.011 | 0.011 | 1.020 |

Note: The table compares daily returns on various South African assets during the ECB Governing Council meeting days with Non-meeting days.

# Chapter 5

# Chapter 5: General Conclusion

The essay has presented three analytical chapters that discuss the problems of debt sustainability, financial crisis and the role of external monetary shocks to the stability of developing countries. This conclusive chapter summarizes the key exercises, findings and contributions of the three chapters — together with some policy lessons.

**Chapter 2** has based itself on the argument that 'unsustainable' debt burdens play a negative role on the growth prospects of developing countries. Many studies conducted on the topic have also arrived at this conclusion and usually set a benchmark that would serve as a sustainability threshold (Schclarek, 2004; Caner et al., 2010; Greenidge et al., 2012; Panizza and Presbitero, 2013).[81] The literature, however, largely fails to address the overall heterogeneity in developing countries, while setting these debt sustainability benchmarks. Particularly, the gaps among developing countries with regards to institutional quality is often overlooked. Thus, in addition to the focus on the non-linear impacts of public debt on growth, the paper makes a contribution by highlighting the role of institutions (specifically those of public sector management quality). We focus on public sector management quality since we are dealing with public debt and the former is an evident determinant. The chapter has particularly focused on how governments with divergent public sector management capacity may see a diverse nexus between public debt and economic growth. And even when the relationship is similar for countries with different quality of institutions, the level of debt that would make it 'unsustainable' could differ - in favor of countries with better institutional quality.

Going to the results, although a linear and straightforward look at the data backs the hypothesized negative relationship between indebtedness and economic growth, deeper looks at the data reveal non-linarites related to the quality of institutions.[82] Most importantly, we notice that what would be deemed as a sustainable level of debt in one country (e.g. a country with efficient public sector, strong revenue mobilization capacity, and low level of corruption) may not be sustainable for another county (e.g. a country with weak institutional quality).

The debt-growth nexus also shows some sensitivity to the level of debt. The argument for non-linear effects of sovereign indebtedness on growth has been captured in the literature of the 'debt-laffer curve' (Krugman, 1989; Claessens, 1990; Megersa, 2015). A simple argument is that,

[81] Within this literature, the infamous study by Reinhart and Rogoff (2010) on public debt in advanced economies has argued that countries start to experience negative impacts on growth after a debt-to-GDP ratio of 90%. However, their analysis have been criticized for arbitrary setting of thresholds and computational issues (Herndon et al., 2013).

[82] When we allow for non-linearity — first) in the cross-country differences of institutional quality and second) across different debt levels, we get varying results in the relationship between public debt and growth. We witnessed a negative linear debt-growth nexus in the group of countries with 'weak' public sector management qualities, but not in the group of developing countries with 'strong' public sector management. This result also persists on alternative country clusters formed using robust procedures and also using disaggregated indices of public sector management instead of aggregate indices.

developing countries lack both key infrastructures that would serve as engines of growth and the capital which could finance such operations (i.e. they need 'development finance'). Initial investments in key projects and strategic sectors would also have bigger marginal productivity contributions to their economy. However, borrowing too much (beyond the repayment capacities) makes them susceptible to debt crisis. Further, 'too much too fast' debt fueled public investments could also make the marginal contribution of investments low and redundant. The gains are further reduced in the context of poor institutions, low transparency and high prevalence of corruption in developing countries (Eden and Kraay, 2014). An interesting outcome of this non-linearity exercise (based on levels of debt) has been that developing countries with better public sector management tend to experience the detrimental impacts of public debt at relatively higher levels — when compared to other developing countries with weaker public sector management quality.

The overall policy implication (and aim of the paper) is that, the discussion on the negative effects of public debt in developing countries should pay attention to the issue of country heterogeneity. Institutional determinants are known to be important but are frequently ignored.[83] Further, the chapter also tries to re-orient some attention to the problems of public debt in developing countries in a period where the major focus has shifted to advanced countries (with historically much higher levels of debt-to-GDP). The fact that many developing countries are again witnessing rapidly rising public debt levels (often due to large government loans in the name of big public projects) only adds to the timeliness of the issue at hand. For instance, the joint IMF's debt sustainability analysis (DSA) puts a number of low-income countries in ('red/Yellow' categories), signaling growing public debt distress (IMF, 2016a).

In **chapter 3**, I studied the predictive power of key macroeconomic variables towards incidents of currency crisis using signals approach.[84] By defining currency crisis episodes as extreme movements in the exchange market pressure index, the approach makes a non-parametric ex-post study in to the behavior of key macroeconomic variables, in the immediate periods preceding identified crisis incidents.[85]

The analysis determines three key episodes of currency crisis in Ethiopia (1992-93, 1999, and 2008). The first crisis displayed relatively higher out-of-sample crisis probabilities, when compared to the latter two crisis. On the basis of the noise-to-signal ratio rule, M2 multiplier, bank deposits, exports, terms of trade, deviation of real ER from trend and lending-deposit rate

[83] Institutional aspects are often left out from empirical excercises for ease of analysis. Employing them usually introduces certain complexities — with respect to difficulty of measurement and lack of data.

[84] The approach was introduced by Kaminsky et al. (1998) at the start of the Asian financial crisis that brought severe currency crisis to a number of emerging countries in East Asia. As a third generation currency crisis model, it builds up on older two generations of currency crisis models. See section 1 of chapter 3 for more.

[85] The changes in exchange market pressure index (EMPI) primarily depend on the movements of its two key components, namely exchange rate movements and accumulation of foreign reserves.

ratio were good indicators which displayed significantly 'abnormal' movements prior to currency crisis events in Ethiopia.

Based on these results, I would like to make two important points, which could well be key lessons for early warning methodologies and their applications. The first has to do with the role of 'political shocks' and the other with the role of 'external financial shocks'. First, key political shocks and structural reforms could have an impact and might even become crisis triggers. This could be clearly seen from the 1992-93 crisis which was a period of significant structural reform in the economy and the 1999 crisis which overlaps Ethiopia's border skirmish with Eritrea. The important lesson driven from this is that, crisis could arise - not necessarily from weakening macroeconomic fundamentals (as is often done in financial early warning methodologies) - but also from significant political shocks. Analysis of crisis episodes in developing countries should especially take this in to account. This becomes even more valid considering that political shocks are big and more frequent in low-income (and sometimes emerging) developing countries than in advanced economies.

However, one could also argue that some of the macroeconomic indicators could capture these political shocks that are not directly accounted for by the 'early warning exercises'. For instance, in the recent Russian currency crisis (2014-15), it took some time for the effects of the political crisis to have visible impact on the wider economy. As the economy gradually started facing capital flight, declining trade, speculative attacks, rapid reserve losses, rising inflation, and loss of confidence; a fully blown crisis was witnessed (Dabrowski, 2016). Thus, perhaps, the significance of these political shocks might as well be captured by the simultaneous shock on key macroeconomic indicators to some extent.

Going to the second point, Ethiopia's loose connection to the world economy in general and to global capital markets in particular, lead me to assume that international shocks do not play a direct key role to its vulnerability. However, I still do not rule out their possible indirect role. Especially the shocks that are global in nature tend to have ripple effects on international trade, foreign direct investments, global interest rate differentials, remittance based international capital flows, aid flows, etc. This is perhaps evident in the results, as some of the crisis events could be roughly matched to concurrent financial turmoil in world economy (e.g. 1992–93 crisis of European Exchange Rate Mechanism; 1997-99 Asian financial crisis; 2008-09 global financial crisis). Examining the exact impact of these events and channels of transmission is, however, something I leave for future research.

A useful improvement of financial early warning systems may also start with the inclusion of more indicators from the real and financial sectors that have better capacity of detecting the transmission of external shocks. This becomes ever more important given the growing internationalization of financial crisis contagion.[86] This would particularly become useful in countries that are relatively more connected with the global economy and international capital

[86] Kaminsky and Reinhart (2000) provide a broad list of indicators that may better enable the detection of financial crisis in the setting of international contagion.

market, thus, are more likely to face the impacts of such shocks. In fact, the discussion in the next chapter walks across these lines by analyzing the impacts of external (monetary policy) shocks on South Africa. With mounting evidence of international transmission of financial shocks, key financial institutions such as the IMF are emphasizing the need to focus on multilateral surveillance techniques for crisis (IMF, 2016b).

However, given the poor performance of existing (even the most complex) 'early warning systems' and repeated failures to foresee a number of past crises (Reinhart and Rogoff, 2009), I do not recommend that monetary authorities of developing countries should solely rely on these tools. Yet, at the minimum, they can be instruments that can warn when 'known anomalies' are seen in the economy - that may potentially progress to a crisis. Having a guideline, even if half perfect, is still better than not having one. Further, having a tool (such as the approach we utilized) that looks at multiple key macroeconomic variables, and sectors, often does a better job of 'early warning'. This is particularly helpful as different crisis may come from weaknesses in different sectors, and those areas of weaknesses may differ from one period to another and from one country to another. This makes the learning process daunting, as future crisis may have origins that are different from those in the past.

Yet, in the end - there are no 'overnight' currency, debt, banking or other forms of financial crises. There are often signs that are overlooked by the experts (economists, monetary authorities, analysts, governments, etc.) before a crisis emerges. Even looking at the great global recession of 2008-09, there were signs that were unfortunately ignored. Banks were taking too much risk, the housing sector (at least in the US) was in a bubble, there were alarming disconnects between the real and financial sector, and there were highly skewed trade balances among major economies, just to mention a few indicators. Nevertheless, it takes a rare capacity (not necessarily a 'Raghuram Rajan')[87] to connect these dots and argue that things are not normal. Especially when what is 'normal' is not objective and static but evolves over time and becomes a 'new normal'. Even more so difficult, when the existing consensus among 'experts' goes against predictions of crisis — "Crisis? What crisis?"

At the conclusion of chapter 3, I noted that developing countries (especially the ones that have relatively established financial sectors and have strong links to international capital markets) should pay more attention to the roles of shocks emanating from the outside. Indeed, this 'warning note' will become relevant to a growing number of developing countries, as many of them are establishing (or expanding) their capital markets. As their local financial markets mature, developing countries will have ever increasing ties to the flow of global capital.

[87] One of the few 'famous' predictions of the global financial crisis was by Raghuram Rajan, who at the moment was 'Economic Counsellor' and Director of the IMF's Research Department on Financial Markets, Financial Fragility, and Central Banking. "The Greenspan Era: Lessons for the Future" (Saturday, August 27, 2005) Jackson Hole, Wyoming, US.
https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp082705

**Chapter 4** tries to make a contribution to the research on problems linked to external financial shocks - by studying the spillovers from the recent unconventional monetary policies of the Fed and ECB. It analyzes the unintended impacts of these shocks on the returns (dynamics) of various South African assets, e.g. currency, bond yields, credit default swap, interbank market rate, and stock market. Since the study wants to investigate the impact of monetary policy announcements (surprises) from two of the world's biggest central banks - and since the transmission of the impact of such policies on global financial markets are 'immediate' (Rey, 2014; Bowman et al., 2014; Fatum and Scholnick, 2007), the chapter employs high frequency daily data.

Going to the results, we see significant evidence for the presence of spillovers from the key unconventional monetary policies of the Fed and ECB. For instance, announcements of the large scale asset purchase program (QE) of the Federal Reserve generally led to the appreciation of the South African currency, reduction in sovereign bond yields (especially during QE1), credit default swaps, reductions in interbank rate, and gains by the stock market. The announcements regarding the tapering (gradually stopping) of Fed's asset purchase programs essentially displayed the reverse effects of the asset purchase programs. It led to the depreciation of the rand, rise in CDS, increase in interbank rate, and decline in key stock market indices.

Just like the non-standard monetary policies of the Fed, the policy instruments followed by the ECB also had spillovers on various South African assets. Overall, the announcements of ECB's 'asset purchases' policies (e.g. 'Securities Markets Program', 'Outright Monetary Transactions', 'Covered Bond Purchases Programs') were followed by appreciation of the rand, falling sovereign bond yields as well as CDS, and a rise in stock market indices. Further, the 'liquidity provision' policy (e.g. 'Fixed Rate Tenders With Full Allotment', 'Long-Term Refinancing Operations', 'Foreign Currency Funding') and the 'collateral easing' programs (mainly comprising of 'Asset-Backed Securities') also had qualitatively similar impact to ECB's asset purchases programs, although the significance of the programs (and their specific instruments) had not been seen on all assets and also depended on the specification of the regressions used.

One key asset investigated, and was often insulated from ECB's key policy announcements, was the South African (3-month) money market rate. The results show an overall weak evidence for the 'international bank lending' channel between Eurozone and South Africa. From a diverse set of ECB's unconventional monetary tools, the instruments that shows a significant impact on the money market rate was the 'foreign currency funding' policy, which is part of ECB's 'liquidity provision' program. This instrument made large provision of foreign currencies (primarily US dollars but also other currencies) to banks in the Eurozone via liquidity swap arrangements with the US Fed and national central banks across Europe.

The results are generally in line with expectations - on the basis of how large scale asset purchase programs by the world's biggest central banks should affect other economies that tend to see significant capital inflows as a result. Conversely, the monetary policy tightening and the end of these policies reverses the flow of capital back to advanced economies. As discussed in the

chapter, this form of capital flow operates on a number of important transmission channels (e.g. international portfolio rebalancing, confidence, and credit channels). Through these channels, the effects of the asset purchase programs get transmitted to other (substitute) countries, where alternative assets that are targets for international investors could be found. For instance, the asset purchase programs such as QE and SMP end up boosting the confidence not only in their intended markets (i.e. the US and Eurozone capital market) but also international capital markets. Further, the prices of assets directly targeted by these unconventional monetary instruments will not be the only ones to be affected. Almost instantaneously, the prices of alternative assets at home (i.e. US and Eurozone) markets and also overseas capital markets will start to respond on the basis of international portfolio rebalancing channel - as investors redirect their capital from less lucrative (low yield) home market to overseas assets with significant returns, once they factor in risk factors overseas.

Further, the combination of the asset purchases and liquidity provisions programs with explicit policy signaling instruments (such as 'Forward Guidance'), enables markets to get clear 'policy signals' that central banks are committed to keeping rates low, banks capitalized, and economic activities high. Low central bank policy rates backed by a QE will send a much 'clearer' signal that the central bank will not easily reverse this policy, as it will be costly to do so - due to balance sheet exposures.[88]

To conclude, we observe clear evidence of spillovers from the so called 'unconventional' monetary policies adopted by the Fed and ECB as response to diverse forms of financial crisis witnessed since the recent 'Great Recession'. Yet, a detailed look at individual monetary policy instrument yields different results in terms of the impact and significance on individual South African financial assets examined by the chapter.

The chapter has used South Africa as a case study because it's an emerging economy with fairly developed domestic financial market and strong links to international capital markets. However, the findings could be relevant for other African countries which, in turn, have strong links to the South African economy (especially those in the southern African region). South Africa is a key player in the region by being a source of capital and an important trade partner. In fact, the country serves as an entry point for international capital to the wider sub-Saharan Africa region. Many South African banks and financial institutions as well as retail, telecom, construction, mining, etc. companies operate in many African countries. Therefore, the direct transmission of international monetary shocks to the country could have an indirect effect (or relevance) on neighboring countries with strong links to its economy.

The motivation of the chapter — apart from examining the vulnerability of small and financially open developing economies to external financial shocks — is the problem that monetary policy conducts of world's major central banks, especially the 'experimental' non-standard policies, have 'unintended' consequences for developing economies. It is often customary to talk about

[88] A sudden rate hike will be costly to a central bank that purchased significant quantity of assets under unsteralized asset purchase programs such as QE.

the 'contagion' of financial crisis (e.g. GFC) that originate in developed countries and move on to affect developing countries. However, the policy 'remedies' designed to deal with the crisis could themselves have downside risks for developing countries. The design and implementation of these policies largely accounted only for the impact on the respective domestic economies of the US and Eurozone, and not the wider world. Therefore, the additional objective of this chapter (and this line of research) is delivering caution to the policy makers and monetary authorities in advanced economies to carefully analyze the diverse potential impacts (intended and unintended) of new policy instruments, before they are implemented.

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