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The verification of purchasing power parity model: evidence from US and Canada

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Abstract: Purchasing power parity theory discusses and compares the relationship of purchasing power of different currencies in different countries. It provides a better prediction method for the movement of long-term exchange rate,so it is inevitable and necessary to do a research on it. This paper focuses on the exchange rate between the US and Canada, in order to explore the validity of the purchasing power parity (PPP) model, which states that the equilibrium exchange rate should be consistent with the ratio of their relative price levels. It mainly uses OLS test, ADF test, Johansen test, VECM and impulse response analysis to verificate the model. Based on the data from 1995 to 2014 in this case, the conclusion indicates that PPP model is well fit. It is therefore concluded that the PPP hypothesis is upheld for Canada and US.

Keywords: purchasing power parity, exchange rate, OLS test, ADF test, Johansen test, VECM, impulse response analysis, US and Canada.

INTRODUCTION

The paper focuses on the exchange rate between the US and Canada, exploring the validity of the purchasing power parity (PPP) model, which states that "the equilibrium exchange rate should be consistent with the ratio of their relative price levels [1]. A necessary and sufficient condition for PPP to hold is that the three variables namely log of exchange rate between two countries and the log of price level of county A and B should be cointegrated with conintegrating vector [1 -1 1]. Based on the previous empirical studies, we collect the time series data (230 observations) from 1995 to 2014 of both countries. The PPP relation can be defined as:

$$LnPdomestic = \beta_0 + \beta_1 Lnex + \beta_2 LnPforeign + \mu_t \quad (1)$$

In this case, lnPdomestic and lnPforeign are defined as the certain price indices of Canada and American in the logarithmic format, respectively. Lnex is the logarithm of exchange rate between Canada and American (price of a unit of US dollar). In the second part, we did main diagnostic tests. The stationarity of the three variables is tested based on the work of Dickey [2] and Fuller [3] known as ADF test. Then, as we already known the variables are integrated of order one respectively, we carried out a cointegration test using the method Johansen [4] suggests. Since the non-stationarity of variables, a Vector Error Correction Model (VECM) is established in the next part, in order to illustrate the long-run relationship of the series. At last, we carried out an impulse response analysis to depict the influences among the series.

EXPERIMENTAL SECTION

OLS test and Major Diagnostic Tests

Based on OLS regression, the PPP relation between US and Canada is:

$$lcn = 4.79 - 0.52lex - 0.01lus + \mu_t \quad (2)$$

From Table 1, the significant T statistic denotes each variable should be incorporated into (2). While R^2statistic indicates the explanatory power is 75.9%.

(1)Test for first order autocorrelation

From Table 1, DW statistic (0.03) is less than the lower critical value (1.50) with 2 degree of freedom, denoting the null hypothesis of no first order autocorrelation is rejected.

(2)Test for higher order autocorrelation

LM test is applied to focus on testing the higher order autocorrelation. From Table 2, following a χ^2 distribution, LM test statistic is 218.83, which exceeds the critical value (5.99) with degree of freedom is 2 at 5% significant level. Hence, the null hypothesis of no second autocorrelation is rejected.

(3)Test for Heteroskedasticity

White's test is used to detect whether there exists heteroskedasticity. From Table 3, the null hypothesis of no heteroskedasticity in equation (1) should be rejected with the Whites' test statistic (69.94) is greater than the critical value (11.07) with 5 degree of freedom at 5% significant level.

(4)Test for normality

From Figure 1, based on the Jarque-Bera test, the P value is 0.000157, which is lower than 5% significant level, denoting there has no evidence of normality.

Test for stationary

To test the stationary of the variables, we may carry out a series of unit root test including Dickry Fuller (DF), Augmented Dickey Fuller (ADF) ,PhillipsPerron (PP) and the stationaritytest (KPSS). ADF test is applied here rather than DF test since it includes lag of difference to eliminate the dynamic structure.

The null hypothesis of ADF and PP test is that the variable has one unit root while for KPSS test is the series is stationary. Hence, from the following table we may see that for ADF and PP test, the null hypothesis could not be rejected while for KPSS test the null is rejected. Hence for level data, stationary does not exist.

Level	ADF	PP	KPSS
lcn(CanadaCPI)	5.205741	7.318922	2.018930***
lex (exchange rates)	-1.155360	-1.201770	1.620437***
lus (USCPI)	-0.572571	-0.342499	0.755177***
*,**,*** indicates significance at the 10%, 5% and 1% levels			

Then the test on first difference of the time series is shown in the second table. Similarly, all three tests yield the same result which is for the first difference of the variables, stationary exists. Hence all variables have one unit root.

FirstDifference	ADF	PP	KPSS
lcn(CanadaCPI)	-10.83114***	-10.98522***	0.060713
lex (exchange rates)	-11.40957***	-11.53469***	0.098692
lus (USCPI)	-5.174759***	-14.14598***	0.175083**
*,**,*** indicates significance at the 10%, 5% and 1% levels			

Test for Spurious Regression

Based on previous OLS test, the good t-ratios and very high R^2 statistic (0.759) > DW statistic (0.03) denotes high probability of spurious regression. Hence, ADF and PP test is applied to test the existence of unit root of residual of equation (2). Clearly, the null hypothesis of having a unit root is rejected, denoting no evidence of spurious regression.

Level	ADF	PP	-
Residual	-2.337809**	-2.265112**	-
*,**,*** indicates significance at the 10%, 5% and 1% levels			

Test for Cointegrate: Johansen Test

For two methods of cointegrate test, Engle-Granger test can only estimate up to one cointegration. Based on the results got before, the Johansen Test is better to use for estimating the correct number even there are more cointegrating relationships in the data. Before that, the optimal lag length should be chose by lag length criteria. Both tests are based on VAR.

Based on the result of AIC in Table 4, 6 lags have been included based on VAR in Johansen cointegration test.

In Table 5, the Trace test and Max test given the number of cointegration, and the estimate values of coefficient are given in the third panel.

First, in Trace Statistic, the estimate value of none cointegration is 45.18194, which is bigger than the critical value (35.19275, 5% significant level) shows in the next line.So the null hypothesis of no cointegrating vector can be rejected. Second, the estimate value of at most one cointegrating vector is 12.28842, which is less than the critical value(20.26184 at 5% level of significance). Then we cannot reject the null of at most one cointegrating vector. At Max-Eigen Statistic, the estimate value of none cointegrate is 32.89352 which is bigger than the critical value (22.29962, 5% significant level) in the next line. Hence, we reject the null hypothesis of no cointegrate. At the next part, the estimate value of at most 1 is 7.515554, which is less than the critical value (15.89120 at 5% significant level). The null hypothesis of at most one cointegrate vector cannot be rejected. In conclusion, we get one cointegrating vector in both statistics.

In next step, one cointegrate vector error correction estimate can be used.

VECM

VECM (vector error correction model) is a restricted VAR model that the restriction is the cointegration. The advantage of the VECM is that the coefficients explain the relationships of variables in long run and short run separately. In other words, VECM products the information that how the domestic price in Canada impacted by the exchange rate and domestic price in US in long run and the implication of the short run deviation by the lags diffidence. From the Johansen Test, it suggests that the long-run relationship exists between the domestic price in Canada, the exchange rate and the domestic price in US.

From the test result in Table 6, the error correction model is:

$$CE1 = LCN(-1) + \underset{(0.25237)}{0.6698}LEX(-1) + \underset{(0.02728)}{0.03959}LUS(-1) - \underset{(0.09991)}{4.5946}$$

The coefficient of LEX(-1) is significant at 5% significant level (critical value at 5% is 1.96), but the coefficient of LUS(-1) is not significant. According to theory, the equilibrium relationship in long run should trend to be zero. If cointegrating vector (CE1) was positive in the previous period which could be because LEX(-1) the exchange rate and LUS(-1) the CPI in US are too high. Therefore, to make equilibrium restored, we need LEX to fall and LUS(-1) to fall in response to a positive CE1. If the CE1 is negative, opposite adjustment may happen. According to adjustment parameter, the coefficients of the D(LCN) and D(LEX) are significant at 5% significant level, but the coefficient of the D(LUS) is not significant. In other words when the domestic price in Canada deviates to the average in long run, the adjustment of the exchange rate will force it to the long-term equilibrium. The domestic price in US will also correct it to equilibrium, but not in a significant way. The coefficient of D(LCN) and D(LUS) is 0.0061 and -0.0142, respectively, which suggest that about 0.61% of disequilibrium "correct" each month by changes in domestic price in Canada LCN, and about 1.42% of disequilibrium "correct" each month by changes in the exchange rate LEX.

The lags of the first different variables impact the short-term relationships, which could be deviated from the equilibrium.

Impulse response

Impulse responses describe the responsiveness of the explained variables in a VAR system to shocks when a unit shock functions in the error one at a time to each variable. To analyse the impulse responses in an explicit way, we choose a first differenced VAR model and get the results as Figure 2. Overall, the change of price level in two consecutive periods can be identified as inflation. Also, the first difference of exchange rate can be treated as the appreciation or depreciation of US dollars (DLEX). Consider the signs of the responses, a positive unit shock in Canada inflation (DLCN) and the US dollar appreciation (DLEX) will have a significant positive impact on DLCN and DLEX, respectively. But the impulse responses weaken rapidly in less than three periods. The response of inflation rate of the US to a unit shock in itself is also positive, but weakens even quicker than DLCN and DLEX, which is less than two periods. As for magnitude, however, DLUS has the strongest response to a unit shock, about one hundred times to DLCN. Not surprisingly, the slightest response comes to the inflation of Canada (DLCN). For the remaining six graphs, a given unit shock does not significantly affect the dependent variables. This may because we choose CPI as the price level of both Canada and the US. MacDonald (1995) argues that CPI includes non-traded goods' price which would lead to some unfavourable empirical results. We also suggest that there are some differences in the goods of basket in CPI of the US and Canada. Therefore, it may be hard for us to identify the connections among LCN, LUS and LEX.

Granger Causality

Granger causality test is applied to examine whether lags of certain variables incorporated into VAR model have significant effects on each dependent variable or not. Based on this case, the corresponding hypotheses can be examined by Granger causality test:

Lags of DLex and DLus do not Granger-cause DLcn;

Lags of DLcn and DLus do not Granger-cause DLex;

Lags of DLcn and DLex do not Granger-cause DLus;

From previously ADF test, all the variables (Lcn, Lex and Lus) are integrated of order 1. Hence, we need to use the stationary variable (first difference form) to conduct Granger causality test with 6 lags based on the AIC information criteria.

From Table 7, there exists unidirectional causality from DLcn and DLex to DLus, denoting only the lags of DLcn and DLex are Granger-cause DLus in the 5% significant level but not vice versa, which indicates DLus is an exogenous variable. Moreover, the lags of DLcn are Granger-cause DLex only if significant level is 10%. Hence, only the third previous hypothesis is accepted at 5% significant level.

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RESULTS AND DISSCUSSION

Based on the data from 1995 to 2014 in this case, the PPP model is well fit. The time series of log exchange rate between Canada and US, log of price level of Canada and log of price level of US are all I(1), however, the variables are cointegrated. It is therefore concluded that the PPP hypothesis is upheld for Canada and US. However the estimated vector error correction model is

$$ce1 = lcn(-1) + 0.6698lex(-1) + 0.0396lus(-1) - 4.5946$$

PPP suggest that the estimated value of the VECM coefficient should be [-1 1 1] where (-1) is the coefficient for the domestic price level (lcn in this case), however the value estimated here is a long way from the expected value. Hence from this point of view, PPP is not perfectly upheld.

CONCLUSION

This paper focuses on the exchange rate between the US and Canada, in order to verificate the PPP model through the data from 1995 to 2014.Several tests have been done. The basic PPP model is constructed through OLS test firstly. ADF test is used to test the stationary of the variables since it includes lag of difference to eliminate the dynamic structure. Based on the results got before, the Johansen Test is applied to use for estimating the correct number. And then, VECM test products the information that how the domestic price in Canada impacted by the exchange rate and domestic price in US in long run and the implication of the short run deviation by the lags diffidence. Next, impulse responses is used to describe the responsiveness of the explained variables in a VAR system to shocks when a unit shock functions in the error one at a time to each variable. Finally, Granger causality test is applied to examine whether lags of certain variables incorporated into VAR model have significant effects on each dependent variable or not. In conclusion, the PPP model is well fit. It means that the PPP hypothesis is upheld for Canada and US.

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Appendix :

Table 1 OLS Regression Result

Dependent Variable: LCN
Method: Least Squares
Date: 04/14/14 Time: 21:05
Sample: 1995M01 2014M02
Included observations: 230

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEX	-0.522745	0.024138	-21.65643	0.0000
LUS	-0.011996	0.002023	-5.928870	0.0000
C	4.790210	0.006625	723.0205	0.0000

R-squared	0.759219	Mean dependent var	4.646150
Adjusted R-squared	0.757097	S.D. dependent var	0.110634
S.E. of regression	0.054526	Akaike info criterion	-2.967308
Sum squared resid	0.674898	Schwarz criterion	-2.922464
Log likelihood	344.2405	Hannan-Quinn criter.	-2.949219
F-statistic	357.8823	Durbin-Watson stat	0.031209
Prob(F-statistic)	0.000000		

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Table 2 Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2203.033	Prob. F(2,225)	0.0000
Obs*R-squared	218.8255	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/16/14 Time: 18:43
Sample: 1995M01 2014M02
Included observations: 230
Presample missing value lagged residuals set to zero.

	Coefficient	Std. Error	t-Statistic	Prob.
LUS	-0.000222	0.000448	-0.494688	0.6213
LEX	0.004611	0.005369	0.858751	0.3914
C	-0.000420	0.001469	-0.285660	0.7754
RESID(-1)	1.107043	0.066341	16.68723	0.0000
RESID(-2)	-0.135000	0.066383	-2.033642	0.0432

R-squared	0.951415	Mean dependent var	-5.31E-16
Adjusted R-squared	0.950551	S.D. dependent var	0.054288
S.E. of regression	0.012072	Akaike info criterion	-5.974359
Sum squared resid	0.032790	Schwarz criterion	-5.899618
Log likelihood	692.0513	Hannan-Quinn criter.	-5.944210
F-statistic	1101.517	Durbin-Watson stat	1.578500
Prob(F-statistic)	0.000000		

Table 3 White's Test

Heteroskedasticity Test: White

F-statistic	19.57645	Prob. F(5,224)	0.0000
Obs*R-squared	69.94146	Prob. Chi-Square(5)	0.0000
Scaled explained SS	66.35659	Prob. Chi-Square(5)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/16/14 Time: 00:44
Sample: 1995M01 2014M02
Included observations: 230

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000649	0.000751	0.864558	0.3882
LEX^2	-0.032053	0.012692	- 2.525393	0.0122
LEX*LUS	-0.009531	0.002453	-3.886226	0.0001
LEX	0.052486	0.007866	6.672464	0.0000
LUS^2	-0.000167	5.64E-05	-2.956989	0.0034
LUS	0.000269	0.000176	1.532151	0.1269

R-squared	0.304093	Mean dependent var	0.002934
Adjusted R-squared	0.288560	S.D. dependent var	0.004104
S.E. of regression	0.003462	Akaike info criterion	-8.468243
Sum squared resid	0.002685	Schwarz criterion	-8.378554
Log likelihood	979.8480	Hannan-Quinn criter.	-8.432065
F-statistic	19.57645	Durbin-Watson stat	0.090536
Prob(F-statistic)	0.000000		

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Table 4 VAR Lag Order Selection Criteria

Endogenous variables: LCN LEX LUS
Exogenous variables: C
Date: 04/14/14 Time: 20:40
Sample: 1995M01 2014M02
Included observations: 218

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.557389	NA	0.000211	0.050985	0.097561	0.069798
1	1488.643	2927.677	2.62e-10	-13.54718	-13.36088*	-13.47193
2	1504.309	30.32633	2.47e-10	-13.60834	-13.28231	-13.47665*
3	1515.904	22.12586	2.41e-10	-13.63214	-13.16639	-13.44402
4	1523.197	13.71661	2.45e-10	-13.61649	-13.01100	-13.37192
5	1537.549	26.59805	2.33e-10	-13.66559	-12.92038	-13.36459
6	1550.789	24.17234	2.25e-10*	13.70449*	-12.81955	-13.34705
7	1558.374	13.63742	2.28e-10	-13.69150	-12.66684	-13.27762
8	1565.761	13.08086	2.31e-10	-13.67671	-12.51232	-13.20639
9	1576.775	19.19905*	2.27e-10	-13.69519	-12.39107	-13.16843
10	1582.116	9.162514	2.35e-10	-13.66162	-12.21777	-13.07843
11	1586.944	8.149819	2.45e-10	-13.62334	-12.03977	-12.98371
12	1590.001	5.076006	2.59e-10	-13.56881	-11.84552	-12.87275

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5 Johansen Cointegration Test

Johansen CointegrationTest
Date: 04/14/14 Time: 20:42
Sample (adjusted): 1995M08 2014M02
Included observations: 223 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LCN LEX LUS
Lags interval (in first differences): 1 to 6
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.137141	45.18194	35.19275	0.0031
At most 1	0.033140	12.28842	20.26184	0.4233
At most 2	0.021176	4.772869	9.164546	0.3092

Trace test indicates 1 cointegratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.137141	32.89352	22.29962	0.0012
At most 1	0.033140	7.515554	15.89210	0.6064
At most 2	0.021176	4.772869	9.164546	0.3092

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level,

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LCN	LEX	LUS	C
-5.020072	-3.362225	-0.198762	23.06547
17.12219	10.58674	0.386934	-83.31427
-8.005229	1.553683	0.112692	36.21233

Unrestricted Adjustment Coefficients (alpha):

D(LCN)	-0.001210	-0.000227	-6.74E-05
D(LEX)	0.002825	-0.002539	0.000324
D(LUS)	-0.016800	0.001672	0.030876

1 Cointegrating Equation(s):		Log likelihood	1591.321
Normalized cointegrating coefficients (standard error in parentheses)			
LCN	LEX	LUS	C
1.000000	0.669756	0.039593	-4.594648
	(0.25237)	(0.02728)	(0.09991)
Adjustment coefficients (standard error in parentheses)			
D(LCN)	0.006074		
	(0.00116)		
D(LEX)	-0.014181		
	(0.00555)		
D(LUS)	0.084338		
	(0.07610)		

2 Cointegrating Equation(s):		Log likelihood	1595.078
Normalized cointegrating coefficients (standard error in parentheses)			
LCN	LEX	LUS	C
1.000000	0.000000	-0.181636	-8.125156
		(0.38715)	(1.28401)
0.000000	1.000000	0.330313	5.271332
		(0.61123)	(2.02719)
Adjustment coefficients (standard error in parentheses)			
D(LCN)	0.002189	0.001666	
	(0.00413)	(0.00257)	
D(LEX)	-0.057660	-0.036381	
	(0.01949)	(0.01213)	
D(LUS)	0.112963	0.074185	
	(0.27048)	(0.16838)	

Table 6 Vector Error Correction Estimates

Date: 04/14/14 Time: 20:44
Sample (adjusted): 1995M08 2014M02
Included observations: 223 after adjustments
Standard errors in ( ) & t-statistics in [ ]

CointegratingEq:	CointEq1		
LCN(-1)	1.000000		
LEX(-1)	0.669756		
	(0.25237)		
	[2.65383]		
LUS(-1)	0.039593		
	(0.02728)		
	[1.45119]		
C	-4.594648		
	(0.09991)		
	[-45.9877]		
Error Correction:	D(LCN)	D(LEX)	D(LUS)

CointEq1	0.006074	-0.014181	0.084338
	(0.00116)	(0.00555)	(0.07610)
	[5.21571]	[-2.55302]	[1.10825]
D(LCN(-1))	0.141610	0.398121	4.096551
	(0.07086)	(0.33797)	(4.63049)
	[1.99855]	[1.17798]	[0.88469]
D(LCN(-2))	-0.059775	-0.452388	1.450250
	(0.07131)	(0.34013)	(4.66012)
	[-0.83824]	[-1.33003]	[0.31120]
D(LCN(-3))	-0.069184	0.304632	-4.960846
	(0.07175)	(0.34224)	(4.68893)
	[-0.96423]	[0.89013]	[-1.05799]
D(LCN(-4))	-0.079033	0.067727	-15.05099
	(0.07201)	(0.34347)	(4.70586)
	[-1.09753]	[0.19718]	[-3.19835]
D(LCN(-5))	-0.156114	0.973472	-5.631222
	(0.07362)	(0.35113)	(4.81081)
	[-2.12067]	[2.77239]	[-1.17053]
D(LCN(-6))	-0.005192	0.557032	-7.007056
	(0.07543)	(0.35976)	(4.92910)
	[-0.06884]	[1.54833]	[-1.42157]
D(LEX(-1))	-0.016677	0.262135	-0.980109
	(0.01450)	(0.06918)	(0.94777)
	[-1.14993]	[3.78940]	[-1.03412]
D(LEX(-2))	-0.006930	0.021690	-4.754567
	(0.01494)	(0.07126)	(0.97631)
	[-0.46387]	[0.30438]	[-4.86994]
D(LEX(-3))	0.003657	0.025546	2.474397
	(0.01536)	(0.07325)	(1.00360)
	[0.23814]	[0.34875]	[2.46551]
D(LEX(-4))	0.003823	0.151907	-0.518892
	(0.01549)	(0.07387)	(1.01214)
	[0.24686]	[2.05630]	[-0.51267]
D(LEX(-5))	0.015330	-0.064963	2.424797
	(0.01524)	(0.07267)	(0.99563)
	[1.00620]	[-0.89396]	[2.43544]
D(LEX(-6))	-0.021720	-0.085446	1.703123
	(0.01505)	(0.07179)	(0.98358)
	[-1.44308]	[-1.19022]	[1.73155]
D(LUS(-1))	-0.000388	0.002017	-0.033029
	(0.00106)	(0.00504)	(0.06899)
	[-0.36760]	[0.40061]	[-0.47874]
D(LUS(-2))	-7.52E-05	0.007465	-0.097117
	(0.00103)	(0.00492)	(0.06743)
	[-0.07288]	[1.51683]	[-1.44022]
D(LUS(-3))	0.001048	-0.009259	0.139364
	(0.00098)	(0.00468)	(0.06406)
	[1.06872]	[-1.98028]	[2.17550]

D(LUS(-4))	-9.67E-05	-0.007638	0.344646
	(0.00098)	(0.00467)	(0.06393)
	[-0.09888]	[-1.63699]	[5.39128]
D(LUS(-5))	-4.63E-05	0.001156	0.099097
	(0.00100)	(0.00478)	(0.06552)
	[-0.04616]	[0.24178]	[1.51253]
D(LUS(-6))	-0.001383	0.001094	-0.036183
	(0.00098)	(0.00468)	(0.06415)
	[-1.40892]	[0.23372]	[-0.56401]
R-squared	0.095871	0.204400	0.309669
Adj. R-squared	0.016095	0.134200	0.248757
Sum sq. resids	0.002448	0.055692	10.45424
S.E. equation	0.003464	0.016523	0.226376
F-statistic	1.201750	2.911683	5.083904
Log likelihood	956.8720	608.4789	24.78500
Akaike AIC	-8.411408	-5.286807	-0.051883
Schwarz SC	-8.121111	-4.996509	0.238414
Mean dependent	0.001547	-0.000932	-0.035454
S.D. dependent	0.003492	0.017757	0.261181

Determinant resid covariance (dof adj.)	1.66E-10
Determinant resid covariance	1.27E-10
Log likelihood	1591.321
Akaike information criterion	-13.72485
Schwarz criterion	-12.79284

Table 7 Granger Causality Test

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 04/19/14 Time: 15:17
Sample: 1995M01 2014M02
Included observations: 223

Dependent variable: DLCN

Excluded	Chi-sq	df	Prob.
DLEX	4.635220	6	0.5914
DLUS	3.648788	6	0.7241
All	7.576967	12	0.8173

Dependent variable: DLEX

Excluded	Chi-sq	df	Prob.
DLCN	11.68131	6	0.0695
DLUS	10.38301	6	0.1094
All	20.65728	12	0.0556

Dependent variable: DLUS

Excluded	Chi-sq	df	Prob.
DLCN	18.66406	6	0.0048
DLEX	40.32178	6	0.0000
All	62.87381	12	0.0000

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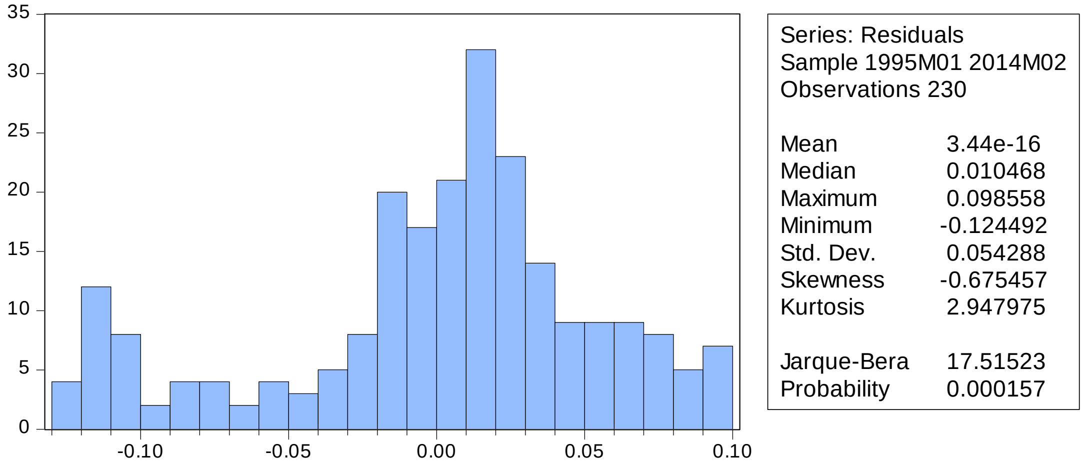

Fig-1 Normality Test

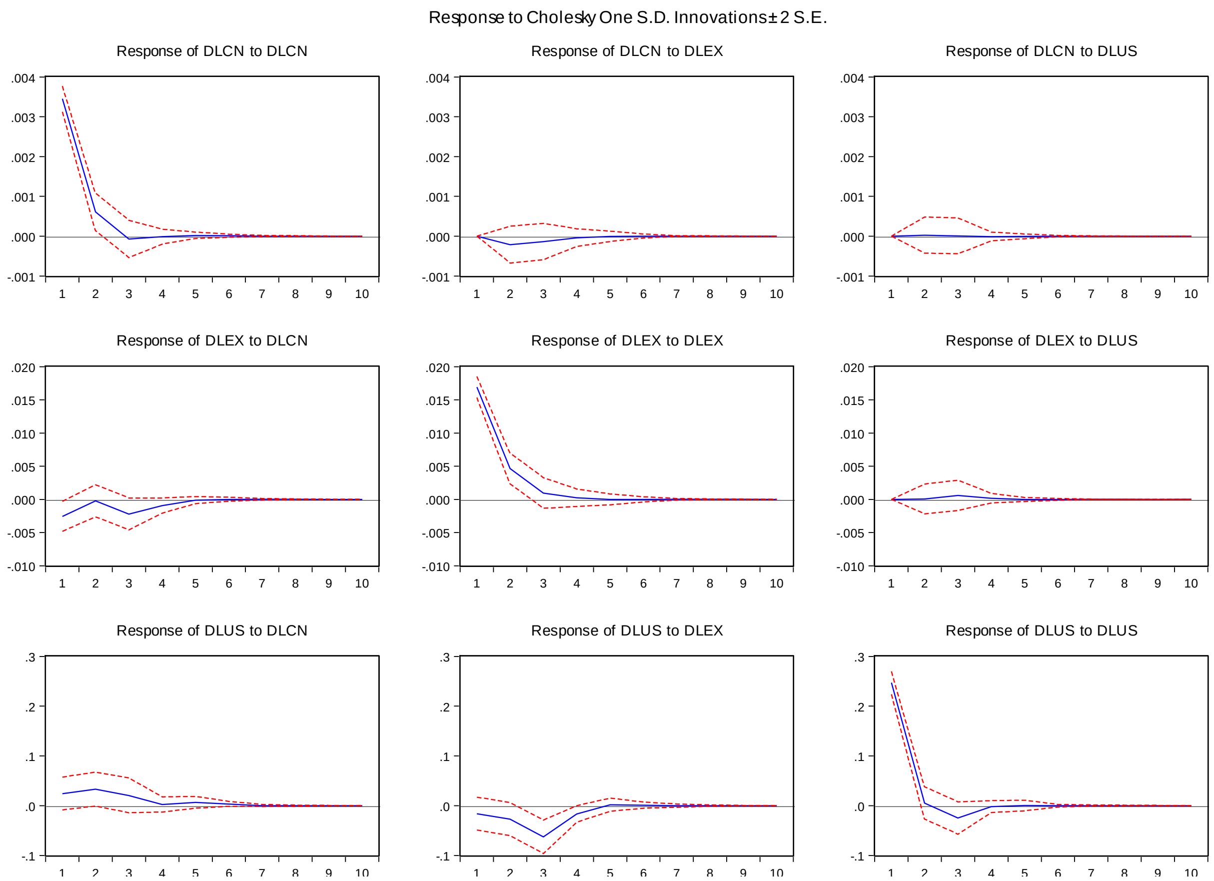

Fig-2: Impulse Response