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Research Paper

Comparative Analysis of Inflation Dynamics of Three African Countries: Ethiopia, Kenya and South Africa

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Abstract

This paper examines a comparative view of the inflation dynamics in three African countries. The study used monthly data from January 2007 to April 2018. To achieve the objectives, the study was deployed varieties of econometric methods. The exploratory analysis reveals that inflation of the sampled countries exhibits similar trends over the long run. The Johansson Co-integration test result evince that inflation, oil price and exchange rate of Ethiopia and South Africa had a long run relationship. Exchange rates had significant positive effects on inflation dynamics of both countries while world oil price contributes positively in Ethiopia but negatively in South Africa. In the short run, inflation in Kenya was found to be a sign of Ethiopia's inflation. Likewise, in South African inflation was an indicator of the inflation in Kenya whereas inflation in Kenya and Ethiopia could not predict inflation would occur in South Africa. Furthermore, the outcome of the impulse response function demonstrates that exchange rates and oil price shocks affected inflation dynamics of the sampled countries at different stages both directly and indirectly. In the short run, shocks to inflation have an interaction effect across the selected countries. The findings also report that world oil prices are not equally contributes for inflation dynamics in the sampled countries.

1. Introduction

Inflation refers to the continuous upsurge in the aggregate level of prices of goods and services in an economy (Romer, 2012). It is clearly known that different economies in different parts of the world experience inflation. The severity level may differ from one country to another due to a number of historical country-specific causes. Majority of developing countries experienced elevated inflation. Even if Ethiopia has had a historically low inflation rate compared to other developing countries, in recent time it is experiencing a high inflation rate. High inflation is often linked with lesser growth and financial crises. As Al-Shammari and Al-Sabaey (2012) stated, emerging countries are disposed to currency and financial crises more than the industrialized countries. The surge of price is further associated with non-proportional production and consumption of goods and services. This can be due to insufficient investments and steady population growth.

High inflation can be a serious problem for many economies worldwide. Currently, majority of the African countries like Ethiopia, South Sudan, Zimbabwe, Kenya, etc. experienced elevated inflation (Durevall and Sjö, 2012; Gudina et al., 2018; Okara and Mutuku , 2019). Knowing the causes of soaring inflation and it's the dynamic nature of inflation has always been

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a key concern of academics and monitory policymakers around the world.

A large body of literature has documented the challenges posed by spiraling inflation on the countries' economy and factors that contribute to rising inflation dynamics (Chou and Tseng, 2011; Durevall et al., 2012; Misati et al., 2013; Abounoori et al., 2014; Brahmasrene et al., 2014; Kargi, 2014; Christine et al., 2015; Habtamu, 2015; Kavila, and Le Roux, 2016; Anh, et al., 2017). These researchers have identified some driving forces of inflation: world food prices, world energy prices such as oil price, domestic food prices, excess money supply, exchange rates, and domestic agricultural supply shocks. Durevall and Sjö (2012) found that inflation dynamics in Ethiopia and Kenya were driven by similar factors; of which world food prices and exchange rates had a long-run impact, whereas money growth and agricultural supply shocks had short-to-medium run effects.

Even though numerous researches have been done, there has been no agreement on the sources of high inflation experienced in recent years and no study scrutinized the interaction effects of inflation dynamics across the countries which are the focus of this study. Inflation dynamics across countries may move together due to some common shocks (for instance world oil price shock, demand and supply shocks) and they may have interaction effects on each other if countries have integrated market system, economic and geographical ties (Eickmeier and Kühnlenz, 2018). Economic and trade integration in Africa is not a recent phenomenon. Particularly, many of the economic and trade integration agreements between Ethiopia and Kenya were signed at various times, and they have warm trade relations. For example, the 2017 import and export data from the Ethiopian Revenues and Customs Authority shows that, Ethiopia exported $ 67,717 to Kenya and $ 10,532 to South Africa. It also imported $ 35,685 and $ 203,974 from Kenya and South Africa respectively.

Ethiopia is the only country that shares borders with all the other countries in the Horn of Africa and is the headquarters of the African Union. Since the selected countries have strong economic and commercial ties, this research examined the inflation dynamics and interaction effects among Ethiopia, Kenya and South Africa.

The study tried to address the following research questions and extends the literatures by considering the research questions: a) To what extent the impacts of the world oil price shock on inflation differ across the selected countries?; b) What are the drivers of domestic inflation dynamics?; and c) Is there any factual interaction effects of inflation dynamics across the selected countries?

The research was carried out to investigate the trend of inflation, illustrate the granger causal relationship of inflation dynamics and identify the major driving force(s) of high inflation dynamics in three African countries. Finally, it suggested the best strategies to manage the variability of inflation for the policy makers and other stakeholders.

2. Methods

Ethiopia, Kenya and South Africa were purposively selected as the focus of this research, for they strong trade integration and economic ties. Kenya and South Africa are top trading partners of Ethiopia. Thus, the researcher considered Ethiopia's, Kenya's and South Africa's inflation dynamics for analysis.

For this study, monthly time series data spanning the period from January 2007 to April 2018 concerning Ethiopian consumer price index (ETHCPI), Kenyan consumer price index (KCPI) and South African consumer price index (SCPI), exchange rates ((Ethiopian Birr/USD Exchange rate (ETHEXR), Kenyan Shilling/ USD exchange rate (KEXR) and South African Rand/USD exchange rate (SEXRT)) and world oil price were collected from National Bank of Ethiopia and International Monitory Fund.

Various parameters such as Consumer Price Index (CPI), Wholesale Price Index (WPI) and Sensitive Price Indicator (SPI) were used for measuring inflation. Consumer Price Indexes (CPI) were used as a proxy for inflation. Consumer prices are very much linked with the world oil prices because oil products are not only used as a final product but are also used as an input in many of the production processes and economic activities. From 2000 to 2008, world oil prices created new records that severely affected the economy of every country of the world (Asghar and Naveed, 2015).

The study used both descriptive and inferential statistics for data analysis.

2.1. Econometric Model Specification and Tests

2.1.1. Tests of stationarity

In econometric analysis involving time series data, before any kind of econometric estimation takes place, the collected data should be tested for their stationarity. For this purpose, the Augmented Dickey-Fuller (ADF) test and Phillip-Perron (PP) tests were used to tests for the stationarity. The ADF test avoids the problem of Dickey-Fuller because it corrects for serial correlation; by adding lagged difference terms (Gujariti, 2004). The ADF test can be represented as:

$$\Delta Y_t = \gamma_1 + \gamma_2 t + \delta Y_{t-1} + \sum_{i=1}^{p} \alpha_i \, \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

where, γ_1, γ_2, δ, and α are the coefficients, t is the stochastic trend, ε_t is a white noise error term and ΔY_{t-1}=Y_{t-1}-Y_{t-2}, ΔY_{t-2}=Y_{t-2}-Y_{t-3}, etc. The test statistic is given below:

$$Z_t = \frac{\hat{\delta}}{SE(\hat{\delta})}$$

where, $SE(\hat{\delta})$ standard error of $\hat{\delta}$. Hypothesis tests: $Ho: \delta = 0$ where, $\delta = \rho - 1$. To perform the tests, conventional F-test is used but compares the test statistic with the critical F-values developed by Dickey and Fuller.

The Phillips-Perron test is an alternative method for unit root tests. A PP test ignores any serial correlation in the error term without adding lagged difference terms and they use the standard DF or ADF test but adjust the t-ratio so that the serial correlation does not affect the asymptotic distribution of the test statistic.

2.1.2. Co-integration tests

Many macroeconomic variables are not stationary at a level but a linear combination of two or more non-stationary series may be stationary and these series are said to be co-integrated. If integrated of order one variables are co-integrated, they are moving together so that there is some long run relationship between them. Traditional time-series models have failed to fully capture the behavior of such complex relationship:

The Johansen's approach takes its initial point in the vector auto regression (VAR) order p specified by:

$$Y_t = \varphi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + ... + \Phi_p Y_{t-p} + \varepsilon_t \qquad (2)$$

The above VAR (p) can be re-specified as:

$$\Delta Y_t = \varphi_0 + \Pi Y_{t-1} + \sum_{t=1}^{p-1} \Gamma_i \Delta Y_{t-1} + \varepsilon_t$$

where, $\Pi = \sum_{t=1}^{p} \Phi_i - I \;\; and \;\; \Gamma_i = \sum_{j=i+1}^{p} \Phi_j$

If the coefficient matrix Π has reduced rank r<n, then there exist nxr matrices α and β each with rank r such that Π = $\alpha\beta'$ and $\beta' Y_t$ is stationary at level. r is the number of co-integrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a co-integrating vector. It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of Y_{t-1} that yields the r largest canonical correlations of ΔY_t with Y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum eigenvalue test, shown as follows respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \qquad (3)$$

$$J_{\max} = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (4)$$

where, T is the sample size and $\hat{\lambda}_i$ is the i[th] largest canonical correlation. The trace test tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of r +1 co-integrating vectors.

2.1.3. Lag Length Selection

The lag length for the VAR (p) model may be determined using model selection criteria. The general approach is to fit VAR (p) models with orders p = 0, 1, 2…, p_{max} and choose the value of p which minimizes some model selection criteria. The three most common information criteria are the Akaike (AIC), Schwarz-Bayesian (BIC) and Hannan-Quinn (HQ):

$$AIC(p) = \ln\left|\hat{\Sigma}(p)\right| + \frac{2}{T} pk^2 \qquad (5)$$

$$BIC(p) = \ln\left|\hat{\Sigma}(p)\right| + \frac{\ln(T)}{T} pk^2 \qquad (6)$$

$$HQ(p) = \ln\left|\hat{\Sigma}(p)\right| + \frac{2\ln\ln T}{T} pk^2 \qquad (7)$$

The AIC criterion asymptotically overestimates the order with positive probability, whereas the BIC and HQ criteria estimate the order consistently under fairly general conditions if the true order p is less than or equal to p_{max}.

2.1.4. Vector Autoregressive (VAR) Model Specification

The vector autoregression (VAR) model is one of the most successful, flexible, and easy to use models for the analysis of multivariate time series. It is a natural extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. A VAR model applies when each variable in the system does not only depend on its lags, but also the lags of other variables.

The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. A multivariate time series Y_t is a VAR process of order p or VAR (p) for short if it follows the mode:

$$Y_t = \varphi_o + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + ... + \Phi_p Y_{t-p} + \varepsilon_t, \quad p > 0,\ t = 1,..., T \qquad (8)$$

where, Y_t is a vector of length k, φ_o is a k-dimensional vector, Φ is a $k \times k$ matrix of autoregressive coefficients for j = 1, 2, ……, p. , and { ε_t } is a sequence of serially uncorrelated random vectors with mean zero and covariance matrix Σ. Y_t is a vector of length k. There are k equations. The coefficient matrix Φ measures the dynamic dependence of Y_t and are unknown and to be estimated from the observed data.

2.1.5. Vector Error Correction Model (VECM)

The use of Vector Autoregressive Models (VAR) and Vector Error Correction Models (VECM) for analyzing dynamic relationships among financial variables has become common in the literature. From the above VAR (p) model specification, we can rewrite as a VECM.

$$\Delta \mathbf{y}_t = \vartheta + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta \boldsymbol{y}_{t-i} + \boldsymbol{\varepsilon}_t \qquad (9)$$

where, $\Pi_i = \alpha\beta', \Gamma_i = -\sum_{j=i+1}^{p} \Phi_j$ and I_n is an identity matrix.

Π and the short-run parameter Γ_i i=1, 2,…, p-1 are p × p matrices of coefficients. The VECM expressed above is convenient because the hypothesis of cointegration can be stated in terms of the long-run impact matrix, Π.

2.1.7. Granger Analysis

This study uses Engle-Granger causality test to analyze the relationship between the selected variables. Let X_t and Y_t be two stationary (after possible transformations) time series of length T. A variable X_t is said to Granger causes another variable Y_t, if Y_t can be better predicted from the past of X_t and Y_t together than the past of Y_t alone, other relevant information being used in the prediction (Pierce, 1977). Likewise the researcher was interested to see the grander causality of inflation dynamics between the selected countries and other selected variables.

2.1.8. Impulse Response Function

The VAR model can be used for structural inference and policy analysis. In structural analysis, certain assumptions about the causal structure of the data under investigation are imposed, and the resulting causal impacts of unexpected shocks or innovations to specified variables on the variables in the model are summarized. Granger-causality may not tell us the complete story about the interactions between the variables of a system. In applied work, it is often of interest to know the response of one variable to an impulse in another variable in a system that involves a number of further variables as well. These causal impacts are usually summarized with impulse response functions and forecast error variance decompositions.

Identification of the underlying structural shocks is necessary if we are to estimate the effects of an exogenous shock to a single variable on the dynamic paths of all of the variables of the system, which we call impulse-response functions (IRFs). The impulse response function can be plotted as the period multipliers against the lag length. An impulse response function traces the response of a variable of interest to an exogenous shock. Often the response is portrayed graphically, with horizon on the horizontal axis and response on the vertical axis. It traces the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables. A shock to the i^{th} variable directly affects the j^{th} variable, and may also transmit to all of the endogenous variables through the dynamic structure of the VAR. Any covariance stationary VAR (p) process has a Wald representation of the form:

The impulse response function (IRF) of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change.

A VAR was written in vector MA (∞) form as:

$$Y_t = \mu + \varepsilon_t + \psi_1 \varepsilon_{t-1} + \psi_2 \varepsilon_{t-2} + \dots \qquad (10)$$

Thus, the matrix ψ_s has the interpretation $\frac{\partial Y_{t+s}}{\partial \varepsilon_t'} = \psi_s$ that is, the row *i*, column j element of ψ_s identifies the consequences of one unit increase in the j^{th} variable's innovation at date *t* (ε_{jt}) for the value of the i^{th} variable at time $t+s$(Y_{it+s}), holding all other innovations at all dates constant.

$\frac{\partial Y_{it+s}}{\partial \varepsilon'_{it}}$ as a function of s is called the impulse response function. It describes the response of Y_{it+s} a one-time impulse in Y_{jt} with all other variables dated t or earlier held constant.

3. Results and Discussions

3.1. Descriptive analysis

Figure 1 depicts the consumer price index (inflation) of the selected countries and world oil price. The graphical plot of the three variables (CPI) shows an upward increasing trend in which the co-movement showed greater similarity starting from the beginning onwards. This graphical plot confirms the finding of Durevall and Sjö (2012). They found that inflation in both Ethiopia and Kenya has increasing patterns. The world oil price is more fluctuated over the given period than inflation. The price increased to higher values in 2008 and it does not show a clear trend which contrasts the finding of Ademe (2015). Domestic inflation of Ethiopia had a similar trend with that of world oil price. The fluctuation in oil prices led to the fluctuation of inflation. The oil prices which were higher will be immediately followed by the rising prices of oil products including gasoline and fuel oil, which were used by the consumer.

The exchange rate of the three countries, generally, showed an increasing trend with high fluctuation (Figure 2). The fluctuation is low in the case of Ethiopia compared to the other countries. This low fluctuation may be due to the fact that Ethiopian exchange rate is characterized by a managed floating regime.

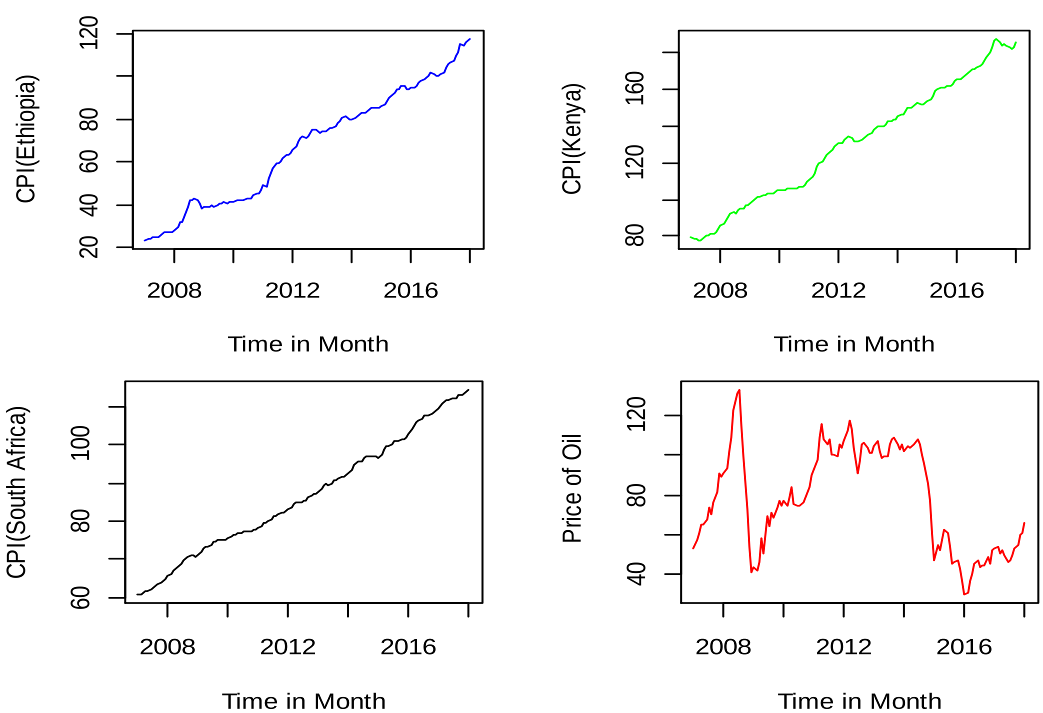
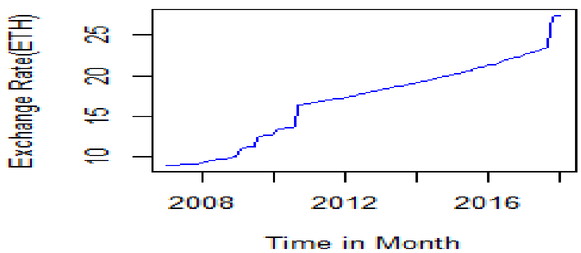


Figure 1: Graphical representation of inflation

3.2. Tests of stationarity

Augmented Dickey-Fuller (ADF) and Philips Perron (PP) tests were used to test the stationarity properties of the series. The summary of the result is given in Table 1a) and b). The result indicates that the null hypothesis of the presence of unit root has failed to reject at 5 percent level of significances. This implies that the series is not stationary at level. On the other hand, all the variables at 5 the percent level of significance are statistically significant in the first difference. We thus realize that all the series over time is stationary in first difference.



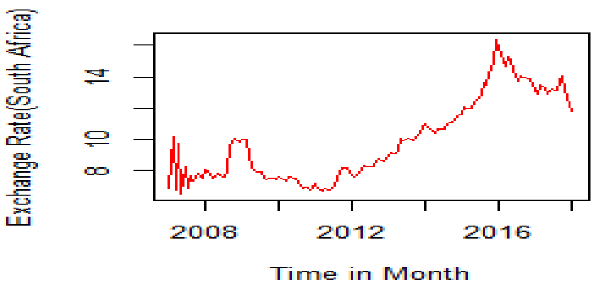


Figure 2: Exchange rate of the selected countries

Table 1a): ADF tests of stationary

Variables	At a level			At the first difference		
	Test Statistic	Critical value at 5%	*P*-values	Test Statistic	Critical value at 5%	*P*-values
Oil price	-1.631	-2.888	0.4669	-5.279	-2.888	0.000
ETHEXR	0.690	-2.888	0.9896	-7.814	-2.888	0.000
ETHCPI	0.906	-2.888	0.9932	-5.772	-2.888	0.000
KEXR	-1.419	-2.888	0.5732	-8.412	-2.888	0.000
KCPI	0.221	-2.888	0.9734	-6.425	-2.888	0.000
SEXR	-0.527	-2.888	0.8867	-6.421	-2.888	0.000
SCPI	0.361	-2.888	0.9800	-8.068	-2.888	0.000

Source: Own computation results on sample data

Table 1b): PP tests of stationarity

Variables	At a level			At first difference		
	Test Statistic	Critical value at 5%	*P*-values	Test Statistic	Critical value at 5%	*P*- values
Oil price	-1.878	-2.888	0.3424	-7.480	-2.888	0.000
ETHEXR	0.546	-2.888	0.9862	-9.108	-2.888	0.000
ETHCPI	0.714	-2.888	0.9901	-7.808	-2.888	0.000
KEXR	-1.138	-2.888	0.6997	-8.559	-2.888	0.000
KCPI	-2.491	-2.888	0.1176	-10.901	-2.888	0.000
SEXR	-1.225	-2.888	0.6629	-21.732	-2.888	0.000
SCPI	0.707	-2.888	0.9900	-8.405	-2.888	0.000

Source: Own computation results on sample data

3.3. Optimal lags determination

Table 2 reports optimal lags order selection statistics. In this Table the minimum values from each of the information criteria are given by star sign (*).The result shows the optimal lag length is one. So, we precede further tests and estimations with lag (1). Hence, the VAR (p) and VECM (P) models which are used are VAR (1) and VECM (1).

3.4. Co-integration analysis

Having confirmed the existence of unit root at a level in the series in Table 1, co-integration tests were conducted by Johansson test of co-integration. Table 3 reports the co-integration analysis outputs. The result shows that the trace test didn't reject the null hypothesis of zero co-integrating vector at 5% level of significance (22.2364*) in Kenya in favor of at most one co-integrating vectors in case of Ethiopia and South Africa (13.8785* and 11.7716*) respectively. Therefore, the computed trace statistics that are greater than the critical trace values at a 5 percent level of significance explains the rejection of the null hypothesis of zero co-integrating vectors. This implies that inflation in the case of Ethiopia and South Africa has a long run relationship with respective to their exchange rate and world oil prices.

3.5. Estimation of the Vector Autoregressive (VAR) Model

Table 4 comprises the result of inflation dynamics computed by using VAR model. The computed values indicate that the past value of the endogenous variable information in Ethiopia is positive significant effect in determining its own current values (33.76%) at five percent significant levels. From the results, it is also clearly inferred that the past values of inflation in Kenya (93.74%) and other constant variables (35.42%) have significant effect in determining the current values of inflation in Ethiopia keeping other variables constant. For the equation of inflation in Kenya, the past values of KCPI and SCPI have positive significant effect on the current values of KCPI at five significant levels.

3.6. Vector error correction model estimation

The presence of co-integration suggests a long run relationship among the variables under consideration. To discuss the long run equilibrium relations and short-run adjustment processes, the researcher estimated vector error correction model. The long run relationship and short-run adjustment processes among inflation, exchange rates and world oil price for 1 co-integrating vector for Ethiopia are shown in Table 5. The coefficients of exchange rate and world oil price-at the first lag were significant at 5% level of significance. From the Table, it is inferred that there was no long-run causality between inflation and its first lag. When we consider the first equation (inflation) the coefficient error correction term values are non-negative and not significant. The values do not confirming long run causality. The coefficient of error correction term of exchange rate equation and world oil prices equation values are negative and significant at 5%. The coefficient values are -22.58 and -27.08 percent monthly, meaning that the system corrects the previous period disequilibrium at a speed of 22.58 and 27.08, respectively. The error correction term which is the normalized co-integrating equation obtained from the VEC model is as follows:

$$\Delta ETHCPI = -45808\ \Delta ETHEXR + 0.3035\ \Delta World\ oil\ price - 144395$$

Table 2: Optimal Lags Determination

Lag	LL	LR	df	*p*	FPE	AIC	HQIC	SBIC
0	-1555.630				55.835	23.888	23.950	24.041*
1	-1471.540	172.190	49	0.000	31.726*	23.321	23.821*	24.550
2	-1424.500	94.079	49	0.000	32.886	23.351	24.288	25.656
3	-1377.370	94.258	49	0.000	34.365	23.380	24.753	26.760
4	-1341.740	71.262*	49	0.021	43.416	23.584	25.394	28.039

Source: Own computation results on sample data

Table 3: Johansson Co-integration Tests

Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% critical value
Johanson Co-integration Tests in case of Ethiopia (ETHCPI,ETHEXR and World oil price)					
0	3	-671.7423	.	38.8071	29.68
1	7	-659.278	0.0589	13.8785*	15.41
2	11	-653.23229	0.0582	1.7871	3.76
3	12	-652.33874	0.01315		
Johansson Co-integration Tests in case of Kenya (KCPI,KERT and World oil price)					
Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% critical value
0	3	-855.7808		22.2364*	29.68
1	7	-848.1779	0.1073	7.0305	15.41
2	11	-844.6693	0.0510	0.0132	3.76
3	12	-844.6693	0.0001		
Johansson Co-integration Tests in case of South Africa (SCPI, SEXR and World oil price)					
Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% critical value
0	3	-551.944	.	39.0134	29.68
1	7	-538.323	0.184	11.7716*	15.41
2	11	-532.444	0.084	0.0124	3.76
3	12	-532.438	0.000		
Johansson Co-integration Tests of Inflation across the Sampled Countries					
Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% critical value
0	3	-412.5450	.	19.7748*	29.68
1	7	-405.3309	0.10136	5.3466	15.41
2	11	-403.4722	0.0272	1.6291	3.76
3	12	-402.6576	0.0120		

Source: Own computation results on sample data

Table 4: Output of VAR model for inflation of the sampled countries

	Coef.	Std. Err.	Z	*P*>z	[95% Conf.	Interval]
D_ETHCPI						
ETHCPI- LD	0.3376	0.0844	4.00	0.000	0.1722	0. 5030
KCPI-LD.	0.9374	0.0387	24.17	0.000	0.8614	1.0134
SCPI- LD.	0.0780	0.2615	0.30	0.766	-0.4345	0.5904
Cons	0.3542	0.1384	2.56	0.011	0.0829	0.6256
D_KCPI						
ETHCPI -LD	-0.0130	0.0719	-0.18	0.857	-0.1539	0.1279
KCPI-LD.	0.4880	0 .0731	6.68	0.000	0. 3138	0.6312
SCPI-LD.	0.5851	0.2228	2.63	0.009	0.1483	1.0219
Cons	0.2210	0.1180	1.87	0.061	-0.0101	0.4523
D_SCPI						
ETHCPI-LD.	0.0311	0.0280	1.11	0.268	-0.0239	0.0861
KCPI-LD.	0.0268	0.0285	0.94	0.347	-0.0290	0.0827
SCPI-LD.	0.2681	0.0870	3.08	0.002	0.0976	0.4387
Cons	0.2615	0.0460	5.68	0.000	0.1712	0.3518

Source: Own computation results on sample data

According to normalized equation, exchange rate and world oil price contributes to inflation in the long-run. Table A-2 (appendix) reports the VEC output of inflation in South Africa. The result shows that the coefficients of error correction terms are significant at 5% significant level. As understood from the VECM model results, exchange rate contributed negatively in the long run to the inflation in Ethiopia and South Africa. That is, contribute negatively to decrease the exchange rate aggravated inflation of the mentioned country. Conversely, world oil price contributes to inflation positively in the long run in case of Ethiopia and but negatively to that of South Africa. The increase in oil prices led to rising inflation and vice versa, which contrasts the finding of Sek et al. (2015). The study found that oil prices have a considerable effect on domestic prices in developing countries which are highly oil dependent.

3.7. Granger causality tests

Recall that even though a co-integration test shows long run relationship among variables, it does not specify the direction of a causal relation. Chi-square statistics and probability values constructed under the null hypothesis is rejected if the probability value is more than 5% significance level. Table 6 provides the VAR & VEC Granger Causality tests results. VEC-Granger causality analyses of inflation, exchange rate, and world oil price in case of Ethiopia provides the existence of unidirectional causality running from the world oil price to inflation at the 5% significance level (0.0021). Moreover, there is unidirectional causality running from the joint exchange rate and world oil price to inflation. This evinces that past values of joint world oil price and exchange rate enabled to predict the present values of inflation. In the case of South Africa, the VEC Granger causality/block exogeneity Wald tests indicate the existence of unidirectional causality running from world oil price to inflation at 5% of significance level. These results are in agreement with the finding of Brahmasrene et al., (2014). They documented that any changes in international oil price will cause a change in inflation. Similarly, the VAR granger causality Wald tests results regarding inflation in the sampled countries show the unidirectional granger causality running from inflation in Southern Africa to inflation in Kenya. This implies that in the short run inflation in South Africa is one of the driving forces of inflation in Kenya in addition to other macro-economic variables. In addition, unidirectional granger causality running from inflation in Kenya to Ethiopia was observed. World oil price has no equal contribution for the inflation fluctuation across the selected countries.

Table 5: output of VECM in case of Ethiopia

	Coef.	Std. Err.	Z	*P*>z	[95% Conf. Interval]	
D_ETHCPI						
CE1_1	0.0071	0.0100	0.72	0.474	-0.0124	0.0267
Cons	0.7240	0.0871	8.32	0.000	0.5531	0.8946
D_ETHEXR						
CE1_2	-0.2258	0.0881	-2.56	0.010	-0.0532	-0.3984
Cons	0.1376	0.028713	4.79	0.000	0.0813	0.1938
D_Oil price						
CEl_3.	-0.2708	0.0602	-4.50	0.000	-0.3888	-0.1528
Cons	0.0181	0.5259	0.03	0.973	-1.0128	1.0490
	Johansen normalization restriction imposed					
Beta	Coef	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
ETHCPI	1					
ETHEXR	-4.5808	0.3470	-13.20	0.000	-5.2609	-3.9007
Oil Price	0.3035	0.0685	4.43	0.000	0.1692	0.4377
Cons	-14.4395					

Source: Own computation results on sample data

Table 6: VAR &VEC granger causality tests results

Equation	Excluded	chi2	Df	Prob>chi2
VEC Granger Causality/Block Exogeneity Wald Tests in case of Ethiopia				
Equation	Excluded	chi2	Df	Prob>chi2
D.ETHCPI	D.Ethexr	0.1940	1	0.6596
	D.Oil price	9.4180	1	0.0021
	All	9.5626	2	0.0084
D.ETHEXR	D. ETHCPI	0.0230	1	0.8796
	D.Oil price.	0.1560	1	0.6929
	All	0.2653	2	0.8758
D.Oil price	D.ETHEXR	0.1195	1	0.7295
	D. ETHCPI	0.1769	1	0.6741
	All	0.3105	2	0.8562
VEC Granger Causality/Block Exogeneity Wald Tests in case of South Africa				
Equation	Excluded	chi2	Df	Prob>chi2
D. SCPI	D. SEXR	2.5478	1	0.1104
	D.Oil price	8.648	1	0.0033
	All	11.7925	2	0.0027
D. SEXR	D. SCPI	0.9112	1	0.3398
	D.Oil price.	8.0359	1	0.0046
	All	10.7764	2	0.0046
D. Oil price	D. SCPI	0.8433	1	0.3585
	D. SEXR	0.0492	1	0.8244
	All	1.0237	2	0.5994
VAR Granger Causality/Block Exogeneity Wald Tests in case of Kenya				
Equation	Excluded	chi2	Df	Prob>chi2
D. KCPI	D. KEXR	2.3925	1	0.1219
	D.Oil price	3.2667	1	0.0707
	All	4.0564	2	0.1317
D. KEXR	D. KCPI	3.6663	1	0.0555
	D.Oil price.	0.2595	1	0.6105
	All	4.7924	2	0.0911
D. Oil price	D. KCPI	0.3027	1	0.5822
	D. KEXR	1.3963	1	0.2373
	All	3.8442	2	0.1463
VAR Granger Causality/Block Exogeneity Wald Tests of inflation in case of Selected Countries				
Equation	Excluded	chi2	Df	Prob>chi2
D. ETHCPI	D. KCPI	6.1847	1	0.0194
	D. SCPI	0.0889	1	0.7660
	All	2.0275	2	0.3630
D. KCPI	D. ETHCPI	.03252	1	0.8570
	D. SCPI.	6.8917	1	0.0090
	All	7.2409	2	0.0270
D. SCPI	D. ETHCPI	1.2269	1	0.2680
	D. KCPI	0.8835	1	0.3470
	All	3.8442	2	0.1463

Source: Own computation results on sample data

3.8. Impulse response function

An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. Figure 3 displays the estimated impulse response of inflation in Ethiopia toward the change of world oil price and Ethiopian Birr/USA Dollar exchange rate. The figure reveals that inflation responds positively over the whole period with slightly increasing when a positive shock given to an exchange rate, which supports the finding of Habtamu Getnet (2015). He has found that the exchange rate has a direct effect on the increments or decrements of domestic inflation of Ethiopia. Figure 4 reports the estimated VAR impulse response function of inflation across the sampled countries. The result shows a one standard error shock of Ethiopian inflation positively influenced Kenyan's inflation, but a positive shock of the inflation in Kenya affected the inflation in Ethiopia negatively. From this, it is evident that when there is positive shock to Ethiopia's inflation, inflation in Kenya is increasing. Nevertheless, the inflation in Ethiopia decreases if Kenya's inflation gets a shock. It also understood that a greater real trade integration and border ties could increase the sensitivity of inflation to cross border shocks.

Figure A-1 (annex) shows that the impulse response function of inflation dynamics in Kenyan to Shilling/ USA Dollar exchange rate and world oil price. The figure reveals that the response of inflation to a unit standard deviation shock to exchange rate is positive and almost with increasing movements which contrasts the finding of Okara and Mutuku (2019). They found that a shock given to exchange rate has negative effects on inflation. Also, the response of inflation to a unit standard deviation shock to world oil price is positive. In other words, when there is a positive innovation given to exchange rate and oil price increases the inflation in that country.

Figure A-2 (annex) exhibits impulse response function of inflation in South Africa towards Rand/USA Dollar exchange rate and world oil price received. The plot shows that the response of inflation in South Africa was positive when exchange rate faced a shock. Exchange rate shocks had a similar positive effect on inflation in both Ethiopia and Kenya, yet negative in South Africa. The response of inflation towards the world oil price is similar in all selected countries over the given time horizon. Furthermore, the response of inflation for itself innovation has little effect for the selected countries.

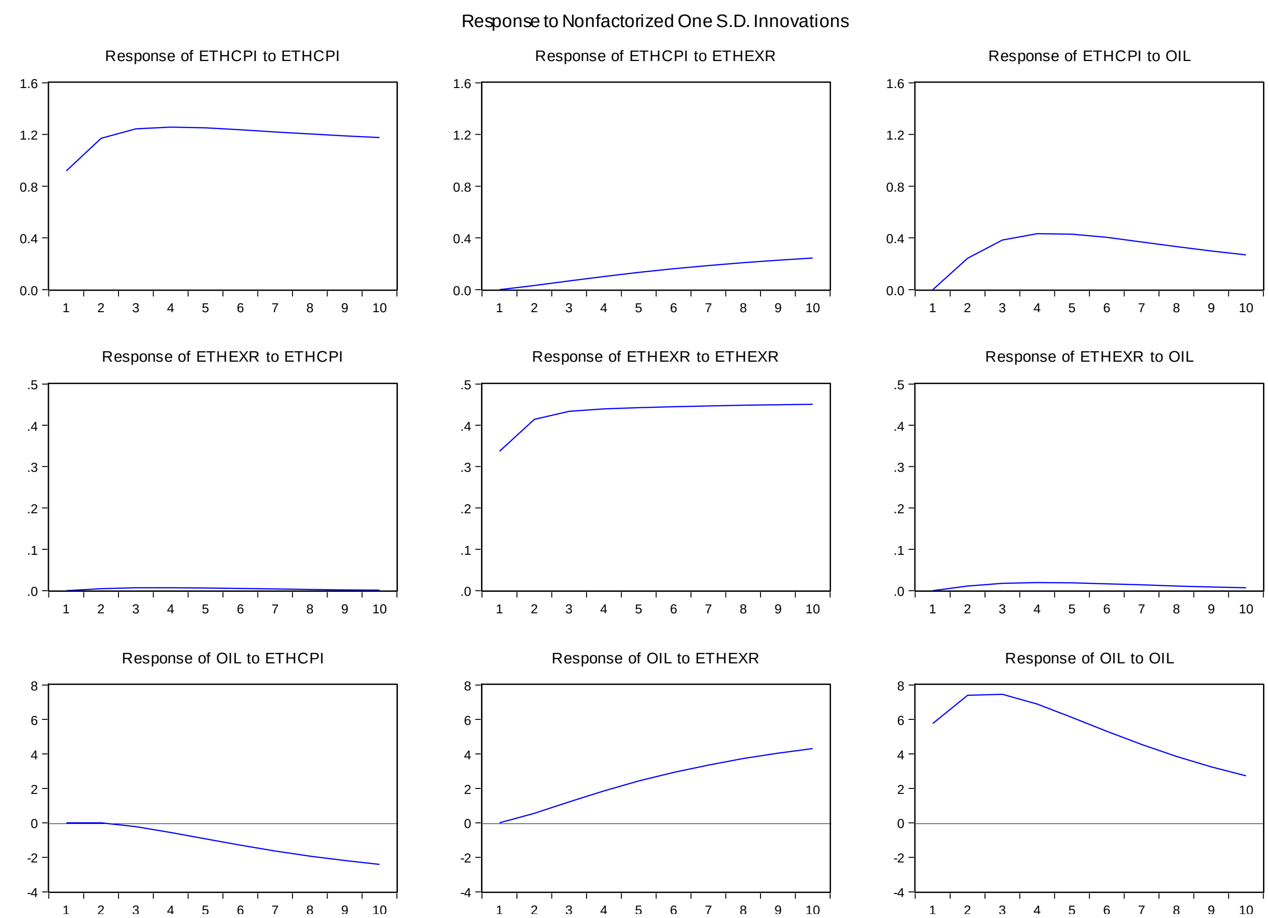


Figure 3: Impulse response functions of inflation in case of Ethiopia

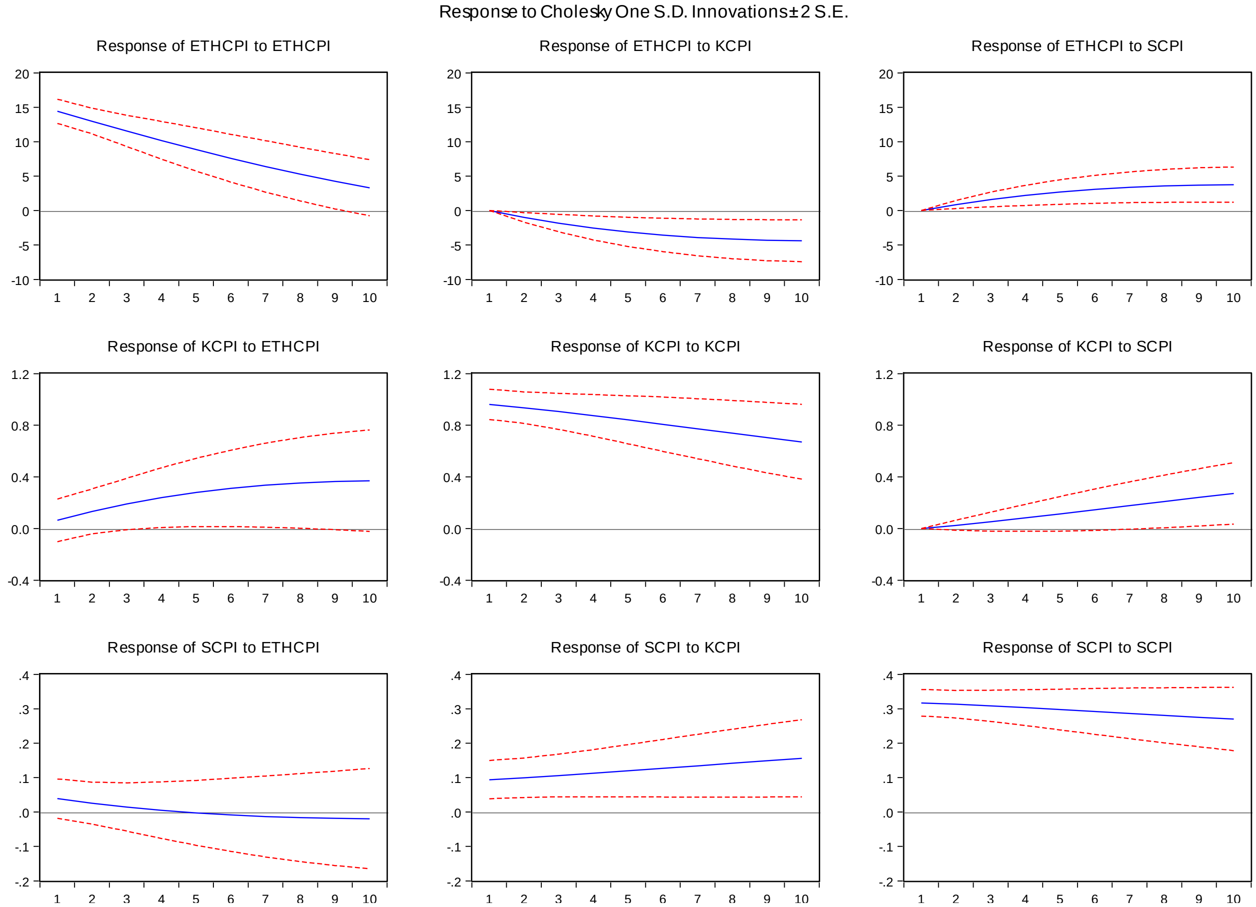


Figure 4: VAR Impulse Response Function of Inflation across the selected countries

4. Conclusions

This study empirically presents the comparative view of inflation dynamics among three African countries. Even though the main driving forces of high inflation across the sampled countries varies, the exploratory analysis of monthly data spanning from January 2007 to April 2018 shows the inflation trend is similar in the long run. The result of Johansen Co-integration test revealed that the CPI, exchange rates and oil price have co-integration relationship in Ethiopia and South Africa case. In the long run, inflation in both countries is driven by exchange rates and world oil price. Exchange rates have positively significant effects on inflation dynamics of both countries while world oil price contributes positively in Ethiopia but negatively in South Africa.

In the short run, inflation in Kenya has a predicting power about inflation in Ethiopia and inflation in South Africa has a predicting power about inflation in Kenya. On the other hand, inflation in Kenya and Ethiopia do not have a predicting power about inflation in South Africa. Furthermore, the outcome of impulse response function demonstrates that exchange rates and oil price shocks affects inflation dynamics of the sampled countries at different stages both directly as well as indirectly. Shocks to inflation in South Africa have positive impact on inflation in Ethiopia while shocks to inflation in Kenya have negative in the short run. Inflation across the sampled countries has no long run interactive relationship.

There are numerous policy implications that can be drawn from this analysis. First, there is growing evidence that exchange rates are a driving force for high inflation for the selected countries. So, establishment of Monitory union is recommended to stabilize this high inflation variability by managing exchange rate variability. Second, fluctuation of oil price is also observed as it is a driving force of high inflation. Low income countries like Ethiopia and Kenya are unlikely to have the resources to have stocks to take advantage of periods of low prices or insurance against rises, so that they will be affected by price increases. Therefore, it is a mandatory for the interference of central bank to stabilize the high variability of oil price by taking into account those countries. Finally, increased economic and trade integrity is likely to lead greater sensitivity of aggregate inflation dynamics to costs of imported inputs, especially when cost changes are large in magnitude. This issue should be a concern of macroeconomic policies coordination because no single country can on its own assure stability to the international economic system.

Annex:

Table A-1: The output of VAR (1) in the case of Kenya

	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
D_KCPI						
KCPI |LD.	0.5255	0.0720	7.30	0.000	0.3830	0.6679
KEXR |LD.	0.0241	0.0384	0.63	0.532	-0.0518	0.1000
oil |LD.	0.0187	0.0112	1.67	0.097	-0.0035	0.0410
_cons	0.4136	0.0921	4.49	0.000	0.2314	0.5958
D_kexr						
KCPI|LD.	0.0983	0.1610	0.61	0.542	-0.2201	0.4168
KEXR |LD.	0.2721	0.0858	3.17	0.002	0.1024	0.4418
oil |LD.	-0.0237	0.0251	-0.94	0.348	-0.0733	0.0260
_cons	0.0885	0.2059	0.43	0.668	-0.3188	0.4958
D_oil						
KCPI | LD.	-0.3095	0.5272	-0.59	0.558	-1.3526	0.7336
KEXR |LD.	-0.4966	0.2809	-1.77	0.079	-1.0524	0.0592
oil | LD.	0.3541	0.0822	4.31	0.000	0.1915	0.5167
_cons	0.4250	0.6743	0.63	0.530	-0.9090	1.7589

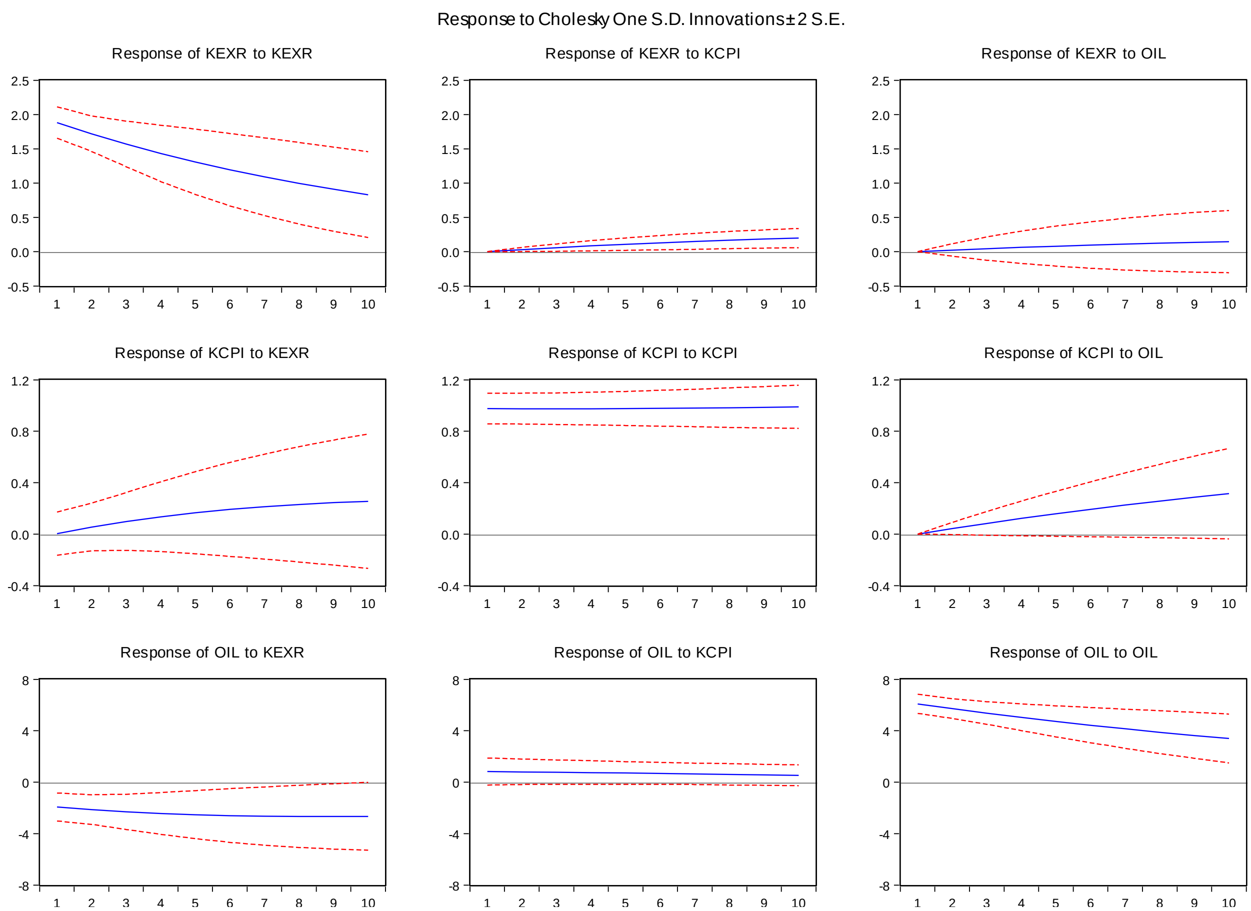


Figure A-1: Impulse Response Function of Inflation Dynamics in case of Kenya Appendix

Table A-2: Output of VECM in case of South Africa

	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
D_SCPI						
_ce1 |L1	-0.0063	0.0022	-2.84	0.004	-0.0107	-0.0020
_cons	0.4164	0.0280	14.89	0.000	0.3616	0.4713
D_SEXR						
_ce1 |L1	0.1087	0.0048	2.27	0.023	0.0015	0.0203
_cons	0.0354	0.0601	0.59	0.556	-0.0824	0.1532
D_oil						
_ce1 | L1.	0.1638	0.0427	3.83	0.000	0.0800	0.2475
_cons	0.0138	0.5359	0.03	0.979	-1.0365	1.0641
	Johansen normalization restriction imposed					
Beta	Coef	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
_SCPI	1					
SEXR	-10.826	0.9508	-11.39	0.000	-12.6899	-8.9630
Oil	-0.5498	0.0980	-5.61	0.000	-0.7418	-0.3577
_cons	64.1050					

Source: Own computation results on sample data

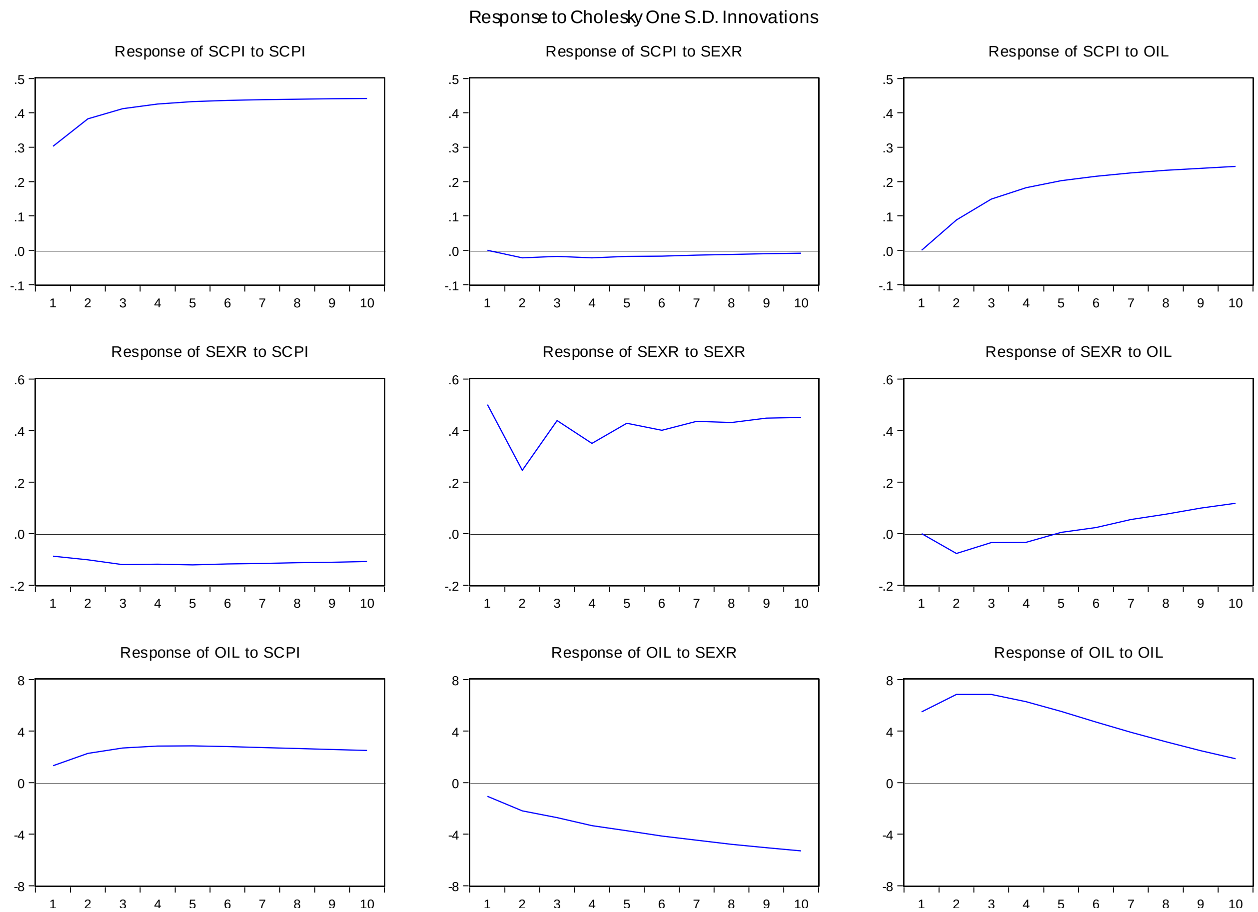


Figure A-2: Impulse Response Function of inflation in case of South Africa

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