Leader followership in monetary policy coordination

Raputsoane, Leroi

3 April 2018

Monetary policy coordination leader followership

Leroi Raputsoane*

April 3, 2018

Abstract

This paper analyses the leader followership phenomenon in monetary policy coordination in South Africa, the Advanced, Developed and Emerging counties. The coordination of monetary policy in Advanced counties is examined in individual countries while such coordination in Developed and Emerging countries is examined in groups of countries. These countries comprise South Africa, United States, Euro area, United Kingdom and Japan while the groups of countries comprise the Developed, BRIC, Eastern Europe, East Asia and Latin American countries. The results show that monetary policy coordination is led by the United States and Developed countries, that monetary policy coordination in United Kingdom, Eastern European countries and the Euro area is intermediate while South Africa and Latin America are followers in monetary policy coordination. The results further show that Japan, BRIC and Eastern Europe coordinate monetary policy independent of the rest of the selected countries.

JEL Classification: C11, C70, E43, E58
Keywords: Central bank, Monetary policy, Causal Inference

*Leroi Raputsoane, lraputsoane@yahoo.com, Pretoria

Introduction

An established phenomenon in international macroeconomics are spillovers, or contagion effects, in particular from Advanced economies to Emerging and developing economies. The United States is often viewed as the originator of most contagion effects hence the popular use of the phrase, "When the U.S. sneezes, the rest of the World catches a cold." A case in point is the recent global financial crisis which manifested in the United States but subsequently reverberated to most economies across the World. Chen et al. (2016) and Salmeron (2016) argue that the 2008 global financial crisis demonstrated the interconnectedness of the World economy and the power of the United States economy to cause and to prevent a global economic depression. Belke and Gros (2005) and Georgiadis (2016) further argue that the belief that majority of policy makers, including the European Central Bank (ECB), follow the United States Federal Reserve's (the Fed's) monetary policy conduct is entrenched amongst market participants and commentators that the search for empirical support would seem trivial. For instance, following the onset of the global financial crisis in 2008, most global economies mirrored the actions of the United States' implementation of quantitative easing and a zero lower bound monetary policy and also followed suit in 2013 during the normalisation of accommodative monetary policy stance.

The leader followership phenomenon in global monetary policy coordination suggests the Stackelberg (1934) and Nash Jr (1950) equillibrium type real World applications of game theory. Belke and Gros (2005) provide the rationale for a leader followership relationship in international monetary policy coordination which include that the policy move by the United States' monetary authorities provide the followers with an important signal given the interconnectedness of global economic cycles as well as that the United States has historically demonstrated efficiency to spot the impending economic problems. Several studies document significant cross border spillovers, or contagion effects, of monetary policy conduct, in particular of the United States, on global macroeconomic variables that include output and inflation as well as the goods and services, financial and currency markets. These studies include Kim (2001), Belke and Gros (2005), Canova (2005), Belke and Cui (2010), Salmeron (2016), Chen et al. (2016) as well as Georgiadis (2016). In particular, Belke and Cui (2010) finds that the European Central

Bank (ECB) follow the Federal Reserve (the Fed) while Chen et al. (2016) find a significant impact of quantitative easing by the United States on both the Advanced and Emerging countries.

The preceding discussion demonstrates an interconnected global economy which is relevant for international macroeconomic management. The discussion further necessitates the understanding of the leader followership phenomenon in global macroeconomic policy coordination in general as well as the global monetary policy conduct in particular. This paper analyses the leader followership phenomenon in monetary policy coordination in South Africa as well as in Advanced, Developed and Emerging counties. The coordination of monetary policy in Advanced counties is examined in individual countries while such coordination in Developed and Emerging countries is examined in groups of countries. The findings in this paper are relevant for the global conduct of monetary policy in that will highlight the sources and recipients of global economic spillovers. Chen et al. (2016) suggests that spillovers are indiscriminate across countries while Chen et al. (2016) and Georgiadis (2016) find that countries with stronger fundamentals experience negligible effects due to spillovers. Thus they suggest that, consequently, it is the responsibility of individual countries to help dampen the effects of spillovers to their economies by strengthening the economic policy credibility and macroeconomic fundamentals.

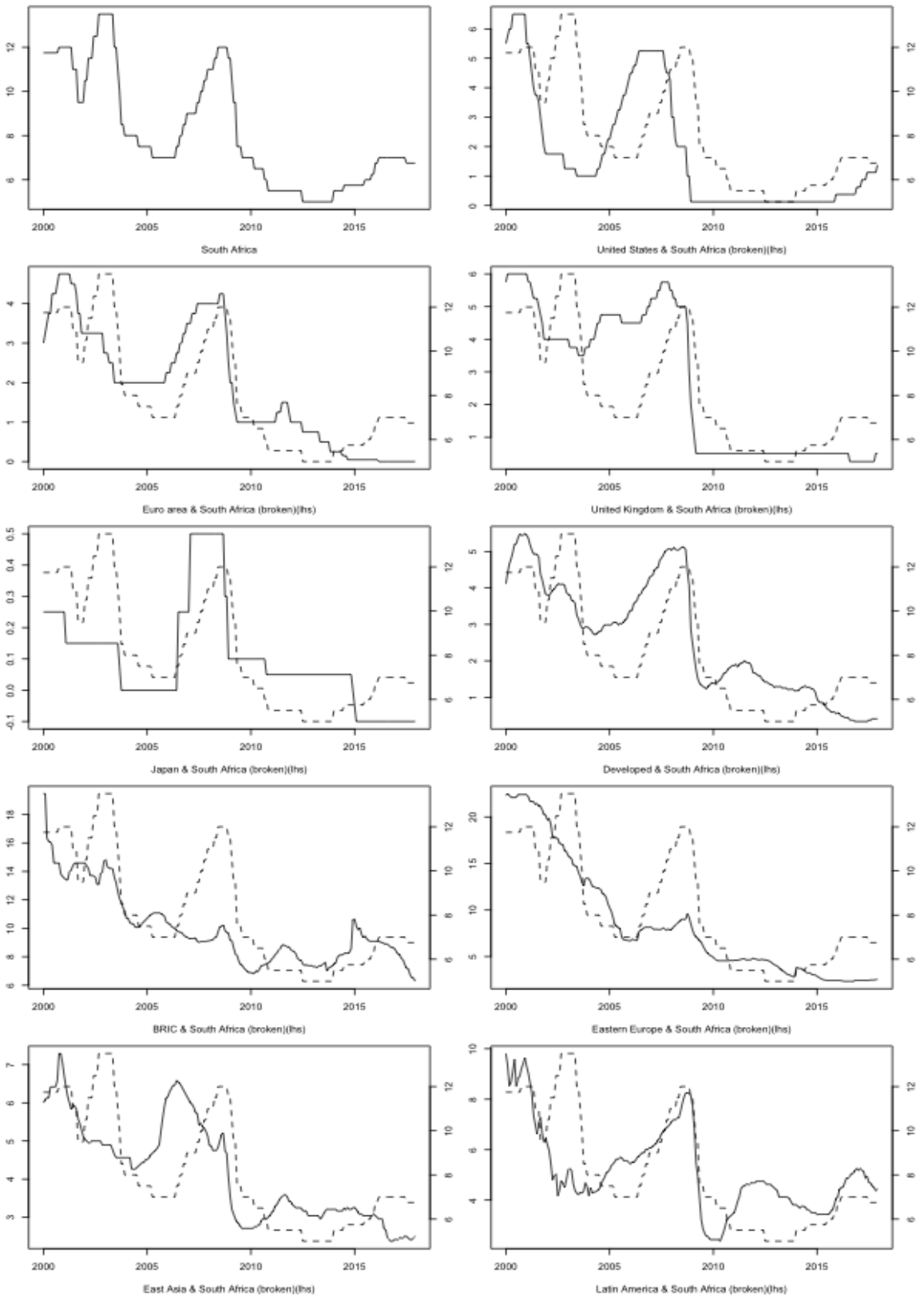
The paper is organised as follows. The next section discusses the data. This is followed by the methodology. Then its the discussion of the results and last is the conclusion.

Data

Monthly data spanning the period 2000 to 2017 is used. The data is sourced from Bank for International Settlements (BIS) database. The data consists of the monetary policy interest rates in 31 countries that include South Africa, United States, Euro area, United Kingdom, Japan, Developed countries, BRIC, Eastern Europe, East Asia and Latin America. The BRIC comprises the equally weighted average of monetary policy interest rates in Brazil, Russia, India and China, Eastern Europe comprises the equally weighted average of monetary policy interest rates in Czech Republic, Hungary, Poland, Romania and Turkey, East Asia comprises the equally weighted average of monetary policy interest rates in Hong Kong, Indonesia, South Korea, Malaysia, Philippines and Thailand while Latin America comprises the equally weighted average of monetary policy interest rates in Chile, Colombia, Mexico and Peru.

Figure 1 depicts the plots of monetary policy interest rates in the selected countries and in the groups of countries in the sample. The monetary policy interest rate in South Africa exhibits two distinct peaks in 2003 and 2008. The interest rate dropped somewhat at the beginning of 2001 but started to rise again later in the same year reaching a peak in late 2002. It then dropped dramatically from early 2003 reaching a low in early 2005. From early 2006, the interest rate increased steadily and peaked in the middle 2008 before it dropped again dramatically to late 2010 where it remained range bound until late 2013. It then increased steadily to the end of 2016 before dropping somewhat in 2017. As with the monetary policy interest rate in South Africa, the monetary policy interest rates in majority of the countries in the sample also show two distinct peaks in 2003 and 2008. The downward trend in monetary policy interest rates that ended in 2001 followed the Asian financial crisis that beset much of East Asia in 1998. The renewed upward trend in the monetary policy interest rates at the end of 2001 coincide with the effects of the 9/11 attacks in 2001 and the South American economic crisis in 2002 as well as the war in Iraq in 2003. These events caused uncertainty in the World oil market which increased the price of oil and consequently led to increased global inflationary pressures. The upward trend in monetary policy interest rates from 2005 largely tracked the overheating United States housing market and the rapidly increasing oil prices that culminated into the 2008 global financial crisis and consequently the rapid decrease in monetary policy interest rates in majority of the countries.

Monetary policy interest rates stayed flat in many countries between 2009 and 2013 saving the Euro zone countries in particular that were affected by the 2011 sovereign debt crisis. Majority of the countries increased their monetary policy interest rates, in particular the Euro area and most of the Developed countries as well as Emerging economies, excluding the United States, United Kingdom, Japan and South Africa. Following the announcement to tapper quantitative easing by the United States in 2013, the monetary policy interest rates of in particularly the Emerging economies decoupled from those in Advanced countries. The announcement sparked strong market reactions and an increase in the monetary policy interest rates in majority of the Emerging economies. The monetary policy normalisation in the United States and domestic economic problems elsewhere in 2015 caused monetary policy interest rates to increase in the United States, Latin America as well as South Africa.



Notes: Own calculations. The set of countries comprise South Africa, United States, Euro area, United Kingdom, Japan, Developed countries, BRIC, Eastern Europe, East Asia and Latin America. See above for detailed variables description.

Figure 1: Plots of the variables

Methodology

The leader followership phenomenon in monetary policy coordination in South Africa, Advanced counties as well as developing and Emerging countries is modeled using Causal Inference analysis. Causal Inference addresses the "correlation does not imply causation" argument in economic empirical analysis similar to the Granger (1969) causality test. According to Buehlmann et al. (2012), Causal Inference models infer information about the causal structure from observational data allowing the deduction of which variables could or could not be a cause of some variable of interest in a system. Scutari and Denis (2014) argue that Causal Inference is a part of Bayesian Networks with a focus on parameter learning and inference. Bayesian networks are graphical structures for representing the probabilistic relationships among a set of variables and performing probabilistic inference with those variables.

Following Buehlmann et al. (2012) and Karvanen and Tikka (2017), a causal model is specified as

$$\mathrm{M} = (\mathrm{V}, \mathrm{F}) \tag{1}$$

where V is a set $(\mathrm{V}_1, \ldots, \mathrm{V}_n)$ of endogenous variables and the functions F is a set $(\mathrm{f}_{\mathrm{V}_1}, \ldots, \mathrm{f}_{\mathrm{V}_n})$. Each f_i represent the value of V_i given the entire set of F has a unique solution. The entire set of F is

$$\mathrm{V}_i = \mathrm{f}_{\mathrm{V}_i}\left(\mathrm{pa}_{\mathrm{V}_i}\right) \quad , \quad i = 1, \ldots, n \tag{2}$$

where pa a realisation of the unique minimal set of variables $\mathrm{pa}_{\mathrm{V}_i}$ sufficient for representing f_i. There exists a corresponding graph

$$\mathrm{G} = (\mathrm{V}, \mathrm{E}) \tag{3}$$

for each causal model M. The edges E and the notes V in graph G are determined by the by the functional relationships between the variables V in the causal model M.

The causal structure of such a system described by many variables can be represented by a directed acyclic graph (DAG) where each node represents a variable and each directed edge represents a direct cause. A causal graph is an ordered pair $\mathrm{G} = (\mathrm{V}, \mathrm{E})$, where V and E are sets such that

$$\mathrm{E} \subset ((\mathrm{X}, \mathrm{Y}) \,|\mathrm{X} \in \mathrm{V}, \mathrm{Y} \in \mathrm{V}, \mathrm{X} \neq \mathrm{Y}) \tag{4}$$

where V are the nodes of G and E are the edges of G. A graph G is directed if E consists of ordered pairs (X, Y) where node V_2 is a child of node V_1 if G contains an edge from V_1 to V_2 so that $(\mathrm{V}_1, \mathrm{V}_2) \subset \mathrm{E}$. Similarly, V_2 is a parent of V_1 if $(\mathrm{V}_2, \mathrm{V}_1) \subset \mathrm{E}$. The child parent relationship is denoted $\mathrm{V}_1 \rightarrow \mathrm{V}_2$, where V_1 is a parent of V_2 and V_2 is a child of V_1. This child parent relationship can also be denoted $\mathrm{V}_2 \leftarrow \mathrm{V}_1$. A node V_2 is a descendant of V_1 in G if there exists a directed path H from V_1 to V_2 and $\mathrm{H} \subset \mathrm{G}$. Respectively, V_2 is an ancestor of V_1 in G, if there exists a directed path H from V_2 to V_1 and $\mathrm{H} \subset \mathrm{G}$. A graph $\mathrm{G} = (\mathrm{V}, \mathrm{E})$ is acyclic if it does not contain cycles, otherwise it is connected.

Denote the variable corresponding to node i in the graph G by X. Similarly, denote the variable corresponding to node j in the graph G by Y. Suppose that, by external intervention, we set the variable X to some value $\tilde{\mathrm{x}}$ and then to $\tilde{\mathrm{x}} + 1$. The average change in variable Y is the causal effect $C(\mathrm{X}, \mathrm{Y}, \tilde{x})$ of X from $\mathrm{X} = \tilde{\mathrm{x}}$ on Y defined as

$$\mathrm{C}(\mathrm{X}, \mathrm{Y}, \tilde{x}) = \mathrm{E}(\mathrm{X}|do(\mathrm{Y} = \tilde{\mathrm{x}} + 1)) - \mathrm{E}(\mathrm{X}|do(\mathrm{Y} = \tilde{\mathrm{x}})) \quad \text{or} \tag{5}$$

$$\mathrm{C}(\mathrm{X}, \mathrm{Y}, \tilde{\mathrm{x}}) = \frac{\delta}{\delta \mathrm{X}} E(\mathrm{Y}|do(\mathrm{X} = \tilde{\mathrm{x}})|_{\mathrm{x}=\tilde{\mathrm{x}}} \tag{6}$$

where $do(\mathrm{X} = \tilde{\mathrm{x}})$ is the Pearl (2003) *do* operator. Equations 5 and 6 are equivalent and do not depend on $\tilde{\mathrm{x}}$ if the causal relationships are linear. Therefore the causal effect of $do(\mathrm{X} = \tilde{\mathrm{x}})$ on Y in M is the marginal distribution of Y in $\mathrm{M}_{\tilde{\mathrm{x}}}$ denoted

$$\mathrm{E}\left(\mathrm{Y}|do(\mathrm{X} = \tilde{\mathrm{x}})\right) = \mathrm{E}_{\mathrm{x}}\left(\mathrm{Y}\right) \tag{7}$$

The interventions $do(\mathrm{X} = \mathrm{x})$ on a causal model M alter the functional relationships between its variables and produces a new model

$$\mathrm{M}_{\mathrm{x}} = (\mathrm{V}, \mathrm{F}_{\mathrm{x}}) \tag{8}$$

where F_{x} is obtained by replacing F for each X with a constant function. The constants are the x values of the interventions $do(\mathrm{X} = \mathrm{x})$.

Refer to Pearl (1995), Pearl (2003), Buehlmann et al. (2012) and Karvanen and Tikka (2017) for a more detailed treatment of Causal Inference. Although the analysis in this paper uses Causal Inference analysis, majority of the studies in the literature use cointergrated Vector Error Correction (VECM) models, variants of the Vector Autoregressive (VAR) that include structural and global VARS as well as two country Dynamic Stochastic General Equilibrium (DSGE) models. The advantage of Causal Inference over the preceding Granger (1969) causality type methods that solely rely on the lead lag structure is that Causal Inference emphasises both the direct and indirect sequentiality in the causal structure of leader followership in monetary policy coordination. See Geiger et al. (2015) for a detailed discussion on the advantages of Causal Inference over the Granger (1969) causality type methods.

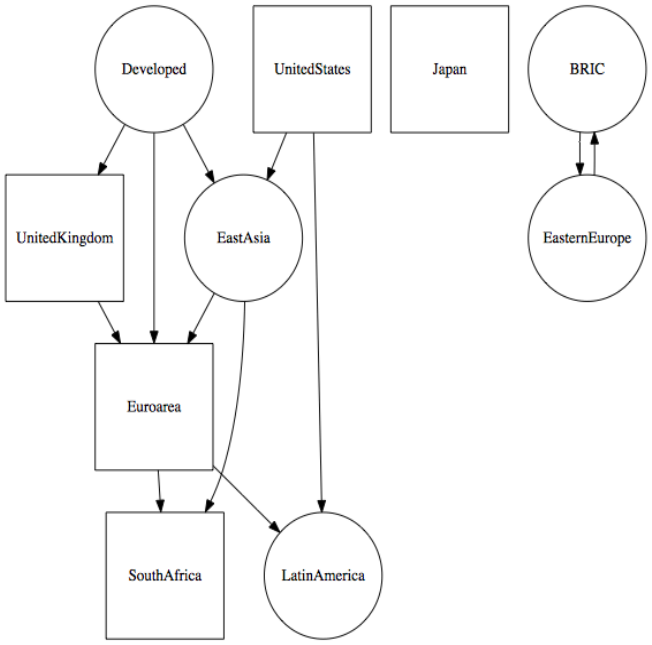
Results

Causal Inference was used to analyse the leader followership phenomenon in monetary policy coordination in South Africa, Advanced counties as well as Developed and Emerging countries. As discussed above, the coordination of monetary policy in Advanced counties is examined in individual countries while the coordination of monetary policy in Developed and Emerging countries is examined in groups of countries. These countries comprise South Africa, United States, Euro area, United Kingdom, Japan while the groups of countries comprise Developed countries, BRIC, Eastern Europe, East Asia and Latin America. Thus the sample consists of 10 continuous variables and 216 observations. The results are presented using a directed acyclic graph (DAG) and the causal effects following Buehlmann et al. (2012) while network visualisation follows Iannone (2018). A directed acyclic graph (DAG) shows the nodes that represent the variables and the directed edges that represent the direction of the cause of effect. The causal effects represent the marginal effects of the variables on each other in the system.

Figure 2 depicts a directed acyclic graph (DAG) and the causal effects of monetary policy coordination in South Africa, Advanced countries as well as Developed and Emerging groups of countries. The causal structure was generated using a conditional independence test with the significance level of 5 percent. The results show that, over the sample period, the coordination of monetary policy starts in the United States and in Developed countries. The monetary policy coordination in the United States is then followed by monetary policy coordination in East Asian countries directly as well as monetary policy coordination in Latin American countries both directly and indirectly. The monetary policy coordination in Developed countries is followed by a similar monetary policy coordination in United Kingdom, East Asian countries and the Euro area. However, monetary policy coordination in the Euro area also follows monetary policy coordination in United Kingdom and East Asian countries.

The monetary policy coordination in the Euro area is subsequently followed by monetary policy coordination in South Africa and in the Latin American countries. As with the Euro area and Latin America, monetary policy coordination in South Africa is also follows monetary policy coordination in the East Asian countries both directly and indirectly. The monetary policy coordination in the BRIC countries and in Eastern European countries show a bidirectional causal effect implying that the monetary authorities in these groups of countries conduct monetary policy in an interdependent manner. The monetary policy coordination in Japan is independent and does not precede nor follow monetary policy coordination of any country or a group of countries in the sample. Both the direct and indirect causal effect in monetary policy coordination are observed from the United States, Developed countries and East Asian countries to the Latin American countries, Euro area and South Africa, respectively. A monetary policy coordination that is independent of all the other countries in the sample is observed in Japan as well as between the BRIC countries and Eastern European countries while an interdependent monetary policy is also realised between the BRIC countries and Eastern European countries.

There does not seem to be a dependence link between monetary policy coordination in United States and monetary policy coordination in Developed countries, United Kingdom, Japan, the BRIC and Eastern European countries. Such a link also does not seem to exist between monetary policy coordination in Developed countries and monetary policy coordination in United States, Japan, the BRIC and Eastern Europe countries. Monetary policy coordination in United States, United Kingdom, South Africa, Developed countries, East Asian countries, Euro area and Latin American countries is linked in descending order of importance of causal nexus while monetary policy coordination in these countries is not linked to monetary policy coordination in Japan, BRIC countries and Eastern Europe. Thus the United States and Developed countries lead monetary policy coordination while South Africa and Latin American countries are followers. Japan, the BRIC and Eastern European countries coordinate monetary policy independent of the other the other countries and groups of countries.



Directed acyclic graph (DAG)

United States

SouthAfrica	0.691897
Euroarea	0.583635
UnitedKingdom	0.942188
Japan	0.044806
BRIC	0.749338
Developed	0.638960
EasternEurope	1.904320
EastAsia	0.598578
LatinAmerica	0.646738

Euro area

SouthAfrica	1.840379
UnitedStates	1.000000
UnitedKingdom	0.000000
Japan	-0.022705
BRIC	0.021724
Developed	0.000000
EasternEurope	4.645213
EastAsia	-0.299034
LatinAmerica	1.460967

Causal effects

Notes: Own calculations. A directed acyclic graph (DAG) shows the nodes that represent the selected countries and the directed edges represent the direction of the causal effects of monetary policy coordination among the selected countries. The causal effects represent the marginal effects of monetary policy coordination among the selected set of countries.

Figure 2: Causal Inference results

The results of the covariance matrix shows that when United states monetary authorities move the monetary policy rate by 1 percentage point, South Africa, Latin American countries, East Asian countries and the Euro area move their monetary policy rates by statistically significantly 69 basis points, 65 basis points, 60 basis points and 58 basis points, respectively, in descending order of importance. A similar move by United States monetary authorities of the monetary policy rate is not statistically significant to the United Kingdom, Developed countries, Japan, the BRIC countries and Eastern Europe countries given that the coordination of monetary policy in the United States and in these counties are independent. The results of the covariance matrix further shows that when the Euro Area monetary authorities move the monetary policy rate by 1 percentage point, the monetary authorities in South Africa and the Latin American countries move their monetary policy rates by statistically significantly 1.8 percentage points and 1.5 percentage points, respectively, in descending order of importance. A similar move by Euro Area monetary authorities of the monetary policy rate is not statistically significant to the United states, United Kingdom, Developed countries, Japan, the BRIC countries and Eastern Europe given that their coordination of monetary policy are independent to that of Euro Area.

The results generally show that Developed countries and the United States lead monetary policy coordination while South Africa and the Latin American countries are followers in monetary policy coordination. Among the Advanced economies, there does not seem to be a link between monetary policy coordination in United States and monetary policy coordination in Developed countries, United Kingdom, Japan, the BRIC countries and Eastern European countries. Monetary policy coordination in the Euro area only lead monetary policy coordination in South Africa and the Latin American countries. Japan, the BRIC countries and Eastern European countries coordinate monetary policy independent of the rest of the selected countries and groups of countries. The results are largely in line with the findings in the literature that include Belke and Gros (2005), Canova (2005), Belke and Cui (2010), Chen et al. (2016) as well as Georgiadis (2016) saving the minor differences on methodological grounds. Thus South Africa and the Latin American countries in particular need to strengthen their economic policy credibility and macroeconomic fundamentals given that Chen et al. (2016) and Georgiadis (2016) find that countries with stronger fundamentals experience negligible effects due to spillovers.

Conclusion

This paper analysed the leader followership phenomenon in monetary policy coordination in South Africa as well as in Advanced, Developed and Emerging counties. The coordination of monetary policy in Advanced counties was examined in individual countries while such coordination in Developed and Emerging countries was examined in groups of countries. These countries comprise South Africa, United States, Euro area, United Kingdom, Japan, Developed countries, BRIC, Eastern Europe, East Asia and Latin America. The results show that monetary policy coordination is led by the United States and Developed countries, that monetary policy coordination in United Kingdom, Eastern European countries and the Euro area is intermediate while South Africa and the Latin American countries are followers in monetary policy coordination. The results further show that Japan, the BRIC countries and Eastern European countries coordinate monetary policy independent of the rest of the selected countries.

References

Belke, A. and Cui, Y. (2010). US-Euro Area Monetary Policy Interdependence: New Evidence from Taylor Rule based VECMs. *The World Economy*, 33(5):778–797.

Belke, A. and Gros, D. (2005). Asymmetries in Transatlantic Monetary Policy Making: Does the ECB Follow the Fed? *Journal of Common Market Studies*, 43(5):921–946.

Buehlmann, P. et al. (2012). Causal Inference Using Graphical Models with the R Package pcalg. *Journal of Statistical Software*, 47(11):1–26.

Canova, F. (2005). The Transmission of US Shocks to Latin America. *Journal of Applied econometrics*, 20(2):229–251.

Chen, Q., Filardo, A., He, D., and Zhu, F. (2016). Financial Crisis, US Unconventional Monetary Policy and International Spillovers. *Journal of International Money and Finance*, 67:62–81.

Geiger, P., Janzing, D., Gong, M., Schoelkopf, B., and Zhang, K. (2015). Causal Inference by Identification of Vector Autoregressive Processes with Hidden Components. In Bach, F. and Blei, D., editors, *International Conference on Machine Learning*, volume 32, pages 1917–1925.

Georgiadis, G. (2016). Determinants of Global Spillovers from US Monetary Policy. *Journal of International Money and Finance*, 67:4161.

Granger, C. W. (1969). Investigating Causal Relations by Econometric Models and Cross Spectral Methods. *Econometrica*, 37(3):424–438.

Iannone, R. (2018). DiagrammeR: Graph/Network Visualization. *R package*, 1.0.0. CRAN.R-project.org.

Karvanen, J. and Tikka, S. (2017). Identifying Causal Effects with the R Package causaleffect. *Journal of Statistical Software*, 76.

Kim, S. (2001). International Transmission of US Monetary Policy Shocks: Evidence from VAR's. *Journal of Monetary Economics*, 48(2):339–372.

Nash Jr, J. F. (1950). The bargaining problem. *Econometrica*, pages 155–162.

Pearl, J. (1995). Causal Diagrams for Empirical Research. *Biometrika*, 82(4):669–688.

Pearl, J. (2003). Causality: Models, Reasoning and Inference. *Econometric Theory*, 19(46):675–685.

Salmeron, A. M. (2016). Monetary Policy: From Independence to Interdependence. *Dossier*, September:34–35. CaixaBank Research.

Scutari, M. and Denis, J. B. (2014). *Bayesian Networks with Examples in R*. Chapman & Hall Press.

Stackelberg, V. H. (1934). *Marktform und gleichgewicht*. Springer.