The Impact of Macroeconomic Variables on GDP: Empirical Evidence from Malaysia

BPTMS

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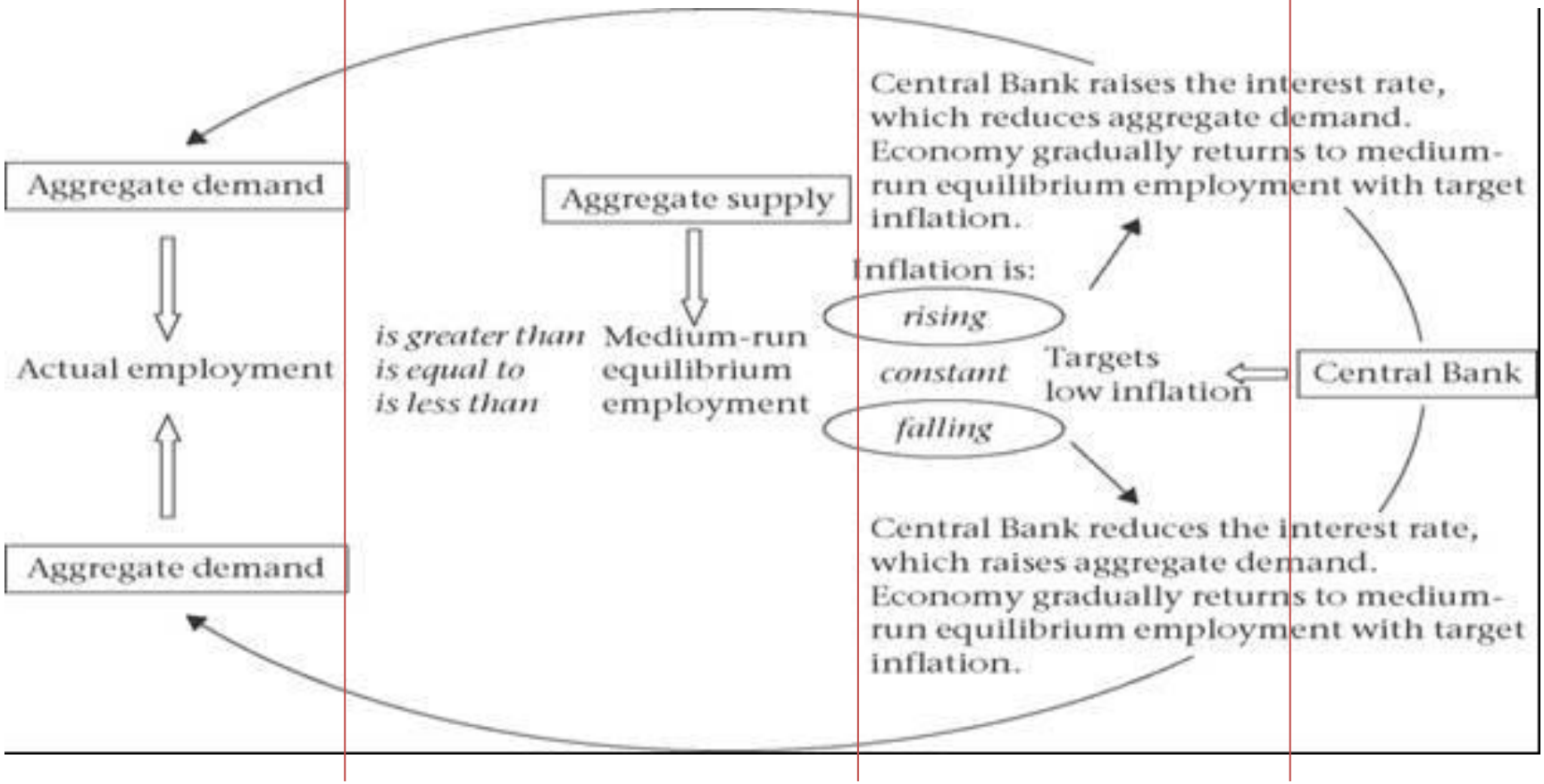
Abstract

The study was to examine the relationship between the independent variables of inflation, unemployment, and interest rate with the economic growth (GDP) in Malaysia during the period of first quarter 2001 to fourth quarter 2016. Autoregressive distributed lag (ARDL)-bounds testing approach by Pesaran et al. [2001] was used to examine the linkages. The results of the bounds test show that there is a stable long-run relationship between the independent variables and economic growth at ARDL(2,3,3,0). In the short-run, the relationship of inflation was negative with GDP while interest rate was positively linked with GDP growth. However, in the short run, the relationship was insignificant with unemployment.

Schematic view of the short- and medium-run macro model



Relationship: GDP, inflation and unemployment

- Economy is healthy (GDP ↑) → unemployment ↓ → wage ↑
- Businesses demand labour to meet the growing economy.
- GDP ↑ → Employment ↑ → unemployment rate ↓
- However, if the **GDP** growth rate is speeding up too fast, the Central Bank may raise interest rates ↑ to stem **inflation**—or the rising of prices for good and services.
- The rise in interest rate ↑ put pressure on aggregate demand, investment ↓ demand for labour decreases ↓ forcing employment ↓ to equal **equilibrium**.

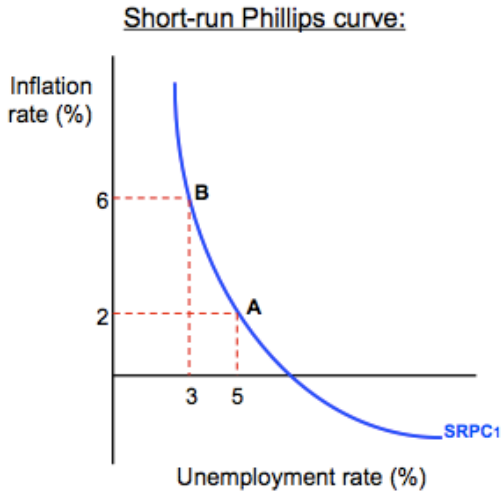
Phillips Curve

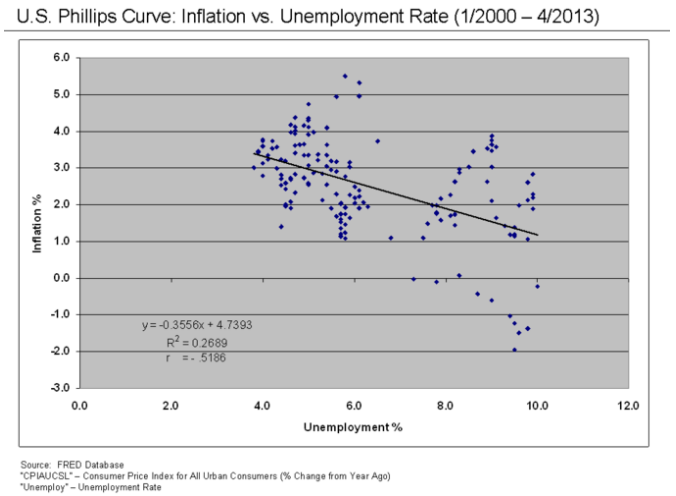
- The **Phillips curve** stated that, decreased unemployment, (i.e., increased levels of employment) in an economy will correlate with higher rates of inflation. (a trade-off between inflation and unemployment)
- In the **long run**, only a single rate of **unemployment** (the NAIRU or "natural" rate) was consistent with a stable **inflation** rate.
- The **long-run** Phillips Curve was thus vertical, so there was no trade-off **between inflation and unemployment (equilibrium)**.

Okun’s Law

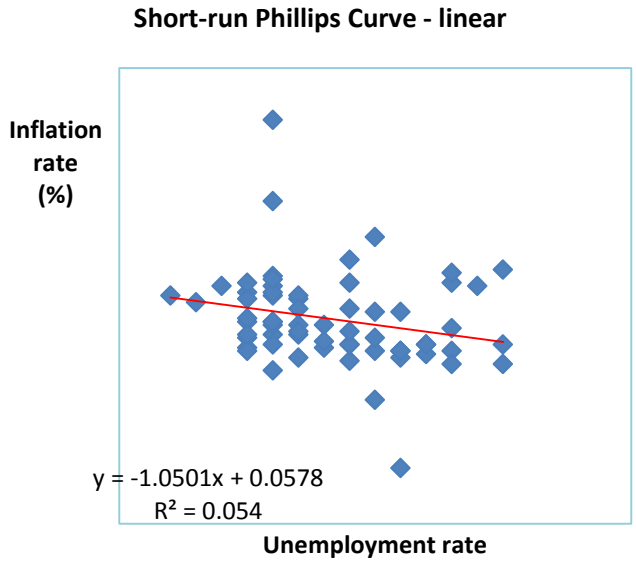
- Okun's law refers to the relationship between increases in unemployment and decreases in a country's gross domestic product (GDP).
- It states that for every 1% increase in unemployment above a "natural" level, that GDP will decrease by anywhere from 2% to 4% from its potential.

Trends

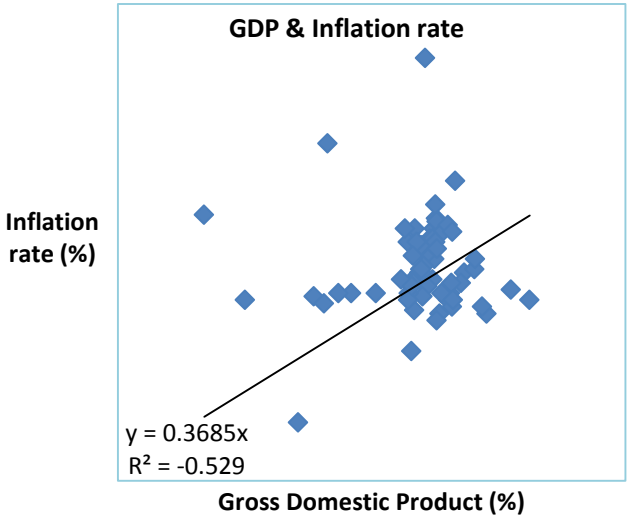


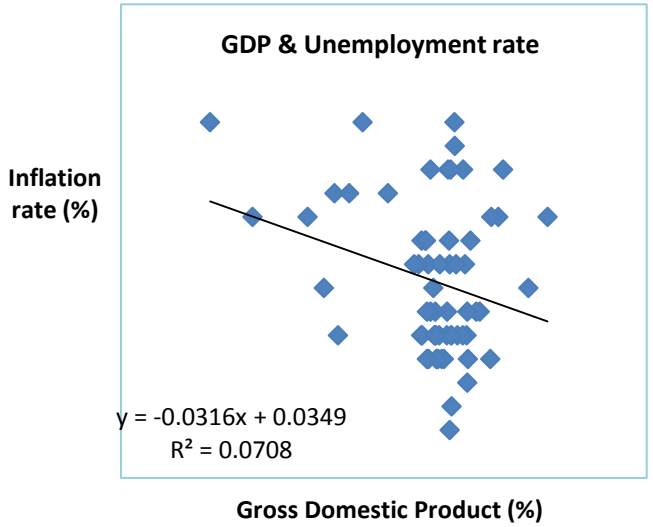


MALAYSIA



Trends





From observation (trends):

1. Inverse relationship between inflation and unemployment rate.
2. When GDP rises, inflation rises.
3. When GDP rises, employment increases and unemployment rate decreases.

ARDL Model

$$\Delta Y_t = \beta_o + \sum_{i=1}^{p} \beta_i \, \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \, \Delta x_{t-i} + \varphi_1 y_{t-1} + \varphi_2 x_{t-1} + \mu_t$$

Short-run Long-run

- Short-run coefficients: β_i , δ_i
- ARCL long-run coefficients: φ_1 , φ_2
- Disturbance (white noise) term: μ_t
- First difference operator: Δ
- Optimal lag length: *p*

Data & Methodology

- Data: Q1/2001 – Q4/2016
- Variables
  - GDP~ GDP growth
  - INF ~ Inflation rate
  - INT ~ Interest rate
  - UER ~ Unemployment rate
- Stationarity: I(0), I(1) no I(2)
- Model: ARDL (Ref: Pesaran and Shin (1999) and Pesaran et. al. (2001))

ARDL(p)

$$\Delta GDP_t = \alpha_0 + \sum_{i=1}^{p} \beta_{\mathrm{i}} \Delta GDP_{t-i} + \sum_{i=1}^{p} \gamma_i \Delta INF_{t-i} + \sum_{i=1}^{p} \delta_i \Delta INT_{t-i} + \sum_{i=1}^{p} \rho_i \Delta UER_{t-i} + \varphi_1 GDP_{t-1} + \varphi_2 INF_{t-1} + \varphi_3 INT_{t-1} + \varphi_4 UER_{t-1} + \mu_t$$

- Short-run coefficients: β_i , γ_i, δ_i, ρ_i
- ARCL long-run coefficients: φ_1 , φ_2, φ_3, φ_4
- Disturbance (white noise) term: μ_t
- First difference operator: Δ
- Optimal lag length: *p*

If there is evidence of long-run relationship (cointegration) of the variables, the following long-run model is estimated:

$$GDP_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1\mathrm{i}} GDP_{t-i} + \sum_{i=1}^{p} \theta_{1i} INF_{t-i} + \sum_{i=1}^{p} \delta_{1i} INT_{t-i} + \sum_{i=1}^{p} \rho_{1i} UER_{t-i} + \gamma_t$$

ARDL(p)

The ARDL specification of the short-run dynamics can be derived by constructing an error correction model (ECM) of the following form:

$$\Delta GDP_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \theta_{2i} \Delta INF_{t-i} + \sum_{i=1}^{p} \delta_{2i} \Delta INT_{t-i} + \sum_{i=1}^{p} \rho_{2i} \Delta UER_{t-i} + \psi ECM_{t-1} + \vartheta_t$$

Where ECM_{t-1} is the error correction term, defined as

$$ECM_t = GDP_t - \alpha_1 - \sum_{i=1}^{p} \beta_{1i} GDP_{t-i} - \sum_{i=1}^{p} \theta_{1i} INF_{t-i} - \sum_{i=1}^{p} \delta_{1i} INT_{t-i} - \sum_{i=1}^{p} \rho_{1i} UER_{t-i}$$

All coefficients of short-run equation are coefficients relating to the short run dynamics of the model's convergence to equilibrium and ψ represents the speed of adjustment.

Results (ARDL(2,3,3,0)

We allow eviews to automatically select the optimal number of lags.

Dependent Variable: GDP
Observations: 61
Model selection method: Hannan-Quinn criterion (HQ)
Number of models evaluated: 500
Best Selected Model: ARDL(2,3,3,0)

Individual coefficient estimates for the selected models (significance)

<u>Summary statistics based on final information</u>
R(squared)=0.885395
Akaike info creterion (AIC)=3.033641
Schwarz criterion (SIC)=3.552708

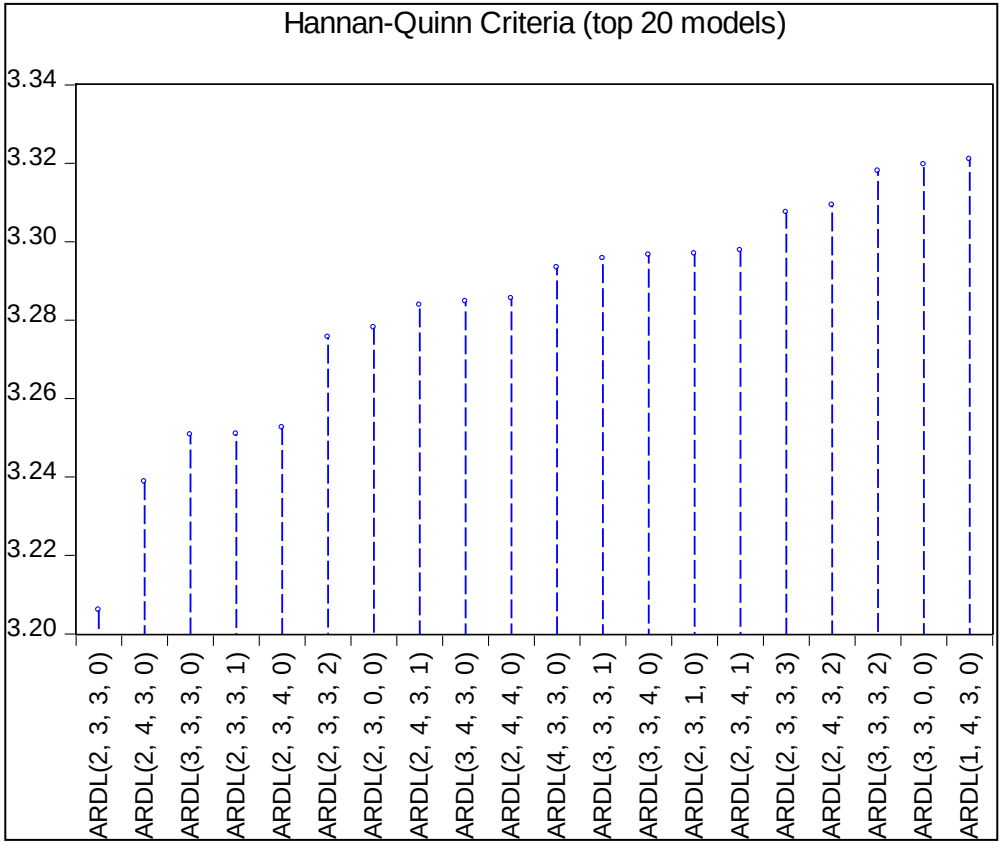
Dependent Variable: GDP
Method: ARDL
Date: 09/28/17 Time: 12:12
Sample (adjusted): 2001Q4 2016Q4
Included observations: 61 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Hannan-Quinn criterion (HQ)
Dynamic regressors (4 lags, automatic): INF INT UER
Fixed regressors: @EXPAND(@QUARTER,@DROPFIRST) C
Number of models evalulated: 500
Selected Model: ARDL(2, 3, 3, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.934420	0.116345	8.031452	0.0000
GDP(-2)	-0.361168	0.096116	-3.757627	0.0005
INF	0.021752	0.154675	0.140633	0.8888
INF(-1)	-0.148158	0.205265	-0.721788	0.4741
INF(-2)	-0.774463	0.227573	-3.403147	0.0014
INF(-3)	0.601316	0.186364	3.226567	0.0023
INT	1.345792	0.752016	1.789580	0.0801
INT(-1)	-0.512504	0.824786	-0.621378	0.5374
INT(-2)	1.130287	0.801362	1.410457	0.1651
INT(-3)	-1.851340	0.663153	-2.791724	0.0076
UER	0.102286	0.517724	0.197569	0.8443
@QUARTER=2	-0.239902	0.390590	-0.614205	0.5421
@QUARTER=3	0.038868	0.403165	0.096407	0.9236
@QUARTER=4	-0.167030	0.390334	-0.427916	0.6707
C	2.245454	2.509171	0.894899	0.3755

R-squared	0.885395	Mean dependent var	5.036105
Adjusted R-squared	0.850515	S.D. dependent var	2.568636
S.E. of regression	0.993120	Akaike info criterion	3.033641
Sum squared resid	45.36923	Schwarz criterion	3.552708
Log likelihood	-77.52604	Hannan-Quinn criter.	3.237068
F-statistic	25.38409	Durbin-Watson stat	2.139420
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

- To judge how strongly the selected model ARDL(2,3,3,0) is preferred over other models:
  - The lower the better.
  - ARDL(2,3,3,0).
  - top 2 models include 2 lags for dependent variable.



Cointegrating long-run relationship

- Speed of adjustment
  - CointEq(-1) is negative and significant.
  - The model converges in the long run.
- Bound test
  - F-statistic (6.324653)
  - 5% (I0=2.79, I1=3.67)
  - F-statistic > 5%
  - There is evidence of long-run relationship.

ARDL Bounds Test
Date: 09/28/17 Time: 12:18
Sample: 2001Q4 2016Q4
Included observations: 61
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.324653	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

ARDL Cointegrating And Long Run Form
Original dep. variable: GDP
Selected Model: ARDL(2, 3, 3, 0)
Date: 09/28/17 Time: 12:16
Sample: 2001Q1 2016Q4
Included observations: 61

Cointegrating Form

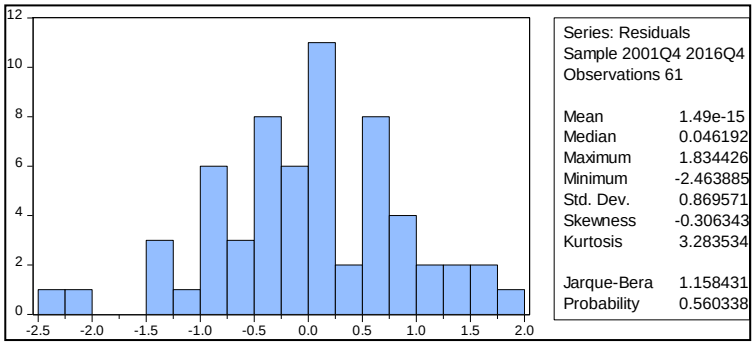
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	0.360122	0.084315	4.271131	0.0001
D(INF)	0.018389	0.134020	0.137210	0.8915
D(INF(-1))	0.171588	0.148511	1.155389	0.2539
D(INF(-2))	-0.601372	0.162334	-3.704529	0.0006
D(INT)	1.317100	0.653255	2.016211	0.0496
D(INT(-1))	0.749511	0.639851	1.171385	0.2475
D(INT(-2))	1.852174	0.628050	2.949085	0.0050
UER	0.000297	0.037334	0.007956	0.9937
D(@QUARTER = 2)	-0.248162	0.229540	-1.081128	0.2853
D(@QUARTER = 3)	0.019320	0.263469	0.073329	0.9419
D(@QUARTER = 4)	-0.185395	0.231470	-0.800944	0.4273
CointEq(-1)	-0.426993	0.074599	-5.723876	0.0000

Cointeq = GDP - (-0.7019*INF + 0.2630*INT + 0.2397*UER -0.5622 *(@QUARTER=2) + 0.0911*(@QUARTER=3) -0.3914*(@QUARTER=4) + 5.2618)

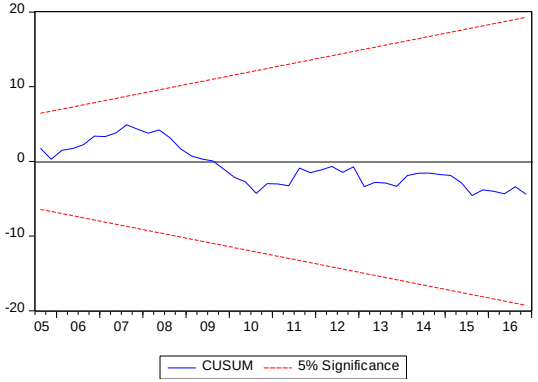
Long Run Coefficients

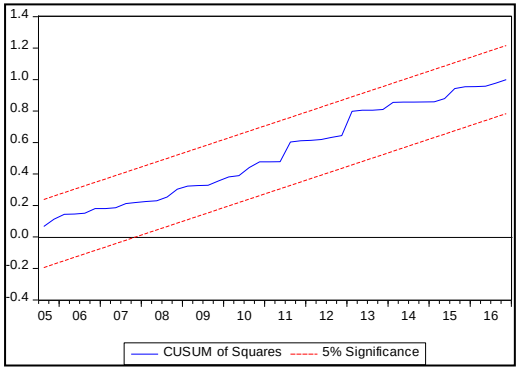
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.701943	0.391339	-1.793695	0.0794
INT	0.263000	1.003032	0.262205	0.7943
UER	0.239687	1.220002	0.196465	0.8451
@QUARTER=2	-0.562164	0.927458	-0.606134	0.5474
@QUARTER=3	0.091080	0.943720	0.096511	0.9235
@QUARTER=4	-0.391403	0.908911	-0.430628	0.6687
C	5.261780	5.813501	0.905097	0.3701

Normality test



Stability test





Serial correlation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.470636	Prob. F(4,42)	0.2282
Obs*R-squared	7.494070	Prob. Chi-Square(4)	0.1120

Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.968638	Prob. F(14,46)	0.4983
Obs*R-squared	13.88858	Prob. Chi-Square(14)	0.4580
Scaled explained SS	9.017605	Prob. Chi-Square(14)	0.8299

Result ARDL(2,3,3,0)

Variables	coefficients
D(GDP(-1))	0.360122***
D(INF(-2))	-0.601372***
D(INT)	1.317100**
D(INT(-2))	1.852174***
COINTEQ(-1)	-0.426993***
LONG RUN COEFFICIENTS	
INF	-0.701943
INT	0.263000
UER	0.239687
***significant ant 1% critical value **significant at 5% critical value *significant at 10% critical value	

Conclusion

- There is a long run relationship between inflation, interest rate and unemployment with GDP.
- In the short run:
  - Inflation was inversely related to GDP (against Phillips Curve theory).
  - Interest rate was positively related to GDP.
  - Unemployment rate (not significant).
- COINTEQ coefficient is negative and significant meaning that the model converges to equilibrium in the long run.
- The system is getting adjusted at the speed of 42.7% towards long run equilibrium.
- Best model : ARDL(2,3,3,0)