TIME SERIES ANALYSIS OF CHINA’S EXTERNAL DEBT COMPONENTS, FOREIGN EXCHANGE RESERVES AND ECONOMIC GROWTH RATES

Hüseyin Çetin

Phd Business Administration Candidate
Okan University Social Science Institute, Istanbul, Turkey

Abstract

China has sustainable economic growth performance after adapting open economy. In this article, time series analysis applied and it has been found that China’s short term external debts, foreign exchange reserves, total external debts have significant impact on China’s economic growth rates within the period of 1982-2009. According to Granger causality analysis, China’s foreign exchange reserves can forecast China’s economic growth rates. Impulse response analysis and variance decomposition analysis implies that China’s foreign exchange reserves innovation impact on China’s economic growth rates is more than China’s short term external debt rates innovation impact on China’s economic growth rates.

Keywords: China’s foreign exchange reserves rates, China’s short term external debt rates, China’s economic growth rates, Johansen cointegration test, Granger causality test, impulse response analysis, variance decomposition analysis

1.0 Introduction

With the collapse of USSR in 1991 and Berlin Wall, trade liberalizations have been increasing remarkably in the world. Since 1991, international business activities have been more active; some of the Asian countries such as China has been developing fast economically. China is one of the most dynamic economy in the world. China’s average economic growth rate since 1980 is higher than many countries average economic growth rate due to the China’s export based regime. Over the first part of the last century, primarily on the Japanese experience of modern industrialization, Prof. Dr. Kanane Akamatsu developed what is known today as the “flying geese theory” in which he splitted countries into different levels of industrialization and economic development into three categories: late developing countries, industrially advanced countries and newly rising countries. This catching up process often embarks with the late developing countries first having imports from industrially advanced countries, then moving forward to domestic production, and finally turning around to export to industrially advanced countries. A flying geese pattern is apparent here in the sense that Japan is leading both in moving into and out of the period of high GDP share of industrial output followed by second wave, Korea, Singapore and Taiwan and then more recently by China (Huang, 2004). Yangtze River Delta is one of the reason for China to achieve higher economic growth rates. That river delta has been increasing China’s international trade intensity. In addition, China Treasury has abundant foreign exchange reserves and China’s foreign exchange reserves have been increasing every year. China uses USA dollar for international trade transactions and since China is export hub of the world, China has been getting substantial amount of loans from World Bank, Asia Development Bank in order to create better infrastructure to serve domestic and international
markets. In this article, by using time series analysis short-term and long term relationship between China’s external debts, foreign exchange reserves and economic growth rates will be scrutinized.

2.0 Literature Review

Wijeweera, Dollery, Pathberiya (2005) indicated that total external debt creates problem since whenever a country has accumulated a substantial debt, a significant proportion of public expenditure and foreign exchange earnings are absorbed by debt servicing, with heavy opportunity cost. The credit rationing effect arises when a debtor nation is unable to repay its debt. In order to narrow the savings investment gap, so as to generate a greater surplus for debt repayment, the authorities in the country may increase interest rates that can in turn, adversely affect new investments and thus subsequently depress future growth prospects.

Pattillo, Ricci and Poiron (2002), assessed the non-linear impact of external debt growth using a panel data of ninety three (93) countries over 1969-98 employing econometric methodologies. Their finding suggested the average impact of debt becomes negative at about 160-170 percent of export or 35-40 percent of gross domestic product (GDP).

The liquidity constraint hypothesis also imposes the same constraint emphasizing on crowding out impact. It states that an increase in external debt servicing leaves less avenues for developing countries to service their debt, that, therefore, affect their ability to borrow further from external resources, putting pressure on domestic borrowing and leading to crowding out. Therefore, a reduction in current debt service should lead to an increase in current investment for any given level of future indebtedness (Cohen 1993).

Karagol (2003) used multivariate co-integration technique to develop a vector error correction model to investigate the long run effects of external debt service on GNP level of Turkey and found out a uni-directional negative relationship between the two variables.

However, Hayami (1997) indicated that theoretically, it is not adequate to fund the domestic investment through external credit borrowing, nevertheless, if such external credits are used for production facilities effectively, it will contribute and facilitate import reduction. Actually, developing countries in far Asia, borrowed excessively for their economies development endeavours. However, the debt export ratio on average decreased for Asian economies and when the outstanding debt reduces the export ratio rises significantly, even more than the velocity of debt accumulation. This type of speedy increase in aggregate exports involves enhancing the export of manufactured commodities. Such correlation appear to demonstrate a vicious cycle operating in fast developing countries, particularly in Asian countries where the domestic investment has risen more intensively through external credits, which boost the production and export volume. Thus, the obtained adequate foreign exchange earnings cover the accumulated debt service. Generally, in less developed countries external debts were not effectively implemented to generate production plan and export capacity.

There is strong empirical evidence that the accumulation of foreign exchange reserves (FER) may lead to lower exchange rates, which in turn stimulate export-led growth. Countries with rapidly growing FER/GDP ratios, other things being equal, exhibit higher investment/GDP ratios, higher trade GDP ratios, higher capital productivity and higher rates of economic growth. At an intuitive level, undervaluation of the exchange rate, while fighting inflation through tight fiscal and monetary policy (sterilization of increases in money supply caused by the growth of foreign exchange reserves), seems to be a way to encourage exports, restructuring, and growth. Undervalued currency appears to be a necessary component of export led growth. It used to be the strategy of Japan, Korea, Taiwan and Singapore some time ago, when those
countries were still poor and were catching up with high income states. This is currently the strategy of many new emerging market economies, especially that of China, which continues to keep the exchange rate at an extremely low level by accumulating foreign exchange reserves at a record pace (Polterovic, Popov, 2003).

3.0 Theoretical Framework

The dual gap analysis explained that development is a function of investment and that such investment which require domestic savings, is not adequate to ensure that development take place. In national income accounting, an excess of investment over domestic saving is equal to excess surplus of import over export.

\[
\text{Income} = \text{consumption} + \text{import} + \text{savings} \\
\text{Output} = \text{consumption} + \text{export} + \text{investment} \\
\text{Income} = \text{output} \\
\text{Investment} – \text{Saving} = \text{Import} – \text{Export}
\]

Turkey’s investment rates are higher than Turkey’s saving rates. For that reason, Turkey’s import rates are higher than Turkey’s export rates and external debt has negative impact on economic development of Turkey. That circumstance corresponds with Karagol’s (2003) finding.

China’s savings rates are higher than China’s investment rates. Thus, China’s export rates are higher than China’s import rates. That circumstance lead China to achieve budget surplus. With that framework it can be argued that external debt and foreign exchange reserves can accelerate the economic development of China.

4.0 Methodology

Data were collected from secondary source which is World Bank and State Administration of Foreign Exchange website. For short term effect 1982-2009 year range was measured.

Research Questions: 1) Do China’s total external debts have significant impact on China’s economic growth rates? 
2) Do China’s short term external debts have significant impact on China’s economic growth rates? 
3) Do China’s long term external debts have significant impact on China’s economic growth rates? 
4) Do China’s foreign exchange reserves have significant impact on China’s economic growth rates? 
5) Do China’s foreign exchange reserves, short term external debt and economic growth rates have long term stable equilibrium relationship? 
6) Are there Granger causality relations between China’s short term external debts and China’s foreign exchange reserves and China’s economic growth rates?

4.1 Hypothesis Testing

H1: China’s total external debts have significant impact on China’s economic growth rates.

H1a: China’s short term external debts have significant impact on China’s economic growth rates.

H1b: China’s long term external debts have significant impact on China’s economic growth rates.

H2: China’s foreign exchange reserves have significant impact on China’s economic growth rates.

H3: China’s short term external debts and China’s foreign exchange reserves have long term relation with China’s economic growth rates.

H4: There is a causality between China’s total external debts and China’s economic growth rates.

H4a: There is a causality between China’s short term external debts and China’s economic growth rates.

H4b: There is a causality between China’s long term external debts and China’s economic growth rates.
H5: There is a causality between China’s foreign exchange reserves and China’s economic growth rates.

First of all, in order to start regression analysis, multicollinearity situation need to be controlled. Since there is no collinearity between China’s long term and short term external debts, those variables can be used together to explain the change of China’s economic growth rates. In addition to that, since there is a high correlation between China’s total external debts and foreign exchange reserves those parameters can not be used to together to explain the change of China’s economic growth rates.

Moreover, in order to prevent high variance problems, log transformation was done.

Dependent Variable: GDP  
Method: Least Squares

Sample: 1 27  
Included observations: 27

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>8.789719</td>
<td>1.525082</td>
<td>5.763440</td>
<td>0.0000</td>
</tr>
<tr>
<td>SHORTE</td>
<td>0.639828</td>
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<td>11.23629</td>
<td>0.0000</td>
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<tr>
<td>LONGE</td>
<td>0.134235</td>
<td>0.083341</td>
<td>1.610675</td>
<td>0.1203</td>
</tr>
</tbody>
</table>

R-squared        0.920886  Mean dependent var 27.43481  
Adjusted R-squared 0.914293  S.D. dependent var 0.941155  
S.E. of regression 0.275530  Akaike info criterion 0.364202  
Sum squared resid  1.822008  Schwarz criterion 0.508184  
Log likelihood    -1.916724  F-statistic 139.6793  
Durbin-Watson stat 0.753293  Prob(F-statistic) 0.000000

LN(CHINA’S GDP)t=a0+ a1LN(China’s total external debt)t + εt
LN(CHINA’S GDP)t=a0+a1LN(China’s foreign exchange reserves)t + εt
LN(CHINA’S GDP)t=a0+(α1)LN(China’s short term external debt)t+(α2)LN(China’s long term external debt)t + εt

REGRESSION ANALYSIS RESULTS:
Shorte corresponds to Short term external debt  
Longe corresponds to Long term external debt  
Fore corresponds to Foreign exchange reserves  
Totaledebt corresponds to Total external debt
Dependent Variable: GDP
Method: Least Squares

Sample: 1 27
Included observations: 27

<table>
<thead>
<tr>
<th>Variable</th>
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<th>t-Statistic</th>
<th>Prob.</th>
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<tbody>
<tr>
<td>C</td>
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<td>0.501466</td>
<td>33.99292</td>
<td>0.0000</td>
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<tr>
<td>TOTALEDEBT</td>
<td>0.825881</td>
<td>0.064655</td>
<td>12.77371</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.945340
Mean dependent var: 27.43481
Adjusted R-squared: 0.943153
S.D. dependent var: 0.941155
S.E. of regression: 0.224395
Akaike info criterion: -0.079628
Sum squared resid: 1.258831
Schwarz criterion: 0.016360
Log likelihood: 3.074983
F-statistic: 432.374
Durbin-Watson stat: 0.593540

Dependent Variable: GDP
Method: Least Squares

Sample: 1 27
Included observations: 27

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Log likelihood: 3.074983
F-statistic: 432.374
Durbin-Watson stat: 0.593540
According to regression analysis results, China’s total external debts and foreign exchange reserves, short term external debts have significant impact on China’s economic growth. But, China’s long term external debts do not have significant impact on China’s economic growth. That regression analysis was calculated for short term impact. Another analysis will be about the long term relationship between China’s GDP, China’s foreign exchange reserves and China’s short term external debt. Because according to Augmented Dickey Fuller test, those variables are non-stationary variables and when their first differences are taken those variables transformed into stationary variables which indicates transformation from I(0) to I(1). Nevertheless, China’s long term external debts and total external debts do not have unit root problem so they can be represented by I(0). Since I(0) and I(1) functions can not be used together in cointegration analysis, China’s GDP, China’s foreign exchange reserves and China’s short term external debt will be used in Johansen cointegration and Granger causality test.

In order to create I(1) process genr function has to be implemented.

\[ \text{genr } GDP1 = \text{GDP} - \text{GDP}(-1) \]
\[ \text{genr } \text{SHORTE1} = \text{SHORTE} - \text{SHORTE}(-1) \]
\[ \text{genr } \text{FORE1} = \text{FORE} - \text{FORE}(-1) \]

After implementing genr function, I(1) functions unit root properties analyzed and stationary problems were resolved.

Moreover, Johansen cointegration test can be used to measure the long term relationship between two or more series. I(0) functions can be measured together and I(1) functions can be measured together. Since the model dependent variable is China’s GDP, I(0) stationary variables will not be used. Functional model is given below.

China’s GDP = f(shorte, fore)

**JOHANSEN COINTEGRATION TEST RESULT**

Unrestricted Cointegration Rank Test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
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</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.482016</td>
<td>33.23933</td>
<td>29.79707</td>
<td>0.0193</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.345241</td>
<td>17.45188</td>
<td>15.49471</td>
<td>0.0251</td>
</tr>
<tr>
<td>At most 2 *</td>
<td>0.261898</td>
<td>7.288153</td>
<td>3.841466</td>
<td>0.0069</td>
</tr>
</tbody>
</table>

According to Johansen cointegration test result, there is a long term relationship between China’s GDP, foreign exchange reserves and short term external debt rates. Lag Exclusion test was applied and lag1 was chosen as threshold. Moreover, Akaike information criteria test was applied and lag1 was more optimal than lag0 for model selection. According to Granger causality analysis result, there is unidirectional relationship between China’s GDP and China’s foreign exchange reserves. China’s foreign exchange reserves can forecast China’s economic growth rates at lag1. In addition to that, according to ellipsoid analysis, there is no multicollinearity between variables. Thus, VAR analysis can be done in confidence. In addition, impulse response analysis and variance
decomposition analysis was applied to stationary variables at lag 1. It has been found that China’s foreign exchange reserves innovation impact on China’s economic growth is more than China’s short term external debt rates innovation impact on China’s economic growth.

5.0 Conclusion

China has unswerving stance for export-orientation policy. China’s economic growth rates lead China’s foreign exchange reserves to increase and China’s accumulated foreign exchange reserves lead China to have more economic growth. In addition, total external debt and short term external debt has significant impact on China’s economic growth. That findings indicate that China does not have credit rationing problem and that findings contradict with Wijeweera, Dollery, Pathberiya’s (2005), Pattillo’s, Ricci’s and Poirson’s (2002) findings and support Hayami’s (1997) indication. Because China has huge surplus and China’s savings rates are higher than China's investment rates. Moreover, according to Johansen cointegration test, China’s short term external debts, foreign exchange reserves, economic growth rates have long term stable equilibrium relationship. China’s foreign exchange reserves can forecast China’s economic growth rates. China’s foreign exchange reserves rates innovation impact on China’s economic growth is more than China’s short term external debt innovation impact on China’s economic growth rates.

6.0 Research Limitations

* Do not have time and resources to interview with World Bank and Asian Development Banks officials

* Some state documents about China economy can be secret and elusive.

* Quarter data of China’s economic growth, short term external debt reserves were not available.

7.0 Future Directions for Research

China’s labor rates and capital rates can be found and theoretical Cobb Douglas framework can be constructed. External debt parameters and foreign exchange reserves can be added to Cobb Douglas framework by regression analysis.

8.0 References


9.0 APPENDIX

APPENDIX A

DATA USED IN ANALYSIS

<table>
<thead>
<tr>
<th>short</th>
<th>long</th>
<th>fore</th>
<th>extdebt</th>
<th>gdp</th>
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<tr>
<td>21.56</td>
<td>22.38</td>
<td>22.67</td>
<td>22.85</td>
<td>26.04</td>
</tr>
<tr>
<td>22.11</td>
<td>22.39</td>
<td>22.91</td>
<td>22.99</td>
<td>26.15</td>
</tr>
<tr>
<td>22.45</td>
<td>22.55</td>
<td>22.83</td>
<td>23.22</td>
<td>26.27</td>
</tr>
<tr>
<td>22.58</td>
<td>23.02</td>
<td>21.70</td>
<td>23.54</td>
<td>26.45</td>
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<td>22.53</td>
<td>23.53</td>
<td>21.45</td>
<td>23.89</td>
<td>26.42</td>
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APPENDIX B
UNIT ROOT TEST RESULTS

Null Hypothesis: FORE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=6)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>0.669276</td>
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</tbody>
</table>

Test critical values:
- 1% level: -3.711457
- 5% level: -2.981038
- 10% level: -2.629906

Null Hypothesis: GDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=6)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
</table>

22.83 23.98 21.80 24.29 26.32
22.90 24.21 21.94 24.47 26.46
22.66 24.34 22.44 24.53 26.56
22.96 24.54 23.13 24.74 26.60
23.10 24.62 23.80 24.82 26.66
23.35 24.79 23.69 25.01 26.77
23.45 24.97 23.78 25.18 26.81
23.58 25.13 24.67 25.33 27.05
23.83 25.27 25.02 25.49 27.31
23.96 25.35 25.38 25.58 27.48
24.17 25.45 25.66 25.71 27.58
23.58 25.32 25.70 25.69 27.65
23.44 25.28 25.76 25.72 27.71
23.29 25.27 25.83 25.70 27.81
24.75 25.23 26.08 25.94 27.91
24.91 25.19 26.38 25.94 28.01
25.20 25.14 26.72 26.05 28.13
25.47 25.20 27.14 26.23 28.29
25.72 25.16 27.43 26.37 28.45
25.88 25.17 27.70 26.50 28.63
26.04 25.19 28.06 26.65 28.88
25.96 25.23 28.30 26.66 29.14
26.21 25.27 28.51 26.82 29.24
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<tr>
<th>Augmented Dickey-Fuller test statistic</th>
<th>1.231656</th>
<th>0.9974</th>
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<tbody>
<tr>
<td>Test critical values:</td>
<td></td>
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<tr>
<td>1% level</td>
<td>-3.724070</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.986225</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.632604</td>
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</tr>
</tbody>
</table>

Null Hypothesis: SHORTE has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic based on SIC, MAXLAG=6)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-6.557313</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.724070</td>
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<td>5% level</td>
<td>-2.986225</td>
</tr>
<tr>
<td>10% level</td>
<td>-2.632604</td>
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</table>

Null Hypothesis: LONGE has a unit root  
Exogenous: Constant  
Lag Length: 1 (Automatic based on SIC, MAXLAG=6)

<table>
<thead>
<tr>
<th>t-Statistic</th>
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<td>Augmented Dickey-Fuller test statistic</td>
<td>-3.825791</td>
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<tr>
<td>Test critical values:</td>
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<tr>
<td>1% level</td>
<td>-3.711457</td>
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<tr>
<td>5% level</td>
<td>-2.981038</td>
</tr>
<tr>
<td>10% level</td>
<td>-2.629906</td>
</tr>
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</table>

Null Hypothesis: TOTALEXDEBT has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic based on SIC, MAXLAG=6)
Included observations: 26

Chi-squared test statistics for lag exclusion:

Numbers in [ ] are p-values

<table>
<thead>
<tr>
<th></th>
<th>GDP1</th>
<th>FORE1</th>
<th>SHORTE1</th>
<th>Joint</th>
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<tbody>
<tr>
<td>Lag 1</td>
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<tr>
<td></td>
<td>[ 0.001566]</td>
<td>[ 0.227773]</td>
<td>[ 0.968238]</td>
<td>[ 0.012410]</td>
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<tr>
<td>df</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
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</tbody>
</table>

VAR Lag Order Selection Criteria

Endogenous variables: GDP1 FORE1 SHORTE1

Exogenous variables: C
Sample: 1 28
Included observations: 26

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
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<td>9.2441</td>
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<td>-0.3393</td>
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* 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

Pairwise Granger Causality Tests
Lags: 1

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Probability</th>
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<tr>
<td>GDP1 does not Granger Cause FORE1</td>
<td>0.12848</td>
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<tr>
<td>SHORTE1 does not Granger Cause GDP1</td>
<td>26</td>
<td>0.76854</td>
<td>0.38974</td>
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<tr>
<td>GDP1 does not Granger Cause SHORTE1</td>
<td>0.00721</td>
<td>0.93305</td>
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</table>
SHORTE1 does not Granger Cause FORE1  26  0.45052  0.50877
FORE1 does not Granger Cause SHORTE1  0.20915  0.65173

Included observations: 26

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

<table>
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<th>SHORTE1</th>
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| df | 3 | 3 | 3 | 9 |
Ellipsoid analysis

Inverse Roots of AR Characteristic Polynomial
Response to Cholesky One S.D. Innovations

Response of GDP1 to GDP1
Response of GDP1 to FORE1
Response of GDP1 to SHORTE1

Response of FORE1 to GDP1
Response of FORE1 to FORE1
Response of FORE1 to SHORTE1

Response of SHORTE1 to GDP1
Response of SHORTE1 to FORE1
Response of SHORTE1 to SHORTE1
Variance Decomposition

Percent GDP1 variance due to GDP1

Percent GDP1 variance due to FORE1

Percent GDP1 variance due to SHORTE1

Percent FORE1 variance due to GDP1

Percent FORE1 variance due to FORE1

Percent FORE1 variance due to SHORTE1

Percent SHORTE1 variance due to GDP1

Percent SHORTE1 variance due to FORE1

Percent SHORTE1 variance due to SHORTE1