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Macroeconomic dynamics and Panel VAR -Analysis in Developing Countries

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Abstract
This study applied the Panel Vector Autoregressive Model (PVAR) to examine the macroeconomic dynamics impact of variables. PVAR examined the results by taking the Data from seven Developing countries; Indonesia, Mexico, Chile, Denmark, China, Israel, and India. Based on this study, five variables are included to run the Panel VAR i.e., Inflation, short-term interest rate, RGDP, Official reserves, and exchange rate Volatility. Developing countries faced lots of difficulties thus examining which variable reflects a high effect to improve countries' infrastructure.Therefore, this study performs the Panel VAR, Variance decomposition, and Impulse response thus stating that inflation and short-term interest have a high impact on developing countries, whereas, RGDP and official reserves have a low impact, resultantly the volatility rate fluctuating highly when little change in inflation and interest rate occurs. Additionally, monetary policy, foreign transactions, and economic growth are also included in this paper. Because inflation relates to the monetary policy, short-term interest rate relates to investors' opportunity, RGDP relates the economic growth, and official reserves reflect foreign transactions or support.
Keywords: Panel VAR, Exchange rate volatility, Inflation, Real GDP, Official reserves, Economic impact, Macroeconomic variables

1. Introduction

Almost everybody agreed that economic harm is caused by the exchange rate fluctuation, where developing countries faced high relative costs. Understanding the concept of exchange rates and their fluctuation becomes an important part to determine the effect on economic variables (Beckmann & Czudaj, 2022; Imran et al., 2021). The exchange rate is not only related to the macroeconomic variables of the domestic country but it also has a strong link with exports, where exports are measured in a different frequency than imports in terms of fluctuation of volatility rate (Aslan et al., 2021).

Exchange rate appreciation and depreciation reflected the controversial impact on domestic activities because of international competitiveness (Beckmann & Comunale, 2021). In Chinses markets exchange rate volatility has a significant effect on environmental policy uncertainty, reflecting that exchange rates fluctuate highly when there are uncertain economic policies made which may cause economic degradation (Chen et al., 2020). Exchange rate volatility either positive or negative harms international trade activities, however, the magnitude of negative volatility is higher than the positive volatility exchange rate (Dada, 2021; Imran et al., 2023). Dada also examined that domestic income has a positive impact, meanwhile, the real volatility rate has a pessimistic and significant effect on international transactions.

The pull and push factor theory identifies factors that affect international trade flows, including those that push trade away from a delivering economy and those that pull trade towards a collecting economy. One crucial macroeconomic factor that affects both developed and developing countries is the exchange rate, which has a significant impact on overall economic activity (Ogundipe et al., 2019; Imran et al., 2022).

Research on the relationships between macroeconomic variables in developed and developing countries has been limited and has not included these variables simultaneously. To fill the gap, research is needed to understand which variables are more or less focused in the context of developing countries. Additionally, previous studies on macroeconomic dynamics have used limited panels of countries or short periods, calling for more comprehensive studies using longer periods and larger panels to better understand the complexities of macroeconomic dynamics in developing countries. More robust and comprehensive studies are needed to understand the complex and dynamic relationships between macroeconomic variables in developing countries. Most previous studies have used limited panels of countries or short periods, which may not accurately capture these relationships. Larger panels of countries and longer periods of analysis are required for a better understanding of the unique features and complexities of macroeconomic dynamics in developing countries.

Firstly, this study is concerned with the Panel VAR model, where the inflation, short-term interest rate, official reserves, real GDP, and volatility are determined. Volatility in terms of change in the exchange rate, because change reflects two sides positive fluctuation and negative fluctuation.

Secondly, the concern of this study is to determine which variable shows a higher impact or play the role in economic development. Specifically, with which variable exchange rate fluctuates
highly. Lastly, how the variables affect the economy of developing countries, which variable reflects the major effect concerning the exchange rate volatility. Additionally, the research gap found that major and minor variables of developing countries are not explored yet. Particularly, the study of macroeconomic variables in developing countries is needed to be highlighted to
improve the country's infrastructure.

This study builds the Panel VAR among macroeconomic variables. A study (Grossmann et al., 2014) also performed the Panel VAR but they compared the developed and developing countries. Another study (Nuhu, 2021) used only inflation to imitate the effect of volatility through rate fluctuations. However, hardly some studies conducted to view the impact in developing countries by using the Panel VAR to discuss the impact among developing countries including major economic variables simultaneously. The study chooses the Panel VAR because using PVAR has its benefits. First, it gives information on all relationships among variables directly. Second, VAR addresses the endogeneity problem. Third, variance decomposition provides a clear-cut self-explanation of variables. Finally,

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the impulse response function gives a direct measure to analyze the significant impact of a particular variable. Section 2 covers the Literature Review, Section 3 covers the Methodology & Data, Section 4 covers the Data Analysis, and Section 5 Covers the Conclusion.

2. Literature Review

(Barguellil et al., 2018) analyzed the fluctuation of exchange rate volatility affected economic growth, the sample size was 45 developing and emerging countries and applied to generalize Autoregressive conditional heteroskedasticity (GARCH). (Žídek & Šuterová, 2017), the study stated that real and nominal exchange rate volatility had a pessimistic and significant impact on economic expansion. (Nuhu, 2021), examined that exchange rate volatility affected inflation, the study was conducted in Switzerland on quarterly data by using the structural vector autoregressive
(SVAR) technique. And examined that pressure on increasing or decreasing inflation is affected by fluctuations in exchange rates. Exchange rate volatility can be recognized through variation in standard deviation because standard deviation is a tool to determine the shocks (Grossmann et al., 2014; Imran et al., 2024). Economic policies and reserves are linked directly with each other (Sula & Oguzoglu, 2021). The study used the linear-log nature model, which stated that maintaining and increasing the reserves lead to economic growth. On other hand, fluctuation in rates would be reduced by the increase in foreign official reserves (Dominguez et al., 2013). In addition, reserves have the impact of exchange rate volatility, (Ramachandran & Srinivasan, 2007) stated that asymmetrical exchange rate intervention where the aggressive purchase of appreciated currency and insignificant effect of depreciated currency affected the pool of reserves. (Umar et al., 2021) used the GARC technique, and the findings support the conclusion that daily returns exhibit substantial volatility. Because daily returns are forecast over a short time, most investors respond to the news pretty quickly. Others, however, take some time to comprehend it and integrate it into the prices, which keeps volatility high. Thus, the volatility shows signs of asymmetry as well. (Aimer, 2019) used the generalized Autoregressive conditional heteroskedasticity (GARCH) technique applied to see the relationship between exchange rate volatility and equity return. Their study stated that the larger exchange rate variation for stock market returns indicates that fluctuations have a substantial effect on the dynamics of the conditional returns on equity market returns. (Liu & Lee, 2022) used the uncovered interest rate to reflect the impact of the interest rate on the exchange rate. Where the study found that the exchange rate was substantially affected by short-term interest rates. Thus, their results indicate that the interest rate parity theory might hold in some subperiods but not throughout the full sample period. (Beckmann & Czudaj, 2022) examined that interest rate is an essential factor to predict the fluctuation of the exchange rate.

Determining the variables which impact on exchange rate makes sense to recreate the economic policies, the study also found the GDP impact on the exchange rate which shows a pessimistic and significant impact on exchange rate volatility (Kilicarslan, 2018). According to the pull and push factors theory, exchange rate volatility is determined by (Ogundipe et al., 2019). Their study used the vector autoregressive model and examined that GDP had high variation; therefore, GDP explained the maximum variation toward the exchange rate volatility. Beckmann & Czudaj analyzed that high GDP leads toward currency appreciation and low inflation leads toward currency depreciation relative to the US. In Addition, (Grossmann et al., 2014) found the four variables which fluctuate the exchange rate highly; real growth domestic product, official reserves, interest rate, and return on equity where the high frequency of exchange rate reflected the fluctuation
in exchange rate volatility. On other hand, in previous studies, inflation was not considered. (Nuhu, 2021) studied that inflation was impacted by fluctuation in the exchange rates, where he found a progressive and substantial impact of inflation on exchange rate volatility.

3. Methodology & Data

This study considered the macroeconomic variables using Panel VAR are inflation (Nuhu, 2021), short-term interest rate, official reserves, real GDP, and Volatility (Grossmann et al., 2014). In the literature review variables discussion, the effect of fluctuation in the rate of volatility is also seemed by manufacturing industries in terms of trading (Ayobami, 2019). Further, the study stated that exchange rate volatility had a substantial impact on imports and exports. Moreover, inflation has an impact on monetary policy, an increase in money supply increases inflation which makes the
expensive trading cost (Abuselidze, 2019), the short-term interest rate is a valuable variable that has an impact on investors' investment opportunities (Hamilton, 2018), official reserves (including gold) have an impact on foreign transactions, higher the reserves stated that country has backhand plans to meet with uncertainties and protect wisely, reserves also maximize the probability of other country's support (Andriyani et al., 2020), and real GDP has an impact on economic growth, domestic products are directly linked with the exchange rate, higher volatility had a harsh impact on developing countries due to slow recovery to meet with uncertainties (Morina et al., 2020).

Table 1: Data measurement

Inflation	=(Countryinf-USinf)/USinf
Short-term Interest rate	$=(Country_{IR}-US_{IR})/US_{IR}$
Official Reserves	$=(Country_{ORES}-US_{ORES})/NGDP$
RGDP	$=(Country_{RGDP}-US_{RGDP})/US_{RGDP}$
Volatility	$=Ln\ (Exchange\ rate_{t} - Exchange\ rate_{t-1})$

Panel VAR is not restricted to reflect the effect of the independent on the dependent variable. Therefore, the output of Panel VAR is concerned with all dependent variables and independent variables simultaneously see Appendix Table 6. Moreover, the Real GDP growth rate and short-term interest rate are considered by IMF and data is measured relative to the US. Real GDP growth is

considered because it adjusts for inflation or deflation. Short-term interest rate is taken because developing countries' even short-term interest rate fluctuates more highly than developed countries. The official reserves assets ratio is measured by dividing the official reserves by nominal GDP (NGDP), Official reserves taken from the world bank, and nominal GDP taken from IMF. Inflation has been taken from OECD, calculated concerning the US, see Table 1.

In Panel VAR all variables are considered endogenous, where there are five variables Inflation (relative to US), IR1(comparative to US), Official reserves (difference in reserves comparative to US), RGDP (relative to US), and Volatility (log change in exchange rate relative to US), See Table 1. Along with it, the unit root test (Appendix table 2), exchange rate volatility (Appendix table 3), Descriptive statistic (Appendix Tables 4 & 5), PVAR (1) output (Appendix table 6) variance decomposition (Appendix table 7), exchange rate volatility (Appendix Fig 1) and impulse responses show the direction (Appendix Fig 2).

At the first lag structure, PVAR (1) Output is shown in Appendix Table 6. Thus, equation (1) is adapted from (Abrigo et al., 2016).

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \cdots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_i + e_{it}$$

$$i \in \{1, 2,...,N\}, t \in \{1, 2,...,T_i\} \quad (1)$$

(Abrigo & Love, 2016), 'Where Y_{it} is a (1×k) vector of dependent variables, X_{it} is a (1×L) vector of exogenous covariates, and u_i and e_{it} are (1 × k) vectors of dependent variable-specific panel fixed effects and idiosyncratic errors, respectively. The (k×k) matrices A_1, A_2,..., A_{p-1}, Ap, and the (L×k) matrix B are parameters to be estimated. In equation (1), "volatility", "inflation", "interest rate", "RGDP", and "official reserves" are the variables interested in this study, and the subscript "i" denotes the cross-sectional unit (e.g., country or region), while "t" denotes the time period, where only lag 1 is considered for simplification purpose. Therefore, in this study, Equation (1) becomes,

$$\text{Volatility}_{it} = \text{Volatility}_{it-1}A_1 + \text{Inflation}_{it-1}B_1 + \text{Interest rate}_{it-1}C_1 + \text{RGDP}_{it-1}D_1 + \text{Official Reserves}_{it-1}E_1 + u_i + e_{it}$$

Similarly, when the dependent variable is Inflation then the expression of equation (1) is changed according to included variables of this study. Apart from it, A_1, B_1, C_1, D_1, and E_1 are the coefficients of variables.

3.1. Unit Root Analysis

Unit root test is done where data of variables are taken from OECD, World Bank, and IMF. Table 1 shows the Unit root test using Augmented Dickey-Filler (ADF) test and lag length selection through Schwarz's Information criteria (SIC), where the Null Hypothesis is variables have a unit root and the Alternative is variables do not have a unit root. In this study, Data is stationary thus variables are significant, see Appendix Table 2. Additionally, this study used Eviews 10 to determine the results.

3.2. Exchange rate Volatility

This study examines the exchange rate volatility of seven developing countries using annual panel data from 2005 to 2020. To measure volatility, exchange rates are directly used and applied to the

logarithm instead of standard deviation, which reflects only positive signs and hinders interpretation. The study is concerned with the real effects of both decreased and increased volatility rates, as shown in Appendix Table 3, which includes negative values. The results indicate that volatility patterns are reflected in Figure 1, with fluctuation not only increasing but also decreasing. The impact of domestic exchange rate fluctuation on economic growth is dynamic, with higher volatility indicating higher risk and economic growth suffering, as seen in the positive volatility of five countries in 2019 except for Indonesia and Israel, during the pandemic.

3.3. Descriptive Analysis

Mexico has a higher mean i.e., 0.040239, but in terms of stability Mexico's standard deviation is high see Appendix Table 4. In this regard, this study found that based on the results, China is the most stable country due to a lower standard deviation among all other developing countries. Apart from calculations, China is a popular and stable country, thus based on the world's knowledge measurements this study also supports the international argument. Further, the Macroeconomic variable of real GDP and Inflation is considered as a more important variable based on mean see Appendix 5. However, official reserves and volatility is more stable variable

for developing countries due to low standard deviation. Hence, this study examined that for developing countries official reserves and volatility are more stable variables to improve the economic conditions and should be focused on more than other variables.

3.4. PVAR (1) output

Based on t-value significance, the coefficient of inflation is higher and significant when the dependent variable is volatility i.e., 1.96 < 2.39703. In this context, small changes in inflation have a large significant impact on volatility. Alternatively, the coefficient of RGDP is high but not significant when ORES is the dependent variable, thus it shows that official reserves do not change, whenever real GDP changes (see Appendix table 6). Therefore, PVAR (1) results vary when effects and impact on variable changes. Comparatively, (Grossmann et al., 2014) study gave a conclusion based on volatility in terms of frequency of standard deviation where high and low volatility were measured from the perspective of developed and developing countries, where inflation was not focused. However, in this study only developing countries are focused on where all five variables play a significant role based on PVAR results.

3.5. Variance Decomposition

The study employed variance decomposition to analyze the contribution of each variable to the total variance in the panel VAR model. By decomposing the variance of each variable into contributions from the other variables in the system, the study aimed to understand the relative importance of each variable in the system. Using the Cholesky order, the study followed a specific sequence of variables - inflation, short-term interest rate (IR), official reserves (ORES1), real GDP (RGDP), and volatility for each variance decomposition. The results, as shown in Appendix Table

7, indicates that inflation explains 72.28% of its variance, with interest rates, official reserves, real GDP, and volatility explaining 13.91%, 0.76%, 6.35%, and 6.68% of their variances, respectively. Interestingly, official reserves and real GDP demonstrate high variation, while the response of other variables is low in that context, suggesting that these variables have a more significant impact on the system's overall variance. This study also found that the results remained consistent when the variables' effects were analyzed in various directions. The percentage of variation explained by each variable was found to be different but still in the same direction. For example, inflation's response to inflation was 72%, while interest rates, official reserves, real GDP, and volatility had response

rates of 44%, 90%, 91%, and 86%, respectively, thus RGDP explains high variation than the rest of the variables. Comparatively, (Grossmann et al., 2014) examined that Volatility explained only 33% of the variation and all other variables had a large impact on the economy of developing countries. (Nuhu, 2021), stated that inflation remained high variation which change the volatility. The findings of this study suggest that official reserves and real GDP explain the high variation and therefore play a critical role in the panel VAR model, and their effects remain low when other variables are linked.

3.6. Impulse Response

Impulse response analysis is a widely used tool in macroeconomics to investigate how a system of variables responds to a shock in one of the variables. In this particular study focusing on developing countries, panel VAR analysis was employed to examine the relationship between inflation, real GDP, official reserves, short-term interest rates, and volatility. Fig 2 displays the impulse response of all five variables, showing different patterns and directions of movement with high and low fluctuations. The study found that the responses of official reserves, interest rates, and real GDP to volatility were negative, while the response of interest rates to inflation was also negative but more pronounced than other variables. The study also found that the response of volatility to the shock in short-term interest rates was positive and significant, indicating a destabilizing effect on the macroeconomy. This underscores the importance of considering the impact of monetary policy on both the real economy and financial stability in developing countries when conducting panel VAR analysis. Comparatively, results somehow differ from those (of Grossmann et al., 2014), in that study RGDP responded positively as well as negatively, similarly, other variables responded negatively as well as positively, a reason is that they analyzed combined results of developing and developed countries, thus, movement and variation represented overall results. Alternatively, (Nuhu, 2021) examined inflation responded positively and then negatively.

To ensure the reliability of the results, the study tested the stability and consistency of its findings using various methods. Changing the Cholesky ordering and increasing the number of periods did
not significantly impact the results, indicating the robustness of the findings. While altering the lag
length structure did affect the results, the overall sense of the variables remained consistent, further suggesting the model's robustness. Thus, the study's results provide reliable insights into the relationship between exchange rate volatility, short-term interest rates, inflation, real GDP, and official reserves in developing countries.

4. Conclusion

This study examined the effects of macroeconomic variables on developing countries, specifically the impact of inflation, short-term interest rates, exchange rate volatility, real GDP, and official reserves. The study found that these variables are interconnected and their effects can have a significant impact on developing countries. Policymakers should prioritize the stability of these variables to foster economic growth and mitigate future uncertainties. The study suggests that monetary policy can affect inflation and short-term interest rates, which can lead to greater exchange rate volatility. Additionally, official reserves can enhance foreign transactions and support, and real GDP is linked to economic growth. Future studies could incorporate additional factors such as financial literacy, debt, and loans, unemployment rates, the balance of trade, government policies, and current accounts to provide more specific recommendations for developing countries to improve trading, foreign transactions, unemployment rates, financial variables, and economic growth. Policymakers in developing countries should focus to revamp the effects of these variables to make better infrastructure domestically.

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Appendix

Table 2: *Unit Root test*

UNIT ROOT TEST RESULTS TABLE (ADF)						
Null Hypothesis: the variable has a unit root						
	At Level					
		INFLATION	IR1	ORES1	RGDP	VOLATILITY
With Constant	t-Statistic	0.0219	0.1310	0.0005	0.0117	0.2267
	Prob.	0.0040	0.0114	0.0217	0.0066	0.0106
		***	**	**	***	**
With Constant & Trend	t-Statistic	0.0789	0.3280	0.0016	0.0275	0.1202
	Prob.	0.0173	0.0313	0.1055	0.0126	0.0360
		**	**	0	**	**
Without Constant & Trend	t-Statistic	0.0025	0.0128	0.0000	0.0001	0.0440
	Prob.	0.0004	0.0005	0.0015	0.0008	0.0005
		***	***	***	***	***
	At First Difference					
		d(INFLATION)	d(IR1)	d(ORES1)	d(RGDP)	d(VOLATILITY)
With Constant	t-Statistic	0.0006	0.0171	0.0002	0.0000	0.0231
	Prob.	0.0001	0.0107	0.0190	0.0001	0.0024
		***	**	**	***	***
With Constant & Trend	t-Statistic	0.0042	0.0756	0.0021	0.0001	0.0939
	Prob.	0.0009	0.0013	0.0058	0.0001	0.0110
		***	***	***	***	**
Without Constant & Trend	t-Statistic	0.0000	0.0008	0.0000	0.0000	0.0016
	Prob.	0.0000	0.0005	0.0009	0.0000	0.0001
		***	***	***	***	***

Notes:
a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant
b: Lag Length based on SIC
c: Probability based on MacKinnon (1996) one-sided p-values.

Table 3: Exchange *rate volatility*

	INDONESIA	MEXICO	CHILE	DENMARK	CHINA	ISRAEL	INDIA
2005	0.082208	-0.034991	-0.085165	0.000976	-0.010016	0.001275	-0.027211
2006	-0.057843	0.000124	-0.054126	-0.008395	-0.027325	-0.007132	0.027003

2007	-0.002002	0.002653	-0.014839	-0.088390	-0.046977	-0.081252	-0.091425
2008	0.059249	0.018273	-5.99E-06	-0.065585	-0.090591	-0.135356	0.050843
2009	0.068819	0.194069	0.070921	0.050252	-0.017016	0.091633	0.106729
2010	-0.133615	-0.067137	-0.094572	0.047931	-0.008991	-0.050422	-0.056946
2011	-0.035836	-0.016975	-0.053501	-0.046468	-0.046685	-0.043971	0.020449
2012	0.067900	0.058325	0.005780	0.075972	-0.023350	0.074770	0.135396
2013	0.108391	-0.030646	0.017931	-0.030885	-0.018640	-0.065692	0.092190
2014	0.125934	0.039942	0.141138	-0.000685	-0.008481	-0.009135	0.040660
2015	0.120854	0.175864	0.137050	0.181274	0.013589	0.082812	0.049897
2016	-0.006074	0.163539	0.034312	0.000566	0.064813	-0.011975	0.046349
2017	0.005433	0.013964	-0.042432	-0.019322	0.017053	-0.064810	-0.031348
2018	0.062017	0.016653	-0.011715	-0.044640	-0.021354	-0.002503	0.048963
2019	-0.006290	0.001002	0.091750	0.054670	0.043251	-0.007276	0.029263
2020	0.030252	0.109164	0.120268	-0.019271	-0.001103	-0.034861	0.050928

Table 4: the summary statistic of Exchange rate Volatility

	INDONESIA	MEXICO	CHILE	DENMARK	CHINA	ISRAEL	INDIA
Mean	0.030587	0.040239	0.016425	0.005500	-0.011364	-0.016493	0.030734
Median	0.044750	0.015309	0.002887	-0.004540	-0.013516	-0.010555	0.043504
Maximum	0.125934	0.194069	0.141138	0.181274	0.064813	0.091633	0.135396
Minimum	-0.133615	-0.067137	-0.094572	-0.088390	-0.090591	-0.135356	-0.091425
Std. Dev.	0.070339	0.079211	0.076585	0.065318	0.036252	0.061080	0.059050

Table 5:The Summary statistic of PANEL Data of Developing Countries

	INFLATION	IR1	ORES1	RGDP	VOLATILITY
Mean	1.358198	0.266172	0.0023383.363878		0.013661
Median	0.498367	0.002354	0.0009910.915033		0.000345
Maximum	52.63968	32.94848	0.11071795.00000		0.194069
Minimum	-31.60742	-35.93698	-0.060495	-6.000000	-0.135356
Std. Dev.	8.442450	9.284824	0.02579612.52602		0.066751

Table 6: Panel VAR-PVAR (1)

	INFLATION	IR1	ORES1	RGDP	VOLATILITY
INFLATION (-1)	0.308311	-0.458597	0.000175	0.033407	0.002467
	(0.10543)	(0.12160)	(0.00035)	(0.18322)	(0.00091)
	[2.92424]	[-3.77138]	[0.49465]	[0.18234]	[2.71573]
IR1(-1)	0.511196	0.001718	0.0000514	-0.029317	0.001785
	(0.09889)	(0.11406)	(0.00033)	(0.17185)	(0.00085)
	[5.16909]	[0.01506]	[0.15475]	[-0.17059]	[2.09543]
ORES1(-1)	-2.600641	-18.78529	0.202444	76.83234	-0.186281
	(33.1820)	(38.2700)	(0.11141)	(57.6621)	(0.28585)
	[-0.07838]	[-0.49086]	[1.81705]	[1.33246]	[-0.65167]
RGDP (-1)	-0.160613	0.091762	0.000332	-0.082937	0.000616
	(0.05917)	(0.06824)	(0.00020)	(0.10281)	(0.00051)
	[-2.71467]	[1.34476]	[1.67049]	[-0.80667]	[1.20840]
VOLATILITY (-1)	28.45444	6.446148	-0.069536	-39.94680	0.171593
	(11.8707)	(13.6909)	(0.03986)	(20.6283)	(0.10226)
	[2.39703]	[0.47084]	[-1.74460]	[-1.93650]	[1.67798]
C	1.272843	0.556401	0.001922	4.470591	0.009399
	(0.83873)	(0.96733)	(0.00282)	(1.45750)	(0.00723)
	[1.51759]	[0.57519]	[0.68240]	[3.06730]	[1.30085]

Source: Authors Calculation

A 1% increase in short-term interest rate decreases the inflation rate by 0.458597%. Similarly, all variables are defined accordingly

Table 7: Variance Decomposition

Variance Decomposition of INFLATION:

Period	S.E.	INFLATION	IR1	ORES1	RGDP	VOLATILITY
1	7.681100	100.0000	0.000000	0.000000	0.000000	0.000000
2	8.870657	75.72452	12.87272	0.331580	6.748515	4.322668
3	9.298542	72.56032	13.97825	0.645225	6.188052	6.628144
4	9.330520	72.33499	13.88355	0.762031	6.352399	6.667026
5	9.333952	72.28908	13.91178	0.763284	6.359261	6.676593
6	9.334964	72.28331	13.91347	0.763996	6.358575	6.680648
7	9.335024	72.28283	13.91331	0.764201	6.359055	6.680602
8	9.335038	72.28267	13.91341	0.764199	6.359056	6.680662
9	9.335041	72.28265	13.91342	0.764203	6.359056	6.680675
10	9.335041	72.28265	13.91342	0.764203	6.359057	6.680675

Variance Decomposition of IR1:

Period	S.E.	INFLATION	IR1	ORES1	RGDP	VOLATILITY
1	8.858877	47.90649	52.09351	0.000000	0.000000	0.000000
2	9.602930	53.63472	44.34136	0.368888	1.465729	0.189302
3	9.806354	51.60416	44.61609	0.386474	2.319479	1.073789
4	9.880914	51.42638	44.31958	0.444292	2.296526	1.513225
5	9.886434	51.41348	44.27028	0.463747	2.327177	1.525319
6	9.887021	51.40852	44.27126	0.464001	2.328784	1.527439
7	9.887196	51.40832	44.27047	0.464124	2.328812	1.528279
8	9.887206	51.40828	44.27038	0.464158	2.328899	1.528283
9	9.887208	51.40827	44.27038	0.464158	2.328901	1.528295
10	9.887209	51.40827	44.27038	0.464159	2.328901	1.528297

Variance Decomposition of ORES1:

Period	S.E.	INFLATION	IR1	ORES1	RGDP	VOLATILITY
1	0.025790	0.017787	2.100134	97.88208	0.000000	0.000000
2	0.026945	0.133755	2.120709	91.72919	3.218601	2.797743
3	0.027098	0.196157	2.098519	91.09501	3.184448	3.425871
4	0.027123	0.196173	2.147154	90.94473	3.194451	3.517489
5	0.027133	0.210665	2.169126	90.88019	3.192656	3.547366
6	0.027135	0.214771	2.170392	90.87095	3.192867	3.551021
7	0.027135	0.214862	2.170395	90.87066	3.193024	3.551060
8	0.027135	0.214881	2.170423	90.87060	3.193024	3.551067
9	0.027135	0.214887	2.170424	90.87060	3.193026	3.551068
10	0.027135	0.214887	2.170424	90.87059	3.193026	3.551068

Variance Decomposition of RGDP:

Period	S.E.	INFLATION	IR1	ORES1	RGDP	VOLATILITY
1	13.34784	0.232779	0.884754	1.882259	97.00021	0.000000
2	13.73168	0.243915	0.853272	3.338302	92.00918	3.555328
3	13.75129	0.272174	0.891892	3.395707	91.74845	3.691773
4	13.75938	0.284724	0.934375	3.396447	91.64793	3.736521
5	13.76141	0.294361	0.939679	3.398316	91.62138	3.746264
6	13.76154	0.294913	0.939667	3.398719	91.62013	3.746570
7	13.76154	0.294926	0.939724	3.398726	91.62005	3.746576
8	13.76155	0.294941	0.939730	3.398725	91.62002	3.746580
9	13.76155	0.294942	0.939730	3.398725	91.62002	3.746580
10	13.76155	0.294942	0.939730	3.398725	91.62002	3.746580

Variance Decomposition of VOLATILITY:

Period	S.E.	INFLATION	IR1	ORES1	RGDP	VOLATILITY
1	0.066170	0.296505	0.444054	2.259686	1.050411	95.94934
2	0.069283	1.987733	3.530316	2.424187	1.959516	90.09825
3	0.070670	2.762156	5.303850	2.330446	2.176135	87.42741
4	0.070991	3.192352	5.374256	2.372757	2.205104	86.85553
5	0.071008	3.196797	5.380031	2.380592	2.229422	86.81316
6	0.071014	3.201174	5.385653	2.380250	2.229221	86.80370
7	0.071015	3.202261	5.385720	2.380413	2.229490	86.80212
8	0.071015	3.202260	5.385759	2.380425	2.229547	86.80201
9	0.071015	3.202277	5.385775	2.380424	2.229546	86.80198
10	0.071015	3.202280	5.385775	2.380425	2.229547	86.80197

Cholesky Ordering: INFLATION IR1 ORES1 RGDP VOLATILITY

Fig 1: Exchange rate volatility of Developing Countries

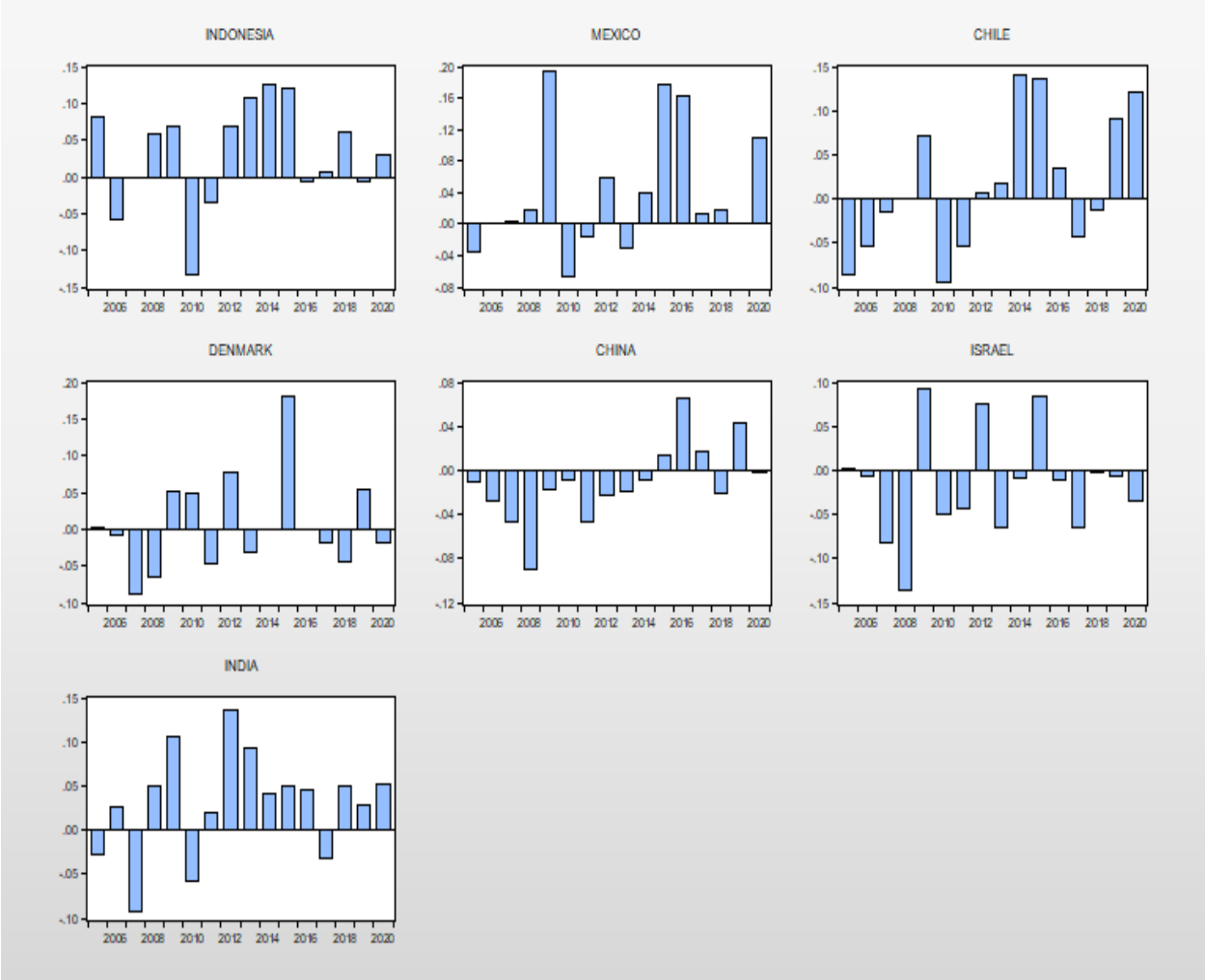

Fig 2: Impulse Response