# UNIVERSITY OF FORT HARE

**ECO 513/ECO 513E**

**DEGREE EXAMINATIONS**

**JUNE MAIN EXAMINATION**

**2023**

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| | |
|---|---|
| **Time:** | **3 HOURS** |
| **Subject:** | **ECONOMETRIC TECHNIQUES** |
| **Marks:** | **100** |

**This paper consists of 18 pages including the cover page**

**Internal Examiners**
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## INSTRUCTIONS

**Answer All Questions**
**Use of equations or mathematical notations where applicable will be fully rewarded**

**Question 1** **[42 marks]**

You are given variables listed in Table 1. There are 11 developed countries in the data set: Canada CAN, Denmark DNK, Finland FIN, France FRA, Germany GER, Japan JPN, Netherlands NLD, Norway NOR, Sweden SWE, United Kingdom UNK, United States USA. In this question, you will explain FDI as a function of country credit risk, market size, openness, infrastructure, and an index of political freedom.

**Table 1** Variable list

| Variable name | Description |
|---|---|
| FDI | FDI as percentage of GDP, both measured in US dollar. |
| CC | Country credit risk index, compiled by *Institutional Investor*, ranging between 0 and 100, with higher values indicating lower credit risk. |
| MS | Market size, expressed as GDP per capita in dollar terms |
| FH | *Freedom House* index measuring civil liberty, political rights and risk. Takes on values between 1 and 7, with 7 the least favourable. |
| T | Infrastructure as proxied by number of telephone mainlines per 1000 of population. |
| OPEN | Degree of openness to international trade, measured as (X+Z)/GDP. |

The following specification was tested:

$$FDI = f(\log(CC), \log(MS), FH, \log(T), \log(OPEN))$$

1.) For the model specification above, hypothesize *a priori* on the expected relationship of each explanatory variable with the dependent variable. Provide some economic intuition. Why would some variables in the theoretical specification not be logged? [7 Marks]

2.) Six variables contained in the specification were pooled into EVIEWS using the "Pool Object". The pooled model and the results are presented below:

Dependent Variable: FDI?
Method: Pooled Least Squares
Sample: 1980 1998

Included observations: 19

Cross-sections included: 11

Total pool (balanced) observations: 209

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LOG(CC?) | 2.477975 | 1.151221 | 2.152475 | 0.0325 |
| LOG(MS?) | -0.002115 | 0.372766 | -0.005673 | 0.9955 |
| FH? | -0.662847 | 0.304469 | -2.177060 | 0.0306 |
| LOG(T?) | -0.177483 | 0.114398 | -1.551445 | 0.1224 |
| LOG(OPEN?) | 0.910883 | 0.198312 | 4.593177 | 0.0000 |
| C | -8.145620 | 6.747396 | -1.207224 | 0.2288 |
| R-squared | 0.149282 | Mean dependent var | | 1.013199 |
| Adjusted R-squared | 0.128328 | S.D. dependent var | | 1.282830 |
| S.E. of regression | 1.197693 | Akaike info criterion | | 3.226960 |
| Sum squared resid | 291.1973 | Schwarz criterion | | 3.322912 |
| Log likelihood | -331.2173 | Hannan-Quinn criter. | | 3.265754 |
| F-statistic | 7.124369 | Durbin-Watson stat | | 0.696106 |
| Prob(F-statistic) | 0.000004 | | | |

(a) Briefly discuss the sign and significance of the pooled coefficients. Do they agree with your expectations? [7 marks]

4.) A test for poolability (pooled model vs. individual regressions) was performed and the results are reported below:

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

| Effects Test | Statistic | d.f. | Prob. |
|---|---|---|---|
| Cross-section F | 190.197781 | (50,1121) | 0.0000 |
| Cross-section Chi-square | 2638.713563 | 50 | 0.0000 |

Comment on the results. [3 marks]

5.) Next, the fixed effects model was estimated and the results are presented below:

Dependent Variable: FDI?
Method: Pooled Least Squares
Sample: 1980 1998

Included observations: 19

Cross-sections included: 11

Total pool (balanced) observations: 209

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LOG(CC?) | 5.792278 | 1.708332 | 3.390605 | 0.0008 |
| LOG(MS?) | 8.817368 | 1.459810 | 6.040079 | 0.0000 |
| FH? | -0.612437 | 0.337332 | -1.815535 | 0.0710 |
| LOG(T?) | -5.748422 | 2.458058 | -2.338603 | 0.0204 |
| LOG(OPEN?) | 3.326562 | 0.581530 | 5.720361 | 0.0000 |
| _CAN--C | -92.91707 | 10.80987 | -8.595575 | 0.0000 |
| _DNK--C | -97.87365 | 11.17194 | -8.760668 | 0.0000 |
| _FIN--C | -95.09448 | 10.96672 | -8.671184 | 0.0000 |
| _FRA--C | -95.24604 | 11.12341 | -8.562667 | 0.0000 |
| _GER--C | -97.87497 | 11.32535 | -8.642118 | 0.0000 |
| _JPN--C | -97.74419 | 11.61423 | -8.415897 | 0.0000 |
| _NLD--C | -97.31904 | 11.19528 | -8.692867 | 0.0000 |
| _NOR--C | -98.52945 | 11.27804 | -8.736396 | 0.0000 |
| _SWE--C | -110.8058 | 15.18841 | -7.295420 | 0.0000 |
| _UNK--C | -91.95052 | 10.85548 | -8.470425 | 0.0000 |
| _USA--C | -93.05239 | 11.14147 | -8.351893 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.551198 | Mean dependent var | 1.013199 |
| Adjusted R-squared | 0.516317 | S.D. dependent var | 1.282830 |
| S.E. of regression | 0.892174 | Akaike info criterion | 2.683155 |
| Sum squared resid | 153.6231 | Schwarz criterion | 2.939027 |
| Log likelihood | -264.3897 | Hannan-Quinn criter. | 2.786606 |
| F-statistic | 15.80224 | Durbin-Watson stat | 1.241202 |
| Prob(F-statistic) | 0.000000 | | |

(a). What are the two possible specifications under the fixed effects model? [4 marks]

(b). Discuss the sign and significance of the pooled coefficients on the above model. Do they agree with your expectations? [7 Marks]

2. (a) Explain how fixed effects models are equivalent to an ordinary least squares regression with dummy variables. [7 marks]

(b) How does the random effects model capture cross-sectional heterogeneity in the intercept term? [7 marks]

## Question 2 [28 Marks]

Asteriou and Price (2001) used GARCH models to capture the effects of socio-political instability in UK GDP. To approximate and quantify socio-political instability, they constructed indices that summarized various variables capturing phenomena of social unrest for the UK over the period 1960 - 97 using quarterly time series data. Specifically, their indices were constructed by applying the method of principal components to the following variables: Terri, the number of terrorist activities that caused mass violence; STRIKES, the number of strikes that were caused by political reasons; ELECT; the number of elections; REGIME, a dummy variable that takes the value of one for government change to different political parties, zero otherwise; FALKL; a dummy variable that takes the value of 1 for the period of Falklands War (1982; q1-q4), zero otherwise; and finally GULF, a dummy variable which takes the value of 1 for the period of the first Gulf War (1991; q1 - q4), zero otherwise. Asterio and Price estimated the following model:

$$\Delta \ln(Y_t) = a_0 + a_{1i}\sum_{i=0}^{4} \Delta ln(Y_{t-i}) + a_{2i}\sum_{1=0}^{4} \Delta \ln(I_{t-i}) + \sum_{j=1}^{6} d_j X_{jt} + u_t$$

$$u_t \sim N(0, h_t)$$

$$h_t = b_1 e_{t-1}^2 + b_2 h_{t-1}$$

Where the growth rate of GDP (denoted by $\Delta \ln(Y_t)$) is modelled as an AR(4) process, including the growth and four lags of investments (denoted by $\Delta \ln(I_t)$) plus the political instability proxies ($X_{jt}$), where the variance is conditioned on the lagged variance and lagged squared residuals.

**Table 2: GARCH Estimates of GDP growth with political uncertainty proxies**

Dependent variable: $\Delta \ln(Y_t)$: Sample 1961q2 – 1997q4

| Parameter | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Constant | 0.003(3.49) | 0.005(3.75) | 0.004(3.80) | 0.006(5.66) |
| $\Delta \ln(Y_{t-3})$ | 0.135(1.36) | 0.194(.199) | 0.186(1.87) | 0.270(3.42) |
| $\Delta \ln(Y_{t-4})$ | 0.131(1.23) | 0.129(1.22) | 0.122(1.48) | 0.131(1.29) |
| $\Delta \ln(I_{t-2})$ | 0.180(2.25) | 0.132(1.48) | 0.162(1.92) | |
| REGIME | | -0.012(-4.91) | | -0.012(-5.63) |
| TERROR | | -0.004(-2.72) | | -0.005(-2.66) |
| STRIKES | | -0.011(-2.58) | | -0.015(-3.44) |
| PC1 | | | -0.005(-4.33) | |
| PC2 | | | -0.003(-2.02) | |

| Variance Equation | | | | |
|---|---|---|---|---|
| Constant | 0.00001(1.83) | 0.00001(1.66) | 0.00000(1.16) | 0.00006(1.71) |
| ARCH(1) | 0.387(3.27) | 0.314(2.44) | 0.491(4.18) | 0.491(4.46) |
| GARCH(1) | 0.485(2.95) | 0.543(3.14) | 0.566(6.210 | 0.566(3.36) |
| $R^2$ | 0.006 | 0.099 | 0.030 | 0.104 |
| S.E of d.v. | 0.010 | 0.010 | 0.010 | 0.010 |
| S.E. of Reg. | 0.010 | 0.010 | 0.010 | 0.010 |
| | | | | |

Based on the results presented in Table 2, answer the following questions:

4.3 Interpret the investment coefficient in model 1. Does the result correspond to the apriori expectation? [2 Marks]

4.4 Evaluate the signs and magnitude of REGIME, TERROR and STRIKES on economic growth as per model 2. Again, explain if these results are consistent with the apriori expectations. [6 marks]

4.5 Asteriou and Price (2001) estimated model 4 without including the investment terms, though including the political uncertainty dummies. Can we conclude that the impact of political uncertainty on growth operate through investment? Explain your answer. [4 Marks]

4.6 Do All models presented in Table 2 adequately captured the conditional volatility? Substantiate your answer. [2 Marks]

4.7 Why, in recent empirical research, have researchers preferred GARCH(1,1) models to pure ARCH($p$)? [4 Marks]

4.8 Describe two extensions to the original GARCH model. What additional characteristics of financial data might they be able to capture? [4 Marks]

4.9 Consider the following GARCH(1,1) model

$$y\_t = \mu + u\_t, \qquad u\_t \sim N(0, \sigma\_t^{\wedge}2)$$

$$\sigma\_t^{\wedge}2 = \alpha\_0 + \alpha\_1\, u\_(t-1)^{\wedge}2 + \beta\sigma\_(t-1)^{\wedge}2$$

If $yt$ is a daily stock return series, what range of values are likely for the coefficients $\mu$, $a0$, $a1$ and $B$? [4 marks]

4.10 Suppose that a researcher wanted to test the null hypothesis that $\alpha\_1 + \beta = 1$ in the equation for part (b). Explain how this might be achieved within the maximum likelihood framework. [2 Marks]

**Question 3** **[30 marks]**

(a) Briefly outline Johansen's methodology for testing for cointegration between a set of variables in the context of a VAR. [6 marks]

(b). Nozuko estimated a household consumption function for South Africa. The theoretical specification of household consumption is presented as follows:

$C = f(Y_d \text{ or } Y_d^e, W, i, \pi \text{ or } \pi^e)$

Where $Y_d$ = disposable income

$Y_d^e$ = expected disposable income

W = wealth (suitably proxied by M3 money supply)

$i$ = short-term interest rates

$\pi$ = inflation rate

$\pi^e$ = expected inflation rate

Her dataset extends from 1970 to 2006 in annual form. She therefore decides to use the ARDL model to estimate the long-run and short-run relationship between the variables, and obtained the following results:

**Table 3: ARDL Bounds test and Long-run Model**

Levels Equation
Case 2: Restricted Constant and No Trend

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LRYD | 0.757883 | 0.079432 | 9.541323 | 0.0000 |
| LRM3 | 0.154708 | 0.072751 | 2.126525 | 0.0421 |
| NRATE | -0.000442 | 0.002602 | -0.169659 | 0.8665 |
| LINFL | 0.001351 | 0.020761 | 0.065097 | 0.9485 |
| C | 1.246859 | 0.365682 | 3.409680 | 0.0019 |

EC = LRCONS - (0.7579*LRYD + 0.1547*LRM3 -0.0004*NRATE + 0.0014 *LINFL + 1.2469 )

| F-Bounds Test | | | Null Hypothesis: No levels relationship | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 43.00281 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |
| | | | Finite Sample: n=40 | |
| Actual Sample Size | 36 | 10% | 2.427 | 3.395 |
| | | 5% | 2.893 | 4 |
| | | 1% | 3.967 | 5.455 |
| | | | Finite Sample: n=35 | |
| | | 10% | 2.46 | 3.46 |
| | | 5% | 2.947 | 4.088 |
| | | 1% | 4.093 | 5.532 |

Required:

(i). Write the general ARDL equation for Nozuko's estimation [3 Marks]

(ii). Using the information in Table 3, test for co-integration between the variables and comment on the long-run effects of income, wealth, inflation and interest rate on consumption in South Africa. State the hypotheses to be tested.

[7 marks]

(iii). Using the information in Table 4, comment on the speed of adjustment to the equilibrium and explain the short-run relationship between the variables.

[3 Marks]

## Table 4: ARDL Error Correction Regression

ARDL Error Correction Regression
Dependent Variable: D(LRCONS)
Selected Model: ARDL(1, 0, 0, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 04/13/23 Time: 22:53
Sample: 1970 2006
Included observations: 36

ECM Regression
Case 2: Restricted Constant and No Trend

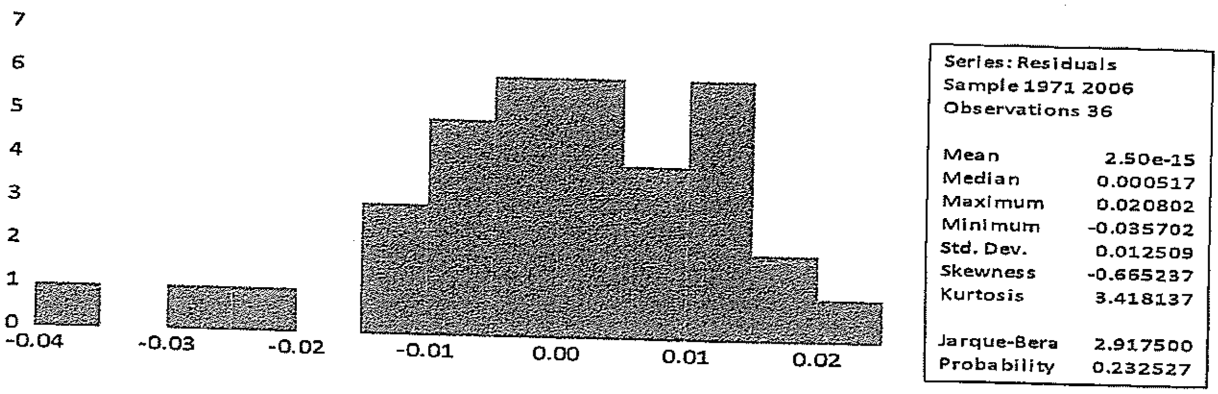
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(NRATE) | 0.003395 | 0.000603 | 5.627996 | 0.0000 |
| CointEq(-1)* | -0.361172 | 0.020766 | -17.39260 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.766013 | Mean dependent var | 0.033358 |
| Adjusted R-squared | 0.759131 | S.D. dependent var | 0.025859 |
| S.E. of regression | 0.012691 | Akaike info criterion | -5.841847 |
| Sum squared resid | 0.005476 | Schwarz criterion | -5.753874 |
| Log likelihood | 107.1532 | Hannan-Quinn criter. | -5.811142 |
| Durbin-Watson stat | 1.811222 | | |

* p-value incompatible with t-Bounds distribution.

(iv). Nozuko now wants to test whether her ARDL results in question 1 did not violate any necessary assumptions. She estimated the outputs presented below.

Figure 1




## Table 5

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 0.316791 | Prob. F(2,27) | 0.7312 |
| Obs*R-squared | 0.825406 | Prob. Chi-Square(2) | 0.6619 |

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 04/13/23 Time: 22:56
Sample: 1971 2006
Included observations: 36
Presample missing value lagged residuals set to zero.

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LRCONS(-1) | -0.025657 | 0.110208 | -0.232805 | 0.8177 |
| LRYD | 0.016075 | 0.091310 | 0.176051 | 0.8616 |
| LRM3 | 0.006955 | 0.030544 | 0.227695 | 0.8216 |
| NRATE | -0.000200 | 0.000973 | -0.205781 | 0.8385 |
| NRATE(-1) | 0.000435 | 0.001120 | 0.388655 | 0.7006 |
| LINFL | 0.001554 | 0.008091 | 0.192112 | 0.8491 |
| C | 0.028481 | 0.187520 | 0.151881 | 0.8804 |
| RESID(-1) | 0.132950 | 0.243838 | 0.545237 | 0.5901 |
| RESID(-2) | -0.129632 | 0.227195 | -0.570577 | 0.5730 |

| | | | |
|---|---|---|---|
| R-squared | 0.022928 | Mean dependent var | 2.50E-15 |
| Adjusted R-squared | -0.266575 | S.D. dependent var | 0.012509 |
| S.E. of regression | 0.014078 | Akaike info criterion | -5.476153 |
| Sum squared resid | 0.005351 | Schwarz criterion | -5.080273 |
| Log likelihood | 107.5708 | Hannan-Quinn criter. | -5.337981 |
| F-statistic | 0.079198 | Durbin-Watson stat | 2.019924 |
| Prob(F-statistic) | 0.999542 | | |

## Table 6

Heteroskedasticity Test: White

Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 0.354376 | Prob. F(6,29) | 0.9015 |
| Obs*R-squared | 2.459184 | Prob. Chi-Square(6) | 0.8730 |
| Scaled explained SS | 1.929447 | Prob. Chi-Square(6) | 0.9261 |

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/13/23 Time: 22:57
Sample: 1971 2006
Included observations: 36

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.000438 | 0.001544 | -0.283825 | 0.7786 |
| LRCONS(-1)^2 | 2.10E-05 | 7.08E-05 | 0.295902 | 0.7694 |
| LRYD^2 | -5.18E-06 | 6.27E-05 | -0.082645 | 0.9347 |
| LRM3^2 | -1.26E-05 | 1.84E-05 | -0.685699 | 0.4983 |
| NRATE^2 | -3.46E-07 | 4.87E-07 | -0.710796 | 0.4829 |
| NRATE(-1)^2 | -1.77E-07 | 5.97E-07 | -0.296025 | 0.7693 |
| LINFL^2 | 2.21E-05 | 3.70E-05 | 0.596326 | 0.5556 |

| | | | |
|---|---|---|---|
| R-squared | 0.068311 | Mean dependent var | 0.000152 |
| Adjusted R-squared | -0.124453 | S.D. dependent var | 0.000240 |
| S.E. of regression | 0.000254 | Akaike info criterion | -13.54266 |
| Sum squared resid | 1.88E-06 | Schwarz criterion | -13.23476 |
| Log likelihood | 250.7679 | Hannan-Quinn criter. | -13.43520 |
| F-statistic | 0.354376 | Durbin-Watson stat | 2.408283 |
| Prob(F-statistic) | 0.901466 | | |

**Figure 2**

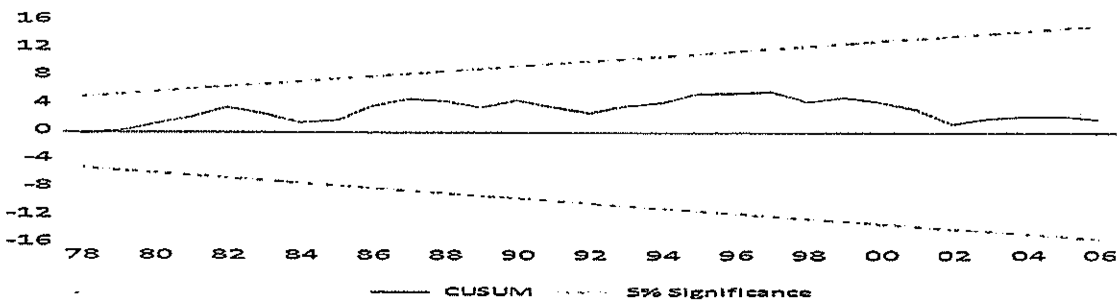
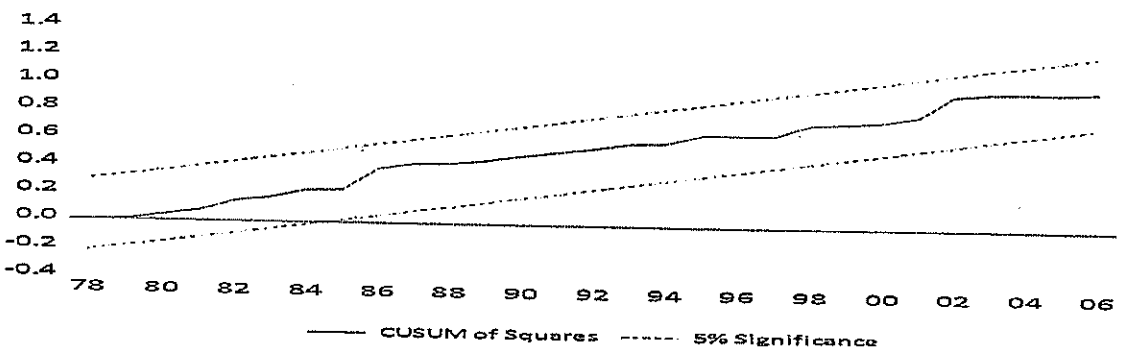



Figure 3




**Required:**

Using the information in Figures 1 and 2 as well as Tables 5 and 6, indicate whether her estimated ARDL results are reliable or not. Present the results in a table format, stating the null hypothesis as well as the relevant statistics and conclusions. [8 marks]

(c) A VAR was estimated in order to examine whether there are lead-lag relationships for the returns to three exchange rates against the US dollar - the euro, the British pound and the Japanese yen. The data are daily and run from 7 July 2002 to 6 June 2013, giving 3986 observations. After determining the appropriate lag length, the following results were obtained:

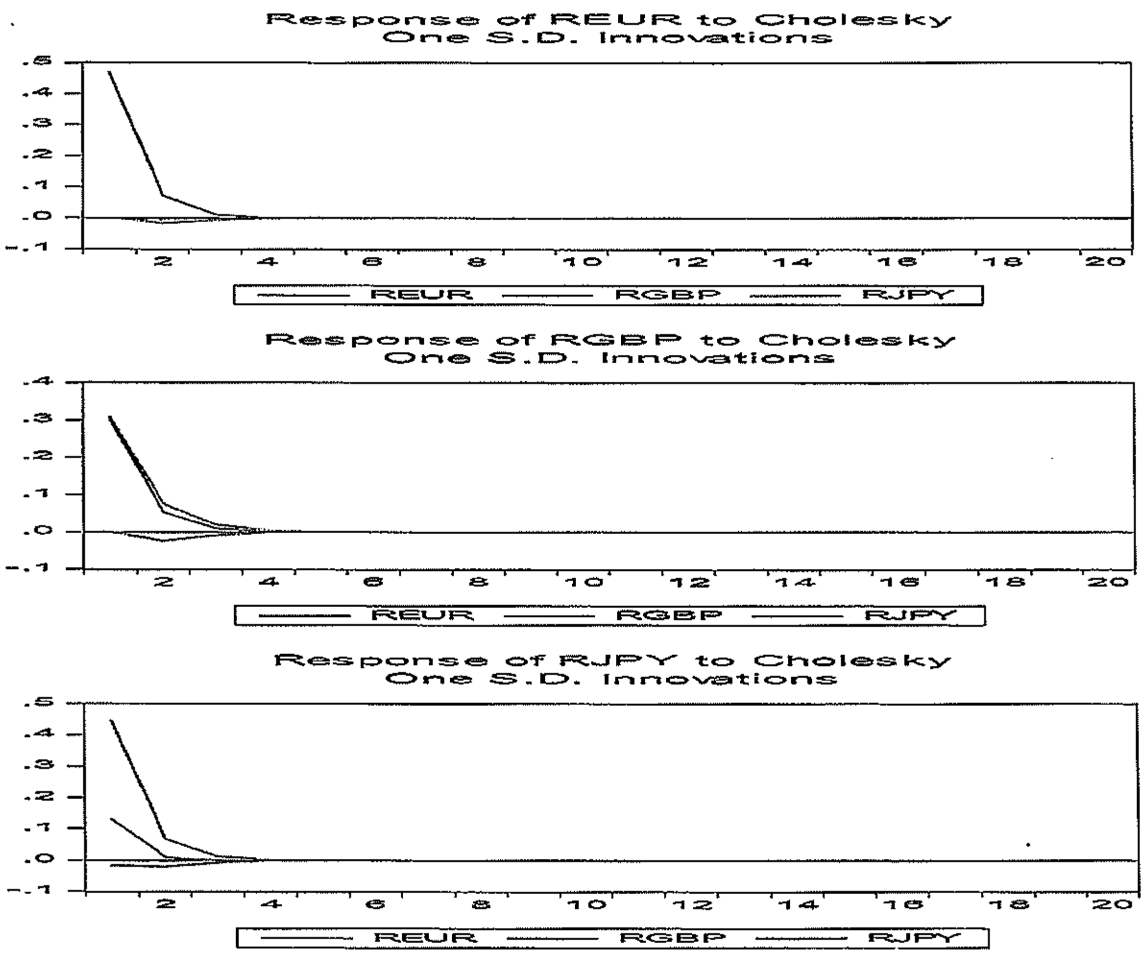
| | | | |
|---|---|---|---|
| VAR Granger Causality/Block Exogeneity Wald Tests | | | |
| Date: 08/05/19 Time: 17:05 | | | |
| Sample: 7/07/2002 6/06/2013 | | | |
| Included observations: 3988 | | | |
| Dependent variable: REUR | | | |
| Excluded | Chi-sq | df | Prob. |
| RGBP | 5.817390 | 1 | 0.0159 |
| RJPY | 1.419007 | 1 | 0.2336 |
| All | 6.933589 | 2 | 0.0312 |
| Dependent variable: RGBP | | | |
| Excluded | Chi-sq | df | Prob. |
| REUR | 1.607119 | 1 | 0.2049 |
| RJPY | 13.01577 | 1 | 0.0003 |
| All | 17.86379 | 2 | 0.0001 |
| Dependent variable: RJPY | | | |
| Excluded | Chi-sq | df | Prob. |
| REUR | 0.443664 | 1 | 0.5054 |

| | | | |
|---|---|---|---|
| RGBP | 6.421052 | 1 | 0.0113 |
| All | 8.470390 | 2 | 0.0145 |

(i) Given the results above, is there evidence of lead-lag relationships between the three exchange rates? [3 Marks]

(ii) To further examine the relationship between the exchange rates, impulse responses were constructed and the following results were obtained:

**Figure 1: Impulse Response Functions**




(i). Interpret the impulse responses in figure 1 below. [2 marks]