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Trade Dependency-Inflation Relationship in Nepal (Cointegration Approach)

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Abstract- The open border between Nepal and India and trade dependency of nascent Nepalese economy with her economic giant neighbor would guide the attention of Nepalese policy-makers to consider the transmission effect of Indian Prices on Inflation in Nepal. The study employs unique variable Trade-Dependency with India as inflation transmitting variable to analyze whether Inflation in Nepal is fully home-made or does Nepal borrow [significant] portion of its inflation from India. Applying Co-Integration and VECM approach of monthly time series data from the period of 2000:01 to 2013:07, our study shows strong positive long-term relationship inflation in Nepal and trade dependency with India.

Index Terms- Cointegration, VECM, Cross Border Inflation Transmission, Trade Dependency

I. Background and Problem Statement

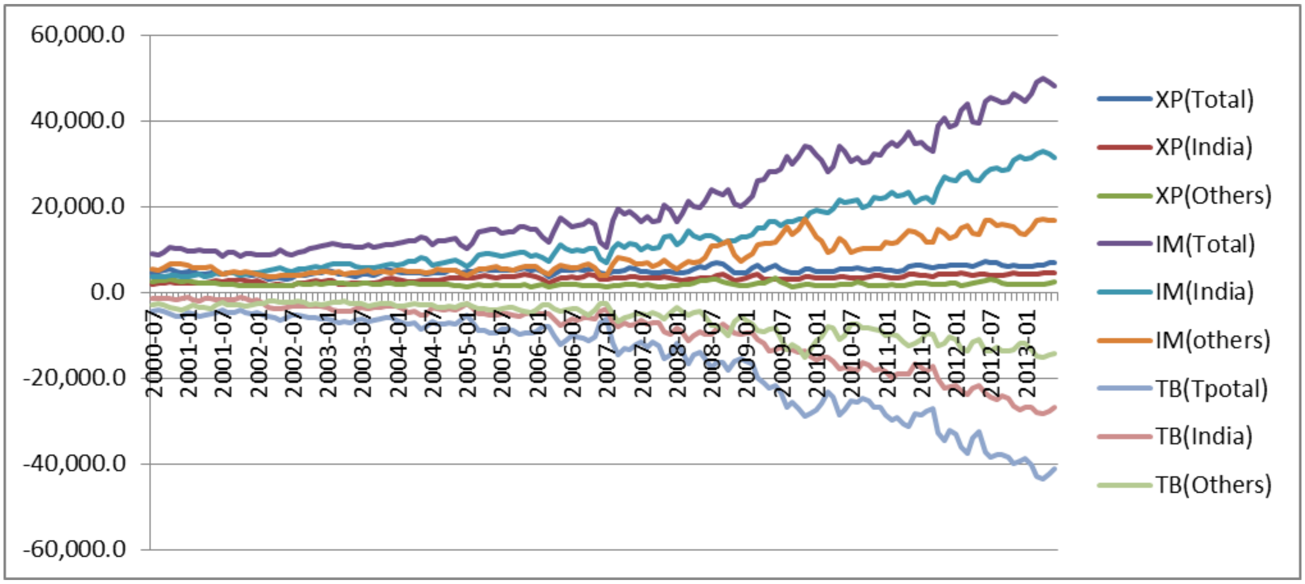
The cost of inflation to an economy is high. It effects the efficiency with which economic exchanges works, as it distorts incentive to save, invest and work, and provides incorrect signals that alters production and work effort (Boughrara, Adel, 2009)[[i]]. Because of this, the accelerators of inflation and their intensities become significant to the policy makers. Inflation accelerators can be broadly categorized into three types[[ii]]: domestic factors (those push or pull domestic price levels), external factors (those results because of trade-partnering nations) and global (those results from global shocks. Nepal is a nascent economy with international trade highly concentrated (65% of total trade as for July 2013)[iii] with her neighbor, India. Figure 1 depicts the concentration of trade, in gross and separately in imports and exports, with India and rest of the world.

Nepal share an open border of 1876 square kilometers with India and Nepalese currency is pegged with Indian currency[1]. As such the global factors would have little impact on the price determination in Nepal and if any, would be captured through its trade concentration with India. This provides an imperative to analyze the relative influence of domestic factors that influence inflation in Nepal and that borrowed from India.

In a domestic economy, among others, monetary policy influence price level. The study has identified Trade deficit with India as a inflation transmitting variable and has attempted to examine the impact of trade deficit with India on of Inflation in Nepal.

[1] The exchange rate of Nepalese Currency has remained fixed (pegged) with Indian Currency since 1960 while flexible exchange rate exists among the former with the rest of the currencies. The present exchange rate of NC 1.60 per unit of IC has been in operation since February 12, 1993.(Source: *NRB, Central Bank of Nepal*)

Figure 1: Status of Exports and Imports of Nepal from July 2000 to June 2013



XP=Export, Im=Import,TB=Trade Balance= Export-Import. Amounts expressed in million of NRs

1.1. Research Question

- Is there long-run relationship between Inflation in Nepal and Trade Dependency with India?

1.2. Delimitation and Scope of Study

The study has based its findings on secondary data. Therefore, this excludes inflation transmission that doesn't come into the picture of national accounting system. Further, the author has parsimoniously excluded explanatory variables for instance, domestic inflation gearing fiscal measures, and central bank's policy on credit expansion. This can be the area of interest for future endeavors.

II. Literature Review

International transmission mechanism is a process whereby economic disturbances are spread from one country to another and this has been one of the focal empirical research areas since early 18th century (Lothian, 1992). Inflation in context has been one of the major economic disturbances that transcends boundaries and as such has global effect (Makdisi, Fattah and Limam, 2007)[iv]. However, the intensity of transmission and its impact on the vector economy depends upon several factors including trade dependence, geographical proximity and openness and currency linkages among the economies as identified by number of researches (Mohanty and Turner, 2008)[v].

The monetarist explanation of inflation operates through the Quantity Theory of Money, $MV = PT$[vi] where M is Money Supply, V is Velocity of Circulation, P is Price level and T is Transactions or Output. As monetarists assume that V and T are determined, in the long run, by real variables, such as the productive capacity of the economy, there is a direct relationship between the growth of the money supply and inflation. The mechanisms by which excess money might be translated into inflation are many (Davoodi, Dixit and Pinter, 2013)[vii]. Individuals can spend their excess money balances directly on goods and services. This has a direct impact on inflation by raising aggregate demand. Also, the increase in the demand for labor resulting from higher demands for goods and services will cause a rise in money wages and unit labor costs. The more inelastic is aggregate supply in the economy, the greater the impact on inflation. The increase in demand for goods and services may cause a rise in imports and may cause imported inflation, which is what the focus of the study is.

Since our interest of the study is to test the transmission effect of inflation from India to Nepal, additional dependent variable, trade deficit with India, that represents Net External Demands and import Prices as shown in the study of Davoodi, Dixit and Pinter, 2013 .

III. Rationale in Selection of Variables

Inflation in Nepal has been measured by Consumer price index[viii]. Money supply (as measured by M1, narrow money supply) has been identified as domestic variable to explain inflation. One alternative and previously studied explanatory variable to capture imported inflation was CPI[2] or WPI of India , which would allow us to compare the headline inflation between Nepal and India directly. However, differences in the basket of computing price level (both CPI and WPI) in and the weightage of items in the baskets in the two countries would lead us to somewhat distorted if not spurious relation. For this, I have applied unique proxy, i.e. Trade Deficit with India, that would capture inflation transmission from India to Nepal, at the same

[2] CPI of India has been employed to analyze inflation transmission from India to Nepal in the study "Inflation In Nepal" published by NRB in 2007.

time, is not affected by these differences in basket and item-loading[3] in computing price indices.

IV. Research Methodology

The concepts of co-integration[ix] and Vector Error Correction Model (VECM)[[x]][[xi]] have highly been employed in macroeconomic studies across the globe over recent years. The wide application of VECM in the areas lies in the fact that it allows the researcher to embed a representation of economic equilibrium relationships within a relatively rich time-series specification. This approach overcomes the previously held dichotomy between the following two cases.

- structural models that faithfully represented macroeconomic theory but failed to fit the data, and
- time-series models that were accurately tailored to the data but difficult if not impossible to interpret in economic terms.

The basic idea of Cointegration relates closely to the concept of unit roots.

1.3. Unit Root Test

The Augmented Dickey–Fuller (ADF) test[xii] is, the *t*-statistic on ′ in the following regression:

$$\Delta y_t = \mu_t + \varphi y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

This test statistic is probably the best-known and most widely used unit root test. It is a one-sided test whose null hypothesis is $\varphi = 0$ versus the alternative $\varphi < 0$.

1.4. Cointegration and Vector Error Correction Model

When we have a set of macroeconomic variables of interest, and we find we cannot reject the hypothesis that some of these variables, considered individually, are non-stationary. Specifically, suppose we judge that a subset of the variables are individually integrated of order 1, or I(1). That is, while they are non-stationary in their levels, their first differences are stationary. Given the statistical problems associated with the analysis of non-stationary data (for example, the threat of spurious regression), the traditional approach in this case was to take first differences of all the variables before proceeding with the analysis. But this can result in the loss of important information. It may be that while the variables in question are I(1) when taken individually, there exists a linear combination of the variables that is stationary without differencing, or I(0).

Let,

$$y_t = \mu_t + A_1 y_{t-1} + A_2 y_{t-2} + \ldots\ldots + A_p y_{t-p} + \varepsilon_t \quad (2)$$

But since, $y_{t-i} = y_{t-1} + (\Delta y_{t-1} + \Delta y_{t-2} + \ldots\ldots. + \Delta y_{t-i+1})$ (3)

We can re-write the above as

$$y_{t-i} = y_{t-1} + (\Delta y_{t-1} + \Delta y_{t-2} + \ldots\ldots. + \Delta y_{t-i}) \quad (4)$$

$$\Delta y_t = \mu_t + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (5)$$

Where $\Pi = \sum_{i=1}^{p} A_i - I \, and . \Gamma_i - \sum_{j=i+1}^{p} A_j$

Equation (5) is VECM representation of equation (1).

The interpretation of 4 depends crucially on r , the rank of the matrix Π.

- If r =0, the processes are all I(1) and not cointegrated.
- If $r = n$, then Π is invertible and the processes are all I(0).
- Cointegration occurs in between, when $0 < r < n$ and Π can be written as $\alpha\beta'$.

In this case, y_t is I(1), but the combination $z_t = \beta' y_t$ is I(0). So, (5) can be written as

$$\Delta y_t = \mu_t + \alpha\beta' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (6)$$

If beta were known, then z_t would be observable and all the remaining parameters could be estimated via OLS. In practice, the procedure estimates β first and then the rest.

The rank of Π is investigated by computing the eigenvalues of a closely related matrix whose rank is the same as Π: however, this matrix is by construction symmetric and positive semidefinite. As a consequence, all its eigenvalues are real and non-negative, and tests on the rank of Π can therefore be carried out by testing how many eigenvalues are 0.

If all the eigenvalues are significantly different from 0, then all the processes are stationary. If, on the contrary, there is at least one zero eigenvalue, then the yt process is integrated, although some linear combination might be stationary. At the other extreme, if no eigenvalues are significantly different from 0, then not only is the process is non-stationary, but the same holds for any linear combination and no cointegration occurs.

V. Data Analysis and Discussions

Money Supply (M1) has increased from below Sixty thousand Million to over two hundred thirty million over the period. The study covers the time period in which price index base has been revised twice, first with base period 1995/96 and secondly with base period 2005/2006. The authors have re-calibrated price index before 2005/06 to accommodate this base adjustment. With this recalibration, CPI has changed from 79.09 to 187.35 during the period of study. Similarly, Trade deficit with India has widened from below one thousand two hundred million to more than twenty eight thousand.

[3] For the details of items in CPI in Nepal and India refer Annex 5.2 (a) of publication "Inflation of Nepal" published by NRB in 2007 (www.nrb.org.np)

Table 1. Summary Statistics

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	C.V.	Skewness
M1	106140.	84179.0	50349.8	230746.	50248.4	0.473418	0.798135
CPI	116.916	105.747	79.0861	187.350	31.9472	0.273249	0.681679
XpIn	3190.16	3283.13	1467.45	4652.00	742.330	0.232694	-0.227891
XpOth	1880.79	1765.27	1139.25	3183.70	407.569	0.216701	1.03019
ImIn	13009.1	10212.9	3504.10	32755.0	8319.30	0.639499	0.854012
ImOth	8233.96	6292.92	3529.95	17130.1	4042.90	0.491003	0.762782
XpT	5070.95	5010.53	3011.90	7123.20	840.707	0.165789	0.175542
ImT	21243.0	16460.0	8410.25	49885.0	12145.2	0.571724	0.810206
TrDepIn	9818.9	6844.1	1149.3	28328	7754.9	0.789	0.889

The descriptive table shown computed central tendencies and dispersion of variables using the observations 2000:01 - 2013:07. M1, XpT, XpIn, ImT and ImIn are in million of NRs. CPI is a unit less Price Index.

Figure 2, Time series of M1, CPI,ImIn and TrdepIn over the period of 2000:01 to 2013:06

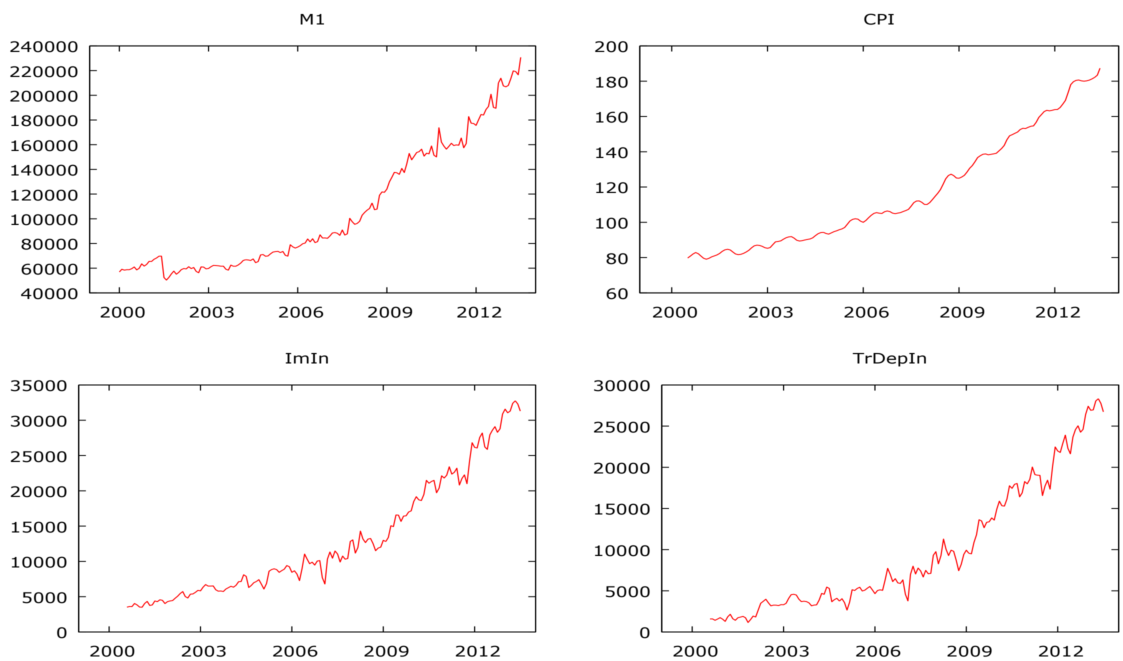


Figure 2 shows the status of variable under study over the period of 2000:01 - 2013:07. The primary impression of the time series of variables, there has been increase in the values monotonically over the periods.

1.5. Unit Root Diagnostics

Table2, Unit Root Test

Status	Variables	p-value	
		With Constant	With Trend and Constant
Level of Variable	logM1	0.9989	0.1301
	logCPI	0.9998	0.8221
	log(TrDepIn)	0.7664	0.08398
1^{st} Difference of Variable	Δ(logM1)	0.03501	0.01934
	ΔlogCPI	0.200	0.06271
	Δlog(TrDepIn)	0.0056	0.02668
Level Of Integration		logM1= I(1), logCPI= I(1) and log(TrDepIn)=I(1)	

Augmented Dickey-Fuller test for including sample size 142. Null hypothesis: Presence of Unit-root. The rejection of null hypothesis of 1st difference of all the three variables would indicate that they may be integrated in the order of 1.

Augmented Dickey Fuller (ADF) test as shown in Table 2, has indicated that all the three variables are non stationary . However, first difference of these variables are stationary indicating that they are integrated in the order of 1 i.e. these variables are I(1).

1.6. Engle Granger Test Of Cointegration

1.6.1. Between logCPI and logTrDepIn

Table 3. Cointegration test logCPI and logTrDepIn

Step	ADF Test for Unit Root	p-value	Detection	Order Of Integration
1	logCPI	~1	Presence of Unit Root	I(1)
2	logTrDepIn	0.7275	Presence of Unit Root	I(1)
3	Residual of cointegrating regression	0.02065	No Unit Root	I(0)

There is evidence for a cointegrating relationship if the unit-root hypothesis is not rejected for the individual variables but the unit-root hypothesis is rejected for the residuals from the cointegrating regression (logCPI~logTrDepIn)

1.6.2. Between logCPI, logTrDepIn and logM1

Table 4. Cointegration test logCPI, logM1 logTrDepIn

Step	ADF Test for Unit Root	p-value	Detection	Order Of Integration
1	logCPI	~1	Presence of Unit Root	I(1)
2	logM1	0.9728	Presence of Unit Root	I(1)
3	logTrDepIn	0.7275	Presence of Unit Root	I(1)
4	Residual of cointegrating regression	0.03302	No Unit Root	I(0)

There is evidence for a cointegrating relationship if the unit-root hypothesis is not rejected for the individual variables but the unit-root hypothesis is rejected for the residuals from the cointegrating regression (logCPI~logM1+logTrDepIn).

1.7. Long Term Relation Between The Variables

Inorder to enquire about the long run relation between the variables following regration has been employed.

$$\log CPI_t = \mu_t + \varphi \log TrDep_t + \varepsilon_t \quad (7)$$

$$\log CPI_t = \mu_t + \log M1_t \varphi \log TrDep_t + \varepsilon_t \quad (8)$$

Table 5, Long term Relation Between Inflation and TradeDep with India

Equation		*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
logTrDepIn as Independent Variable	Constant	2.13818	0.145269	14.7188	<0.00001***
	logTrDepIn	0.292873	0.0160003	18.3043	<0.00001***
logTrDepIn and logM1 as Independent Variables	Constant	-0.857934	0.277228	-3.0947	0.00235***
	logTrDepIn	0.0905408	0.0226539	3.9967	0.00010***
	logM1	0.416683	0.0402232	10.3593	<0.00001***

*Dependent Variable in logCPI. *** indicates the parameter is significant at 0.01.*

Table 5 shows the results of regression equations (7) and (8).The results show that the parameter coefficients are significant. With equation (7) we can see that 100 percent points change in trade deficit with India would result 29.29 percent point change in long run price level.

Even if we take money supply as additional explanatory variable as in equation (7) (though caution should be taken for multicollinearity as there is high positive correlation (0.9448 with p-value 0.1538 between logM1 and logCPI) the marginal impact of trade deficit variable is 0.09 percent point for every 100 percent point change in CPI. This clearly depicts that there is long run relation (co-integration) between inflation in Nepal and trade-deficit of Nepal with India.

1.8. Error Correction and Short-Run Disequilibrium Adjustment.

Table 6, Error Corrrection (α)

Equation		*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Equation 1: logCPI	EC1	-0.0388114	0.0039872	-9.7340	<0.00001***
Equation 2: logTrDepIn	EC2	-0.0167993	0.0667557	-0.2517	0.80165
R-square-Equation (1)	0.383993				
R-square-Equation (2)	0.000416				

**** indicates significant at 0.01*

Table 6 shows that there is short-run disequilibrium of logCPI and hence the adjustment parameter (α) is significant. On the other hand, logTrDepIn is stable and hence dis-equilibrium coefficient is not significant. This result seems intuitive in that, the TrDepIn is causal variable, here in the study.

VI. Conclusion

The analysis and discussions in the previous section confirms the existence of long run relationship between inflation in Nepal and trade deficit with India. Inflation in Nepal is not only homemade but also borrowed from India. Policy to address trade dependency with India, therefore, appears to be a matter of concern for policy makers if they aim to price stability in Nepalese economy. The actual values of logCPI versus predicted logCPI as shown in figure 7, suggests the robustness of the employed Cointegration models. Additionally, the residuals of Cointegrating and VECM regressions are normally distributed as indicated by figures 3,4, and 6 show that the residuals are normally distributed suggesting the strength of the models used and efficiency of estimated parameters.

VII. Annexure

Table 7, Normality Of Residuals

Equation	*Test Statistic (χ2)*	*p-value*
logTrDepIn as Independent Variable	2.34707	0.309272
logTrDepIn and logM1as Independent Variable	1.04272	0.593711

Chi square test has been employed to detect the normality of distribution of residuals. Null hypothesis(H_o) is Residual is normally distributed.

Table 8, OLS, using observations 2000:08-2013:06 (T = 155) Dependent variable: logCPI

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	2.13818	0.145269	14.7188	<0.00001***
logTrDepIn	0.292873	0.0160003	18.3043	<0.00001***

Mean dependent var	4.728778		S.D. dependent var	0.260724
Sum squared resid	0.766815		S.E. of regression	0.070795
R-squared	0.926750		Adjusted R-squared	0.926271
F(1, 153)	335.0463		P-value(F)	2.24e-40
Log-likelihood	191.5070		Akaike criterion	-379.0139
Schwarz criterion	-372.9271		Hannan-Quinn	-376.5416
rho	0.834215		Durbin-Watson	0.327741

Table 9, Correlation coefficients, using the observations 2000:01 - 2013:07. 5% critical value (two-tailed) = 0.1538 for n = 163

logM1	logTrDepIn	
1.0000	0.9448	logM1
	1.0000	logTrDepIn

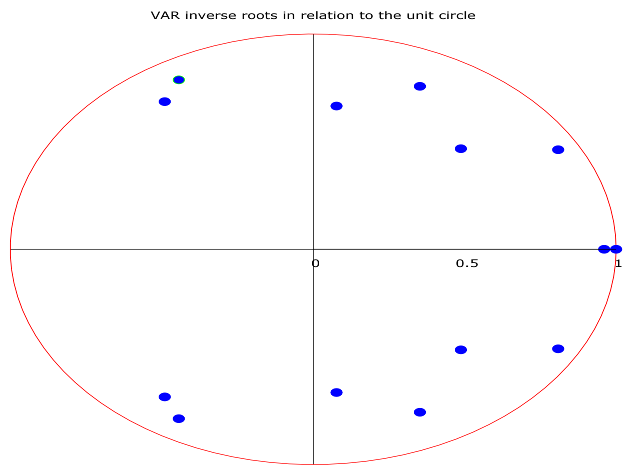


Figure 3, Normality of Residuals from co-integrating regression equation (7)

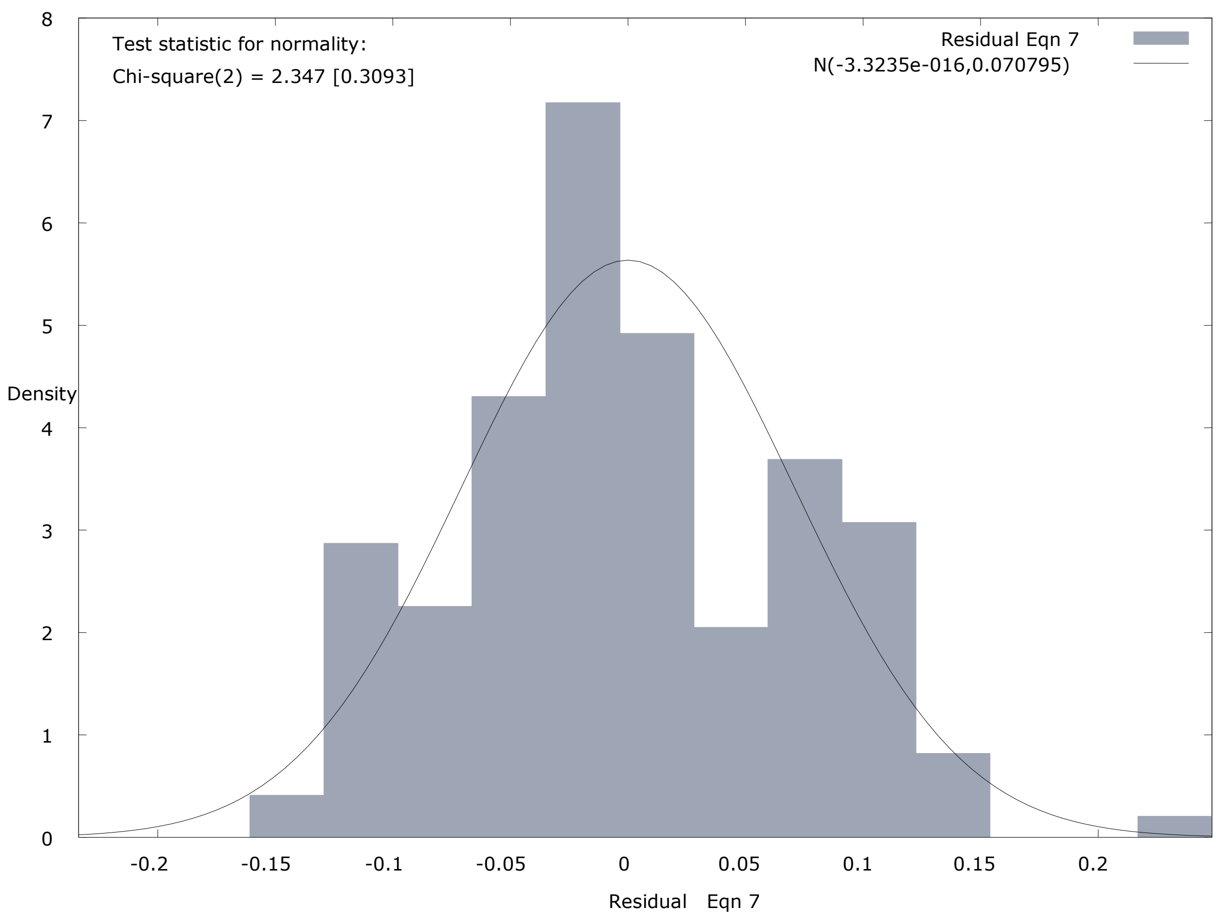


Figure 4, Residual plot of VECM model

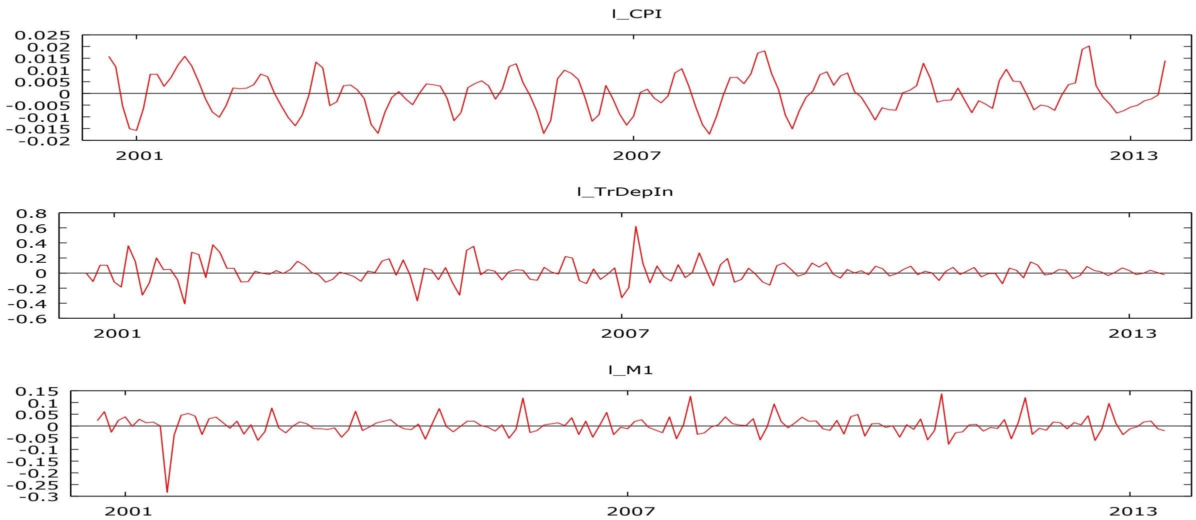


Figure 5, Normality of Cointegrating Regression as given by equation 8

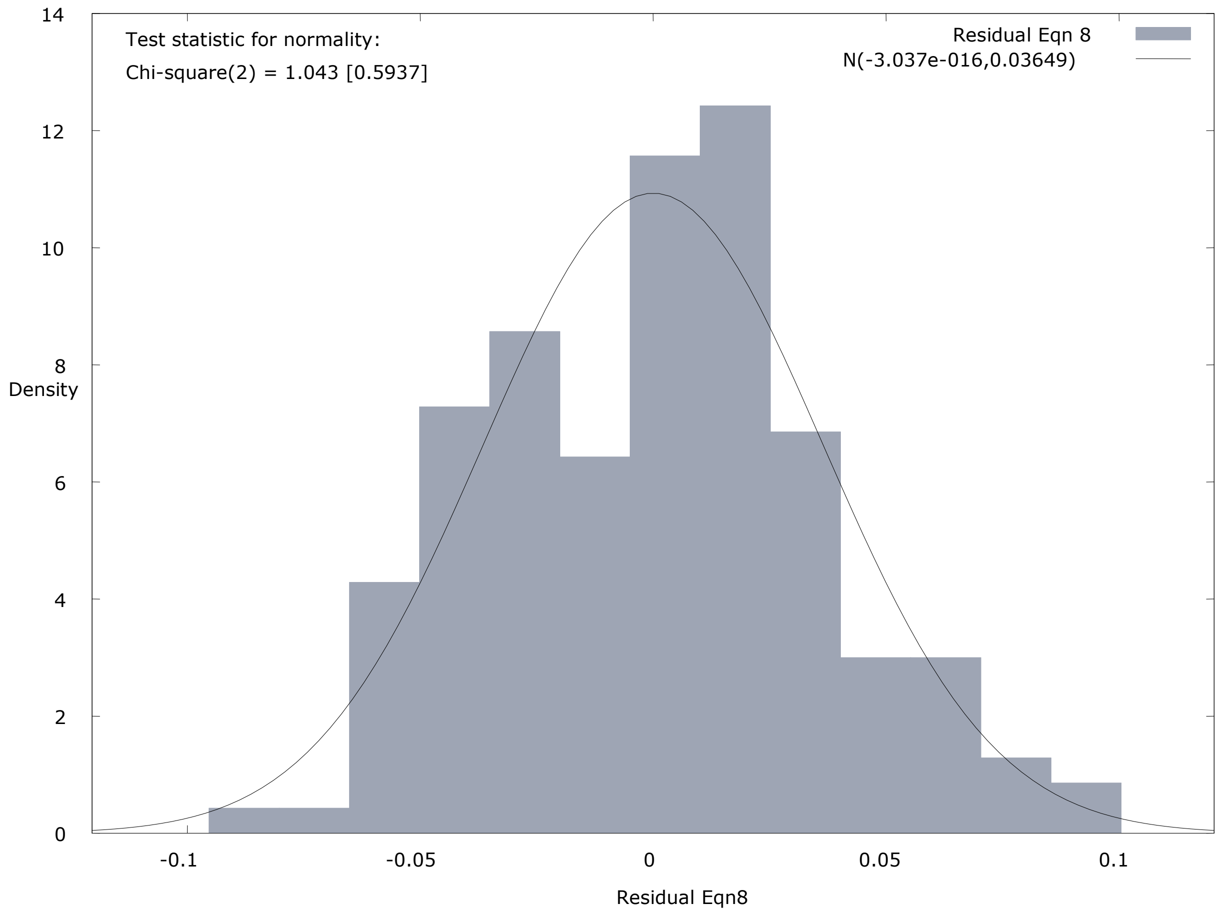


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Figure 6. Impulse Response Function

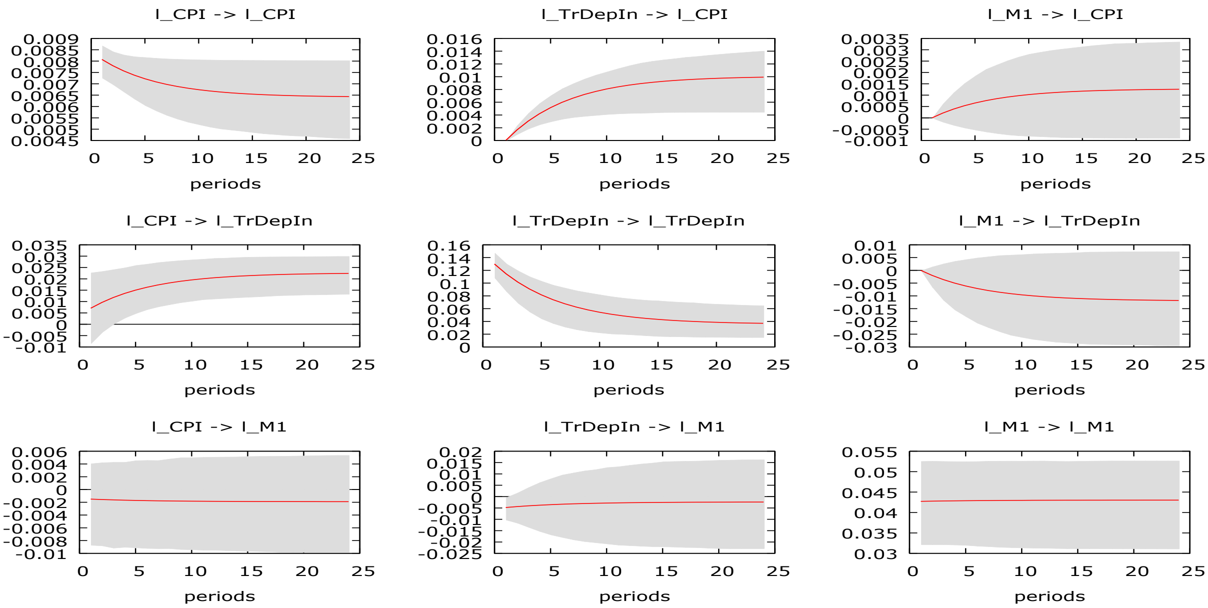


Figure 6, Normality of Residual of VECM model.

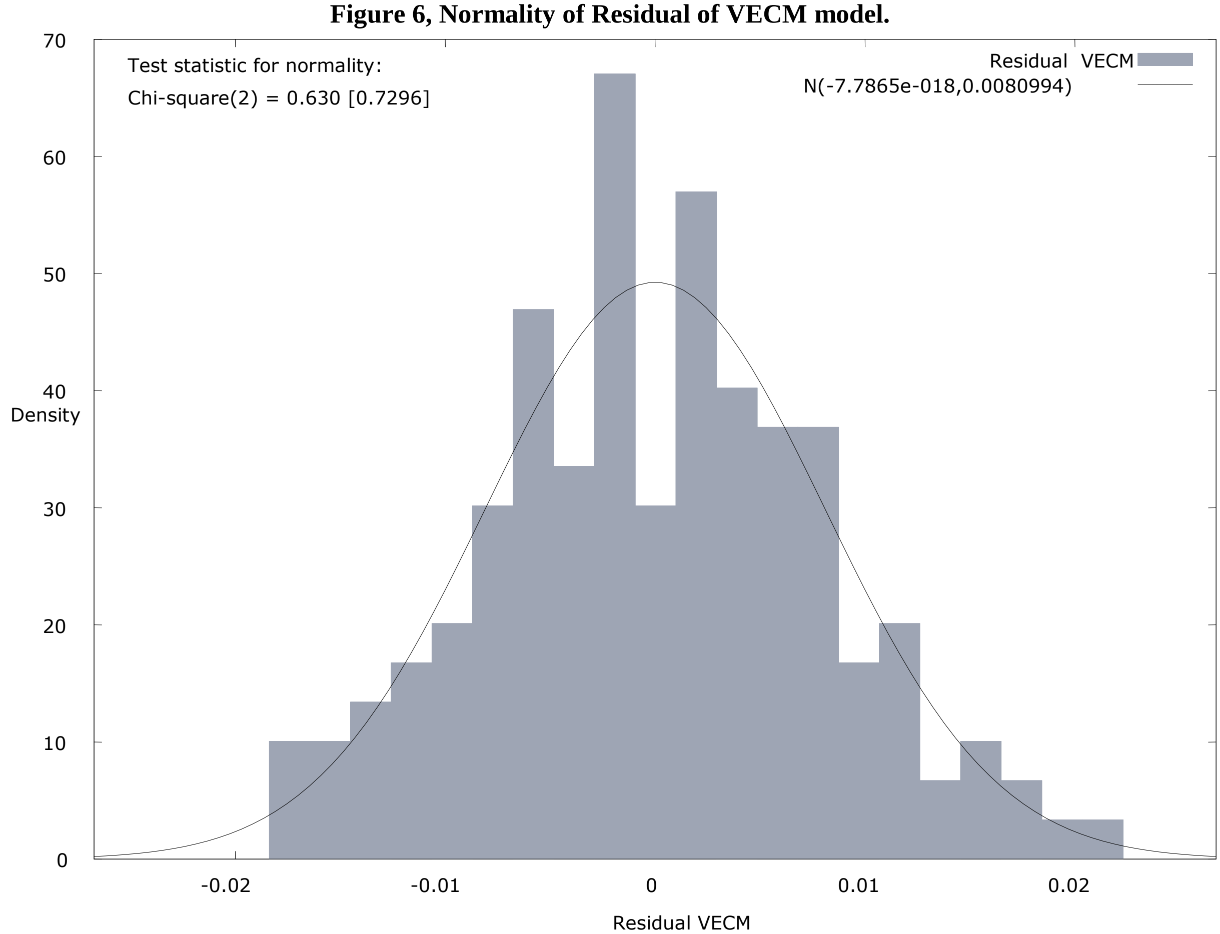
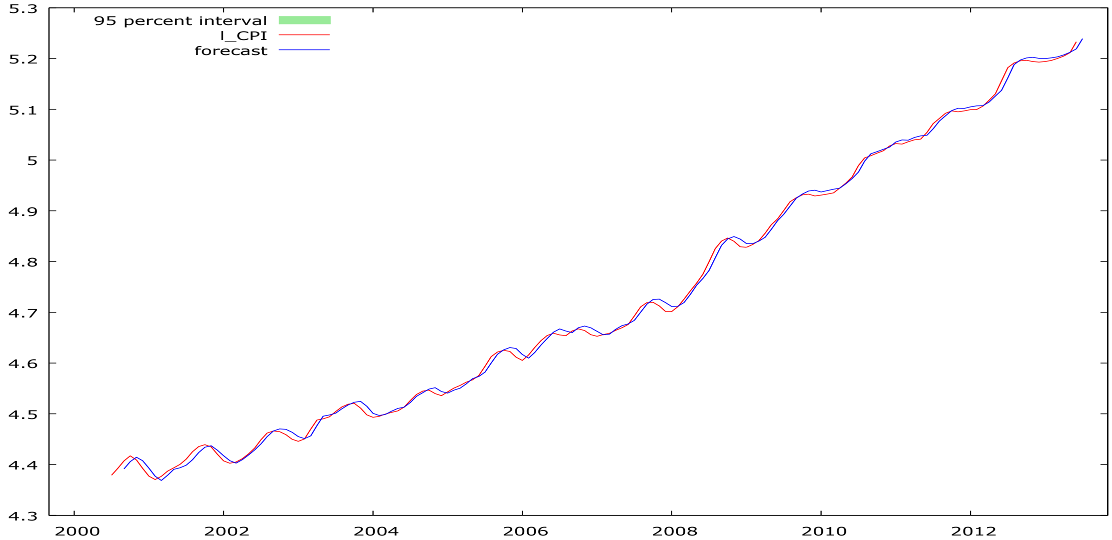


Figure 7, Forecasted CPI based on Cointegration and VECM model



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