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High Price Inflation And Its Co-Integration With Macroeconomic Factors In Ethiopia

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Abstract: Achieving stable price inflation and sustainable economic growth are the key objectives pursued by the government. The existence of unstable price inflation and imbalance of macro-economy is the existing fact in Ethiopia. Thus, in this study, the major objective such as "Modelling Current General Price Inflation and its Co-Integration with Macroeconomic Factors in Ethiopia" was addressed using Vector Error Correction Model (VECM) for the monthly time series data which spans from 1996 to 2021. Vector error correction model was conducted in order to model both short term and long-run relationships among Price Inflation(PRI) and other macroeconomic series such as; Broad Money Supply(BMS), Interest Rate(IR), Exchange Rate (EXCHRT) and Real GDP. Among major findings of this study, the existence of long run relationship between broad money supply and price inflation which were positive and significant was confirmed. It was also seen that the rate of adjustment per month for broad money supply was at 43.902% and 10.73% for price inflation respectively. This study has also affirmed the existence of disequilibrium (long run relationship) between price inflation and exchange rate based on the result of VECM analysis. Particularly, the value of standardized eigenvector which was -0.2405 has shown that, as the exchange rate (Birr/$USD) increases by a unit, it leads to increase in price inflation by 24.05% assuming other macroeconomic factors remaining constant. The rate of adjustment to equilibrium per month of exchange rate was seen at 19% per month. Moreover, there were also disequilibrium between price inflation rate and real gross domestic product (RGDP) in Ethiopia. The rate at which RGDP adjusts to the disequilibrium was at 43% per month for the study time. Thus, government should play great role on minimizing the adverse effect of foreign currency on high and instable price inflation in Ethiopia. Additionally, the monitory market should be well managed through significant monetary policy and other relevant macroeconomic measurements.

Key-Words: Co integration; Price inflation; VECM; Money Supply; Exchange Rate; Real GDP

1 Introduction

Price stability and consistent economic growth are among the major macroeconomic goals of the governments in any country. High and instable inflation rate is harmful to economic growth and social welfare in any country's economy. This realization had a strong impact on the profession, leading scholars and policymakers to devote great effort to fully comprehend the inflationary process and attain price stability [7]. Regarding current price inflation in Ethiopia, annual and monthly report of CSA (Central Statistical Agency) on general price inflation, annual Price inflation rate in Ethiopia has shown as it was inched down to 34.5% in January 2021 to January 2022, from 35.1% in December which was the highest inflation rate in Ethiopia since February 2012. The rate was at 20.6 in January 2021 and increased up to 24.5 in June of 2021 and 35.1 in January of 2022. This was mainly due to the conflict in Ethiopia which has been forcing to macroeconomic imbalances. There were also plenty of causes of macroeconomic instability such as droughts, flooding, desert and COVID-19 pandemic, [22]. According to [21] Ethiopia's inflation rate remains persistently high, reaching 33.6% in February 2022. The headline inflation in February 2022 is lower than the 34.5% recorded in January 2022. Food inflation stood at 41.9% in February, up from 39.9% the previous month. Non-food inflation declined to 22.9% from 27.3% registered in January 2022. There were plenty of macroeconomic disequilibrium leading to high inflation and macroeconomic instability in Ethiopia. According to [20], in the long-run oil price, government expenditure and Broad money supply affect inflation positively. Moreover, in the short run, real exchange rate and government expenditure affect inflation positively. The findings of [23], revealed that, the major factors driving food inflation are spikes in price of cooking oils and fats, non-alcoholic beverages, bread and cereals, fish and sea foods, dairy, and meat products. Weak domestic market supply due to agricultural production constraints and steady devaluation of the local currency are among the major factors contributing to the staggeringly high inflation levels. However, it is vital to study the short run and long run macroeconomic disequilibrium which causes high and instable price inflation in Ethiopia. Thus, in this study, the disequilibrium among macroeconomic determinates and their effects on price inflation both in long run and short-run were modelled. Moreover, the objective of suggesting stockholders to cop up with problems of high inflation through macroeconomic policies was achieved.

1.2. Statement of the problem

Empirical studies support the view that inflation is associated with greater uncertainty about future prices and that the degree of uncertainty rises with the rate of inflation (Marc L. 2011). Particularly, when the rate inflation is high and variant, it indicates instability of the macro economy in a country [8]. Among the popular theories of causes and consequences of price inflation, new neoclassical synthesis theory of inflation is one. It suggests that, when the price movements are anticipated, output will not depart systematically from its equilibrium path and unemployment will not depart systematically from some natural or equilibrium rate. In most versions of these new classical models, unanticipated changes in prices come from monetary surprises. Expected changes in money fully reflected in corresponding changes in the average price level and have no effects on output or employment. Keynes and his followers emphasize the increase in aggregate demand, which comprises consumption, investment and government expenditure as a source of demand-pull inflation. For Cost-push inflation theorist's, inflation is a

phenomenon in which the general price levels rise due to increases in the cost of wages and raw materials. For monitory theory followers, the main cause for inflation in any economy is money supply [5]. Regarding empirical studies on high price inflation and its causes in Ethiopia, plenty of studies has been attempted to address the underlying causes of continuous price rise. Now a day, price inflation rate in Ethiopia is highly instable and causing overall macroeconomic instability. Even through, inflation rate at moderate level has positive impact on economic growth of a countries, the rate of inflation in Ethiopia is very high and volatile as it adversely affects smooth growth of economy [4]. Moreover, the finding of policy research wor king paper [15] considered four measures of inflation such as cereals, food, non-food, and all items consumer price index inflation and concluded that there were disequilibria in the monetary sector, grains sector, and food markets have long-run effects on inflation. According to [14], basically, differentiating external and internal macroeconomic burdens on particular developing country's price inflation should be well articulated to draw effective policy measures. However, tragedy of current price inflation in Ethiopia needs empirical findings, which helps as an alert for the government and other stockholders to pay attention. It was also needs to help policy makers to get estimated facts from most efficient econometric models in relation with associated macroeconomic determinates contributing to high inflation rate in Ethiopia. Therefore, in this study, the long run and short run relationships with other macroeconomic variables were modelled using most applicable econometric model to study long run equilibrium such as VEC or Vector Error Correction Model. Moreover, the direction of the effect between inflation and macroeconomic variables was estimated and thereby the following research questions were addressed.

- ♣ Are there inflation inertia and disequilibrium between price inflation and economic growth in Ethiopia?
- ♣ Is there co integrating relationship between money supply, exchange rate and interest rate with price inflation in Ethiopia?

1.3. Objectives of the study

The general objective of this study was modelling inflation dynamics and its co integration with macro-economic imbalances in Ethiopia. The specific objectives were also presented as follows.

- ♣ To model disequilibrium price inflation with economic growth and price shocks in Ethiopia
- ♣ To estimate co integrating relationship between money supply, exchange rate and interest rate with price inflation in Ethiopia

2. Data and Methodology of the Study

2.1. The Data and Variables of the Study

The general price inflation data monthly measured by CSA (Central Statistical Agency) of Ethiopia, which spans from 1996-2021 was used as dependent variable of this study. Moreover, among internal macroeconomic variables, Interest Rate, Broad Money Supply and RGDP (Real Gross Domestic Product) were considered as associated factors with domestic inflation. Among the external macroeconomic factors, exchange rate (USD) with Birr was considered through effective data manipulation (multiple imputation method).

2.2. Econometric Models

2.2.1. Multivariate Time Series Models for Co-integration Analysis

Economic globalization and internet communication have accelerated the integration of world financial markets in recent years. Price movements in one market can spread easily and instantly to another market. For this reason, financial markets are more dependent on each other than ever before, and one must consider them jointly to better understand the dynamic structure of global finance. In this study, the existence of long run and short run relationship between some macro-economic variables such as, General Price Inflation, Broad Money Supply, Interest Rate and Exchange rate (USD) was tested and analyzed. After confirming the existence of significant co integration among the series, most efficient econometric model such as VEC model (Vector Error Correction Model) was applied. This is because a regression model that combines non-stationary series and yields stationary residuals or a co-integrating regression suggests the existence of long run and short run dynamic relationships which should be modeled using vector error correction model. The vector autoregressive model should be generalized to VEC model so as to captures existing long run equilibrium among the series [15].

2.2.2. Model specification of vector auto regressive model

A univarite time series models such as AR, MA, ARMA and ARIMA models can be generalized to VAR (p) time series when there are two or more dependent variables in the model which are covariates of each other. The VAR (P) model for p-dependent series in the model can be written as:

$x_t = \mu_t + \Phi_1 x_{t-1} + \ldots + \Phi_p x_{t-p} + \varepsilon_t$, Where the innovation ε_t is assumed to be Gaussian and $\mu_t = \mu_0 + \mu_{1t}$ where μ_0 and μ_1 k-dimensional constant vectors.

2.2.3. Extension of vector autoregressive model to VEC Model

In most financial time series analysis, two or more series grow or decline simultaneously which suggesting the existence of both short run and long-run relationships. Conducting VAR (Vector Autoregressive Model) in order to model such series will result in loss of modelling long run-run relationships among the series. Thus, VAR (Vector Autoregressive Model) should be extended to VECM (Vector Error Correction model) to capture such properties among financial time series. In this model, the co-integrating term which also known as the error correction term is added since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments (Brooks, 2002). An error-

correction model (ECM) for the VAR (p) process x_t can be written as:

$$\nabla x_t = \mu_t + \Pi x_{t-1} + \Phi^*_1 \nabla x_{t-1} + \ldots + \Phi^*_{p-1} \nabla x_{t-p+1} + \varepsilon_t$$

Where Φ_j^* and Πx_{t-1} is error correction term which plays a key role in co-integration study. The following rules are applicable in VECM in order to model both long run and short run relationships among time series data.

1. If the coefficient matrix (Π) of the multivariate time series is equal to zero, it is better to take differentiation to make it stationary and apply VAR (p) or vector autoregressive model or VARM (p, q) model. In this cases, equation 3 reduces to :
$$\nabla x_t = \mu_t + \Phi^*_1 \nabla x_{t-1} + \ldots + \Phi^*_{p-1} \nabla x_{t-p+1} + \varepsilon_t$$
2. If the coefficient matrix (Π) has full rank, the time series is considered as stationary and multivariate time series models can be applied without any need to differentiate the series. Thus, there is no integration $I(0)$ in the series (differentiation is not needed) for this type of series.
3. If the coefficient matrix (Π) of the multivariate time series has number of rank more than zero and less than k (number of the columns of the coefficient matrix), it clearly confirms the existence of co-integrity between two or more series. If this is a case, differentiating the series leads to losing long run relationship between economic variables and VECM (vector error correction model) should be applied in order to estimate both long run and short run economic relationships between them [13].

In this study, after confirming the existence of co integration between the series, VEC model was estimated in order to examine both short-run and long run causality between price inflation and other macroeconomic variables. Thus, VEC models such as:

$$\Delta PRI = \alpha_0 + \alpha_{1i}\Delta PRI_{t-1} + \alpha_{2i}\Delta MS_{t-1} + \alpha_{3i}\Delta ER_{t-1} + \alpha_{4i}\Delta RGDP_{t-1} + \alpha_{5i}\Delta IR_{t-1} + \alpha_1[PRI - \beta_1 - \beta_2 MS] + \alpha_2[PRI - \beta_3 - \beta_4 ER] + \alpha_3[PRI - \beta_5 - \beta_6 RGDP] + \alpha_4[PRI - \beta_7 - \beta_8 IR] + \varepsilon_t$$

Where, $\alpha_{1i,}\ \alpha_{2i,}\ \alpha_{3i,}\ \alpha_{4i,}\ \alpha_{5i}$ are short run effects of the money supply, interest rate, exchange rate and Real GDP. Moreover, $\alpha_{1,}\ \alpha_{2,}\ \alpha_{3,}\ \alpha_{4,}\ \alpha_5$ are coefficients of the rate of the adjustment to disequilibrium; $\beta_{1,}\ \beta_{3,}\ \beta_{5,}\ \beta_{7,}$ are constants and

$\beta_{2,}\ \beta_{4,}\ \beta_{6,}\ \beta_{8,}$ coefficients of the long run equilibrium between Price Inflation and Money Supply, Interest rate, Exchange Rate and Real GDP.

2.2.4. Maximum Likelihood Estimation

After model specification and confirming the existence of co integration among two or more series, parameters of the model (VEC model) were estimated using maximum likelihood estimation technique. Thus, the un normalized maximum likelihood estimate (MLE) of the co integrating vector β is $\hat{\beta} = [e_1 \ldots\ldots\ldots, e_m]$ from which we can obtain a MLE for β that satisfies the identifying constraint and normalization condition. The MLE of other parameters can then be obtained by the multivariate linear regression

$$\Delta x_t = \mu d_t + \alpha \hat{\beta}_c x_{t-1} + \Phi_1^* \Delta x_{t-1} + \ldots + \Phi^*_{p-1} \Delta x_{t-p+1} + \varepsilon_t$$

Then the maximized value of the likelihood function based on m co integrating vectors is

$$L_{\max}^{-1/2} \infty |S_{00}| \prod_{i=1}^{m} (1 - \hat{\lambda}_i)$$

This value is used in the maximum likelihood ratio test for testing Rank = m. Finally, estimates of the orthogonal complements of α and β can be obtained using

$$\hat{\alpha} \perp = S_{00}^{-1} S_{11} [e_{m+1}, \ldots, e_k] \qquad \hat{\beta} \perp = S_{11} [e_{m+1}, \ldots, e_k]$$

, Where $S_{oo} = \frac{1}{T-P} \sum_{t=p+1}^{T} \hat{u}_t \hat{u}_t'$, $S_{o1} = \frac{1}{T-P} \sum_{t=p+1}^{T} \hat{u}_t \hat{v}_t'$

and $S_{11} = \frac{1}{T-P} \sum_{t=p+1}^{T} \hat{v}_t \hat{v}_t'$ [15].

2.2.5. Co-integration tests

Most powerful econometric approach which was known as Engle-Granger approach was used in a simple model with two variables. However, Johansen co integration approach which is suitable for a multivariate series can be applied for co integration test [13]. Thus, Johansen co integration test was efficient for this study because there are more than two co integrating series.

2.2.6. Rank and lag order test

Obtaining efficient number of lags is one of the crucial steps in multivariate time series models. In this study, Schwarz information criteria (SBIC), HQC, and Akaike information criteria (AIC) were conducted. The mathematical expressions of the information criteria were given as follows.

$$AIC = -2\left(\frac{LL}{T}\right) + \frac{2t_p}{T}$$

$$SBIC = -2\left(\frac{LL}{T}\right) + \frac{\ln(T)}{T} t_p$$

$$HQIC = -2\left(\frac{LL}{T}\right) + \frac{2\ln\{(\ln T)\}}{T} t_p$$ Where tp is total parameters used in the model

2.2.7. Stationarity of the series

For a VAR (P) model for p-dependent series such as:

$x_t = \mu_t + \Phi_1 x_{t-1} + \ldots + \Phi_p x_{t-p} + \varepsilon_t$ Which can also be written as: $\Phi(B) = I - \Phi_1 B - \ldots - \Phi_p B^p$

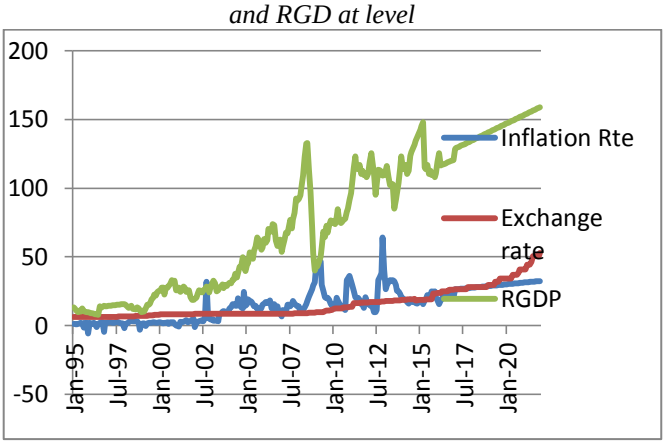
If all zeros of the determinant $|\Phi(B)|$ are outside the unit circle, then x_t is unit-root stationary, which confirms that the series is not integrated and it is known as unit-root non-stationary series. Augmented dickey fuller test, which helps

to accept or reject the null hypothesis, was conducted in this study in order to examine the stationarity of the series.

3. Results and Discussion

3.1. Time series plots of the series

Figure 1: *time series plot of price inflation, exchange rate and RGD at level*



Source: *NBE and CSA (National Bank and Central Statistical Agency of Ethiopia) from1996 to 2021*

Time series plot of all series considered in this study such as price inflation, exchange rate and RGDP at level were depicted on figure 1 above. As the graph of the series clearly shows, the entire series on the Graph confirmed the existence of non-stationarity because they shows time variant pattern within the study time span (1996-2021). The time series plot of the series are also trending up ward through time. Which suggests the existence of co-integration between them in long-run.

3.2. Stationarity test of the Series

Before conducting, any analysis on time series data the stationarity condition of the series should be confirmed. In this study, well-known Dickey-Fuller test was applied and the result of the test is depicted within Table 1 below.

Table 1: *Unit-root tests at level and after first order differentiation for explanatory variables*

Variables at level	ADF unit root test at level		ADF unit root test at first difference	
	t- value (ADF)	P-value (ADF)	t- value (ADF)	P-value (ADF)
Inflation	-1.09	0.891	-12.76	0.000
BMS	-0.89	0.642	-13.885	0.000
Exchange rate	-2.28	0.712	-18.98	0.000
Interest rate	-3.48	0.154	-21.26	0.000
RGDP	-0.48	0.247	-20.47	0.000

Source: *Model Output*

In time series analysis, strong stationarity condition is very difficult to be satisfied empirically. However, time they must satisfy weak stationarity condition before modelling [16]. Based on the result of the ADF test which is depicted within Table 1, the entire time series data such as price inflation, RGDP, money supply, exchange rate and interest rate were non-stationary at level. This is because the probability value of the Dickey Fuller test, which is greater than 0.05 does not allow rejecting the null hypothesis of non-staionarity at 95% confidence interval. However, they satisfied stationarity condition after first order differentiation of the data which allows conducting time series analysis. This is because the probability value of the Dickey Fuller test was less than 0.05 which suggest rejecting the null hypothesis of non-stationarity at 95% confidence interval.

3.3. Analysis of Cointegration Between the Series

3.3.1. Jonson co-integration test result

In this study, the rank test was conducted in order to determine the maximum amount of co integrating series in VECM model and the result of the test is depicted as follows.

Table 2: *The result of rank test for co integration among the time series*

Maximum rank	Eigen value	Trace statistic	5% critical value
0	-	18.042	15.41
1	0.024	12.58	10.34
2	0.09905	12.98	11.56
3	0.33714*	3.6507*	3.76*
4	0.894	4.56	4.08
5	0.048	9.85	8.98
6	0.0546	10.28	9.98

Source: *Model Output*

Based on the rank test result for co-integration between the series which was depicted within Table 2 above, the number of the rank of the coefficient matrix was three. Thus, it can be seen as the evidence for the existence of the long-run relationship between one or more series because the coefficient matrix was not full ranked matrix. As it was suggested in [15], the value of the rank of the coefficient matrix being zero leads to the conclusion that the series are non-stationary and there is no any co-integration (long-run relationship) between the series and it should be modelled by VAR model after first order differentiation. However, in the rank test result depicted within Table 2, the trace statistics at rank (0, 1, 2) exceeds the critical value. Therefore, the null hypothesis of no co-integrating series should be rejected at 95% confidence interval. The trace statistics at rank (3) is less than the critical value. This leads to rejection of the null hypothesis which states there is no co-integration between inflation, real GDP, money supply interest rate, exchange rate in Ethiopia. Based this evidence, the application of VECM is needed in order to model the log-run relationship between the series.

3.3.2. Engle-Granger test of co integration between each series with price inflation

Based on the result of Joinson Co integration test within Table 2 above, it was confirmed that there were three co integrating series among Price inflation, Broad Money Supply, Exchange rate, Real GDP and Interest Rate. However, it is vital to test each single equation test (Engle-Granger test) in order to understand which series among them was co integrated with price inflation. The residual based test was conducted in this study and the result of the test is depicted in Table 3 as follows.

3.3.2.1. Co integration between Broad money supply and price inflation

Table 3: *the result of co integration between broad money supply and price inflation*

Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=12)

Dependent	tau-statistics statistic	Prob.*	z-statistic	Prob.*
BMS	-7.2	0.0000	-104.4323	0.0000
PRI	-9.938	0.0000	-198.7486	0.0000

*MacKinnon (1996) p-values.

Source: *model output*

Based on the result of the single equation co integration test (residual based test), there were highly significant co integration between price inflation and broad money supply. This is because the null hypothesis of residual of the both series was non-stationary was rejected at 99% confidence interval. Thus, there were long run relationship between broad money supply and price inflation series in Ethiopia which should be modelled VEC Model.

3.3.2.2. Co integration between Exchange Rate and price inflation

Table 4: *The test result of co integration between price inflation and exchange rate*

Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=12)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
PRI	-2.868411	0.0478	-15.756	0.024
EXCHRT	-1.936704	0.0016	-8.76505	0.038

*MacKinnon (1996) p-values.

Source: *model output*

The result of the Engle-Granger single equation test for co integration between exchange rate and price inflation in Ethiopia was conducted and depicted within Table 4 above. Based on the probability value of the test there were no evidence to accept the null hypothesis of the test which states that the residual of the series were non stationary at 95% confidence interval. The result suggests that there were long run relationship (co integration) between exchange rate and price inflation which should be modelled by VEC model.

3.3.2.2. Co integration between real GDP and price inflation

Table 5: *The result of Engle-Granger test for co integration between price inflation and RGDP*

Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=12)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
PRI	-4.67152	0.000	-54.13848	0.0000
RGDP	-3.51057	0.036	-26.82780	0.0118

*MacKinnon (1996) p-values.

Source: *Model Output*

Within Table 5 above, the result of Engle-Granger test based on the residuals of the series (price inflation and real GDP) were depicted. Based on the test result, real GDP and price inflation was co integrated there were long run relationship between them indeed. This is because, the null hypothesis of the test which states that no co integration between the series was rejected at 95% confidence interval. The existence of the long run disequilibrium between price inflation and real GDP should be modelled through most efficient econometric model (VECM) in order to examine the amount of disequilibrium. Moreover, Engle-Granger test of single equation based on residuals were conducted on price inflation and interest rate and the result is presented in Appendix Table 5. The result of the test has confirmed that the null hypothesis of no co integration between the series was not rejected at 95% confidence interval. Thus, there was no effect of interest rate on price inflation in Ethiopia in long run.

3.3.2. Lag order selection for the series

After testing co-integration, selecting an appropriate order of lags for the time series should take place. In this study, most applicable information criteria's, such as AIC, BIC and HQIC were conducted in order to select an appropriate lag order for the time series model as follows.

Table 6: *the result of information criteria's for lag order selection*

Lag	LL	LR	p-value	AIC	HQIC	SBIC
0	-147.24	-	0.894	8.52	8.559	8.617
1	-46.28*	202.7*	0.000*	2.983*	3.075*	3.25*
2	-44.320	3.78	0.76	3.104	3.257	3.54

Source: *Model Output*

As depicted within Table 6 above, the Hannan–Quinn information criterion (HQIC) method, Schwarz Bayesian information criterion (SBIC) method and sequential likelihood-ratio (LR) tests were significant at lag order of one, as indicated by the "*". At lag one order in the given result all information criteria's have minimum values. Therefore, the lag order one is an appropriate order for this analysis.

3.3.3. Estimating VECM model

Within Appendix Table 1, the result of VEC model analysis for three co integrating equations were estimated and result for price inflation series and other macroeconomic series such as broad money supply (MS), exchange rate (EXCHR), interest rate (IRT), and real GDP were depicted. Based on the result of the normalized co integrating coefficients model, broad money supply, exchange rate and real GDP were affirmed as long-run macroeconomic factors of high price inflation in Ethiopia. However, the long run equilibrium coefficient of interest rate was not statistically significant. Thus, there were no long run associations (co integration) between interest rate with price inflation.

On the other hand, broad money supply, RGDP and exchange rate were co integrated with price inflation in Ethiopia. This is because, the coefficient of long run equilibrium for these macroeconomic variables were highly significant.

The equilibrium between price inflation and broad money supply was -0.035 with probability value = 0.00254 which is highly significant or significant at 99% confidence interval. Since the coefficient of long run equilibrium is different from zero, there was disequilibrium between broad money supply and price inflation in Ethiopia. Thus, there were positive and significant long run association between broad money supply and price inflation in Ethiopia. The rate of adjustment per month for broad money supply was seen as 43.902% and 10.73% for price inflation respectively as the adjustment coefficient indicates. Broad money supply was not affecting price inflation in long run, but also it has significant short run effect as the result of the lagged term confirmed.

Regarding the exchange rate and price inflation in Ethiopia, there was disequilibrium among them because the value of the co integrating coefficient was different from zero (-0.23) and its probability value (0.04142) suggests rejecting the null hypothesis of no co integration at 95% confidence interval. The value of the standardized eigenvector ($\widehat{\beta}$ = -0.0405) confirmed the existence of positive and statistically significant long run association between exchange rate and price inflation in Ethiopia. This shows, as the exchange rate (Birr/$USD) increases by a unit, it results in the increase of the price inflation by 4.05% assuming other macroeconomic factors remain constant. Moreover, the rate of adjustment to equilibrium per month of exchange rate was seen as 19% based on the result of adjustment coefficient to equilibrium.

There were also disequilibrium between price inflation rate and real gross domestic product (RGDP). This is because, the value of the standardized eigenvector (β_i =0.404012) with probability value of 0.00086 is different from zero. Moreover, the positive value of the standardized eigenvector affirms the rate of price inflation in the economy gets lower and lower as RGDP gets higher and higher assuming other factors remain constant. The rate at which RGDP adjusts to the disequilibrium was 43.12% per month for the study time. This is higher rate of adjustment when compared with the rate at which price inflation adjusts per month to growth in Ethiopia. Moreover, the rate of interest in Ethiopia was not associated with price inflation as the result of the VEC model within Appendix Table 1 confirmed. This is because the probability value of the normalized co integrating coefficients was above 0.05, which leads to accept null hypothesis of no long run association between price inflation and interest rate within the study time.

In addition to the long run association between price inflation with broad money supply, exchange rate, interest rate and RGDP, there short run association was also estimated and depicted within Appendix Table 1. The result has confirmed that there was inflation inertia in price inflation of Ethiopia in the study time. This was confirmed through the coefficient of the price inflation at lag one. This clearly shows that price inflation is sensitive and a unit change of price inflation will result in 0.19% changes in the next month.

Moreover, interest rate was seen as one of the short run causes of price inflation in Ethiopia. The effect of interest rate on price inflation was positive and significant at 95% confidence interval. Thus, a unit changes in interest rate leads to increase in price inflation by 33% .There was also short run association between broad money supply and price inflation in Ethiopia as the p-value of short run dynamic coefficient (p=0.0011) within Appendix Table 1 confirmed. Thus, broad money supply was not only affecting price inflation in Ethiopia, but also it had contribution to price inflation instability in Ethiopia.

3.4. Model diagnosis test

3.4.1. Test for serial autocorrelation (LM test)

Table 7: *the result of LM test for serial autocorrelation*

Lags order	LM test Value	Probability of the test	Decision
1	12.58	0.65	Accept null hypothesis
2	101.25	0.94	Accept null hypothesis
3	2.541	0.77	Accept null hypothesis
4	32.15	0.84	Accept null hypothesis
5	55.47	0.69	Accept null hypothesis
6	40.87	0.81	Accept null hypothesis

Source: *Model output*

Within Table 8 above, the result of Lagiragian Multiplier test result for serial autocorrelation was conducted and depicted. Based on the probability value of the test which is greater than 0.05 for lag order one up to six, the null hypothesis of no serial autocorrelation cannot be rejected. This confirms that the co integrating models were specified correctly.

3.5. Conclusions of the Study

Inflation inertia: There were price inflation and macroeconomic disequilibrium in Ethiopia as the result of VEC model confirmed. In addition to this the price inflation was determined by inflation inertia (lagged inflation price). Thus, inflation rate is also a function of the last price shocks in Ethiopia.

Broad Money supply: One of the major findings of this study was that the instability of price inflation in Ethiopia is rooted on broad money supply. This is because the existence of long run co integration was confirmed by VEC model as the result of the model confirmed. There was highly statistically significant and negative long run association between broad money supply and price inflation in Ethiopia. There were also significant short run effect of broad money supply on price inflation in Ethiopia. This finding is consistent with the monitory-quantity theory of money (MQT) which considers money supply as one of the key factors of inflation particularly in developing countries like Ethiopia. Among the noticeable causes of rise of money supply is deficit budgeting of the government at higher level (IMF, 2008). According to [11], there was a bi-directional causality between broad money supply growth and inflation and unidirectional causality between currency devaluation and inflation. The causality running from inflation to broad money supply growth was stronger than that the other way round.

Exchange rate: Regarding the foreign exchange rate (Birr/USD), the result of VEC model affirmed as one of the co-integrating macroeconomic factor of unstable price inflation in Ethiopia. Thus, it can be considered as one of the long-run causes of price instability in Ethiopia. The effect of exchange rate on price inflation instability is due to the deficit of trade balance in developing countries. When the import price of a country is very high which is followed with less export price gain, it creates devaluation of domestic currency and leads to price rise of the imported goods. In relation with this finding, [16] domestic price inflation is mainly affected through foreign exchange rate depending on cost and weight of imported goods. These directly create balance of payment disequilibrium (results in deficit of balance of payment).

Real Gross domestic product (RGDP): It was affirmed that price inflation in Ethiopia is co-integrated with gross domestic product as it was confirmed based on the result of cointegration tests in this study. Continuous rise of price is caused by economic growth of a country (GDP) as it is increasing at moderate level. This study has also confirmed that there were positive impact of growth in adjusting the rate of price inflation in Ethiopia. It was confirmed that price inflation in Ethiopia has been negatively contributing to RGDP. This finding is in line with the fact that a high level of inflation disrupts the smooth functioning of a market economy [18]. Moreover, the rate of inflation if it is 1% and 3% has positive impact on economic growth in industrialized countries. The rate of inflation between 11% and 12% is suitable for developing countries [19].

3.6. Recommendations of the Study

- ✓ For economists following quantity of money theory, inflation is the result of monitory market imbalance in any country. Thus, controlling money supply through macroeconomic policies needs attention of the government in order to eliminate the adverse effect of money supply on price instability in long run in Ethiopia.
- ✓ The adverse effect of exchange rate on domestic currency which is caused by international trade imbalance was confirmed as major findings in this study. Thus, it should be tackled through stable exchange rate polices and monitory policies.
- ✓ Moreover, the adverse effect of deficit in foreign currency on local currencies should be eliminated through expansion of the level of export of a country. Related with this finding, the study of [6] explained the role of FDI in export expansion and employment generation. Thus, foreign direct investment and other investment options should be followed in Ethiopia in order to increases the dimension of export in order to reduce the adverse effect of foreign countries on local currency.
- ✓ It also needs to lift up the export dimension through investment expansion policies and facilitating domestic investment. Moreover, it also needs to limit the amount of imported goods through improving domestic tax policies, which helps to reduce informal expenses needed for huge amount of luxury goods to be imported.
- ✓ As it was confirmed in the findings of this study, since inflation rate of the last period significantly causes high price inflation in the future time. Thus, high rate of inflation should be tackled in order to get moderate or low rate of price inflation in the future time.

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Appendix

Appendix Table 1: *VEC model result for price inflation and other series*

estimation of co integrating equations

Normalized co integrating coefficients β_i (p-value)			Standardized adjustment coefficient, α_i (p-value)		Lagged effects	
					PRI(-1)	BMS(-1)
PRI	**BMS**	**C**	**CointEq1**			
1.000	-0.235212 (0.00254*) -4.47683	4.352984	D(PRI) -0.10731 (0.01221) [-3.68318] C=0.12988	D(BMS) 0.439021 9.000748 [1.65209] C=115.889	0.190382 (0.00556)** [1.62661]	0.29201 (0.9001)* [0.0156]
PRI	**EXCH**	**C**	**CointEq2**			**EXCH(-1)**
1						
1.000	-0.040544 (0.04142*) [-0.97884]	-1.071725	**D(PRI)** 0.158209 (0.04524) [-3.65472] C= 0.0202	**D(EXCH)** -0.196278 (1.41347) [0.60716] C=0.5601		575.3866 (410.871) [1.40041]
PRI	**IRT**	**C**	**CointEq2**			**IRT (-1)**
1.000	0.004125 (0.21411) [0.89460]	56.265	**D(PRI)** 0.018021 0.501214 [0.18721] C=51.2154	**D(IRT)** 15.879455 (0.548766) [12.548761] C=2.54873		-5.07012 0.00009 0.03328
PRI	**RGDP**	**C**	**CointEq3** **D(PRI)**	**D(RGDP)**		**RGDP(-1)**
1.000	0.404012 (0.00086*) [4.18717]	-68.07536	0.08389 (-0.04291) (0.82464) C=0.5781	-0.431221 (73.1005) [-4.03025] C=78.8584		3963.021 (6167.92) [0.64252]

Source: Model Output