1. The variance of the error term is a constant σ^2.
2. That the critical value is larger than the observed absolute value of the test statistic.
3. 6.10
4. $H_0: \beta_2 = 0 \quad vs \quad H_1: \beta_2 \neq 0$

5. EVIEW'S OUTPUT

Dependent Variable: GROWTH
Method: Least Squares
Date: 10/29/16 Time: 13:42
Sample: 1 67
Included observations: 67

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.77580	2.903024	4.400860	0.0000
TRADESHARE	-2.887517	3.009213	-0.959559	0.3411
TRADESHARE^2	3.303345	2.402065	1.375210	0.1742
LYEARSSCHOOL	2.126822	0.350757	6.063513	0.0000
REVCOUPS	-2.123621	0.981602	-2.163424	0.0345
ASSASSINATIONS	0.116144	0.430908	0.269532	0.7884
LRGDP60	-1.616195	0.384638	-4.201858	0.0001

R-squared	0.465154	Mean dependent var	1.882841
Adjusted R-squared	0.411669	S.D. dependent var	1.777772
S.E. of regression	1.363599	Akaike info criterion	3.556740
Sum squared resid	111.5642	Schwarz criterion	3.787081
Log likelihood	-112.1508	Hannan-Quinn criter.	3.647886
F-statistic	8.696963	Durbin-Watson stat	2.041431
Prob(F-statistic)	0.000001		

a) Estimated equation

$$\widehat{Growth} = 12.7758 - 2.887517 tradeshare + 3.303345 tradeshare^2 + 2.126822 lyearsschool - 2.123621 revcoups + 0.116144 assassinations - 1.616195 lrgdp60$$

Coefficients and correspondent standard errors:

$\widehat{\beta_0} = 12.77580, \quad \widehat{\beta_1} = -2.887517, \quad \widehat{\beta_2} = 3.303345, \quad \widehat{\beta_3} = 2.126822;$

$\widehat{\beta_4} = -2.123621, \quad \widehat{\beta_5} = 0.116144, \quad \widehat{\beta_6} = -1.616195;$

$\widehat{\sigma_{\beta_0}} = 2.903024, \quad \widehat{\sigma_{\beta_1}} = 3.009213, \quad \widehat{\sigma_{\beta_2}} = 2.402065, \quad \widehat{\sigma_{\beta_3}} = 0.350757;$

$\widehat{\sigma_{\beta_4}} = 0.981602, \quad \widehat{\sigma_{\beta_5}} = 0.430908, \quad \widehat{\sigma_{\beta_6}} = 0.384638;$

b)

Coefficient β_5: $\widehat{\beta_5} = 0.116144$. Regarding, all other factors fixed (*ceteris paribus*), for each unit increased in the variable $assassinations$, the average annual percentage growth of real GDP, $Growth$ increases 0.116144 (percentage points), since it is a lin-lin relation. However, this effect is not statistically significant at 5%. Therefore, we have evidence that the average annual number of political assassinations in a country does not affect the value of the variable $Growth$, given the other variables in the model.

Coefficient β_6: $\widehat{\beta_6} = -1.616195$; Regarding, all other factors fixed (*ceteris paribus*), for each increase of 1% in GDP per capita, $rgdp60$, the average annual percentage growth of real GDP, $Growth$ decreases $\frac{1.616195}{100}$, since it is a lin-log relation. Therefore, the higher is the GDP per capita in 1960, the lower is the value of the variable $Growth$ and this effect is statistically significant at 5%. The negative sign in this coefficient shows that the richer are the countries (measured by GDP per capita) the lower is the Growth rate, which makes some sense because well developed economies have not much space to grow while less developed economies may have more growth opportunities.

c) The coefficient on $tradeshare$ is negative and the coefficient on $tradeshare^2$ is positive. This means that there is always a point where the value of $tradeshare$ has a zero effect on the variable $Growth$. Before this point, $tradeshare$ has a negative effect on $Growth$ and after this point $tradeshare$ has a positive effect on $Growth$.

The "turning point" is given by $\left|\frac{\widehat{\beta_1}}{2\times\widehat{\beta_2}}\right| = \left|\frac{-2.887517}{2\times3.303345}\right|$ ≈0.43706

Hence the marginal effect of $tradeshare$ on $Growth$ becomes positive at the point where $tradeshare = 0.43706$. Therefore, trade is beneficial for the growth of a country (given the other factors in the model) only when it is higher than 44% of GDP.

d)

Joint Hypothesis Test

Test of hypothesis:

$$H_0: \beta_4 = \beta_5 = 0 \quad vs \quad H_1: \exists \beta_4, \beta_5 \neq 0$$

Number of restrictions: $q = 2$.

In Eview's the output for this test is:

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.763774	(2, 60)	0.0711
Chi-square	5.527548	2	0.0631

Null Hypothesis: C(5)=C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	-2.123621	0.981602
C(6)	0.116144	0.430908

Restrictions are linear in coefficients.

F statistic:

$F = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-k-1)} \sim F_{(q,n-k-1)}$ (Under H_0), in this case $F \sim F_{(2,60)}$

Observed value of the F Statistic:

$F_{obs} = 2.763774$

Rejection Rule

Reject H_0 if $F_{obs} > c$, where c is the critical value.

$$\alpha = 1\% \Rightarrow c = 4.977432;\ \alpha = 5\% \Rightarrow c = 3.150411;\ \alpha = 10\% \Rightarrow c = 2.393255$$

Also, p-value= P ($F > F_{obs}$) =0.071092 ≈ 0.0711 (same value given in the output)

Conclusion:

For $\alpha = 1\%, 5\%$, $F_{obs} < c$ ⇒ Do not reject H_0

Alternatively $pvalue = 0.0711 > \alpha \Rightarrow$ Do not reject $H_0: \beta_4 = \beta_5 = 0$. There is enough evidence to assume that the coefficients on $revcoups$ and $assassinations$ are not jointly significant and so, they are statistically equal zero, at a significance level of 1% and 5%.

For $\alpha = 10\%$, $F_{obs} > c$ ⇒ Reject H_0

Alternatively $p - value = 0.0711 < \alpha \Rightarrow$ Reject $H_0: \beta_4 = \beta_5 = 0$. There is enough evidence to assume that the coefficients on $revcoups$ and $assassinations$ are jointly significant and statistically different from zero, at a significance level of 10%.

Individual Hypothesis Test for β_4 (coefficient on RevCoups)

Test of hypothesis:

$H_0: \beta_4 = 0 \quad vs \quad H_1: \beta_4 \neq 0$

Test statistic:

$t = \frac{\widehat{\beta_4} - \beta_4}{se(\widehat{\beta_4})} \sim t_{(n-k-1)}$ (Under H_0) since the sample is large is it possible to write

$t = \frac{\widehat{\beta_4} - \beta_4}{se(\widehat{\beta_4})} \sim N(0,1)$ (Under H_0)

Observed value of the Test Statistic:

$t_{obs} = -2.163424$

Rejection Rule:

Reject H_0 if $|t_{obs}| > c$, where c is the critical value.

$$\alpha = 1\% \Rightarrow c = z_{\frac{0.01}{2}} = 2.576;$$
$$\alpha = 5\% \Rightarrow c = z_{0.05/2} = 1.96;$$
$$\alpha = 10\% \Rightarrow c = z_{0.10/2=} z_{0.05} = 1.645$$

Also, $pvalue = 0.0345$

Conclusion:

For $\alpha = 1\%$, $|\, t_{obs}| < c$ ⇒ Do not reject H_0.

Alternatively $pvalue = P(t(60) > |-2.163424|) = 0.0345 > \alpha = 0.01 \Rightarrow$ Do not reject $H_0: \beta_4 = 0$. There is enough evidence to assume that the coefficient on $revcoups$ is not statistically significant and so it is assumed to be statistically equal zero, at a significance level of 1%.

For $\alpha = 5\%\ and\ 10\%$, $|\, t_{obs}| > c$ ⇒ Reject H_0.

Alternatively $pvalue = 0.0345 < \alpha \Rightarrow$Reject $H_0: \beta_4 = 0$. There is enough evidence to assume that the coefficient on $revcoups$ is statistically significant and so it is assumed to be statistically different from zero, at a significance level of 5% and 10%.

Individual Hypothesis Test for β_5 (coefficient on Assassinations)

Test of hypothesis:

$H_0: \beta_5 = 0 \quad vs \quad H_1: \beta_5 \neq 0$

Test statistic:

$t = \frac{\widehat{\beta_5} - \beta_5}{se(\widehat{\beta_5})} \sim t_{(n-k-1)}$ (Under H_0) since the sample is large is it possible to write

$t = \frac{\widehat{\beta_5} - \beta_5}{se(\widehat{\beta_5})} \sim N(0,1)$ (Under H_0)

Observed value of the Test Statistic:

$t_{obs} = 0.269532$

Rejection Rule:

Reject H_0 if $|t_{obs}| > c$, where c is the critical value.

$$\alpha = 1\% \Rightarrow c = z_{\frac{0.01}{2}} = 2.576;$$
$$\alpha = 5\% \Rightarrow c = z_{0.05/2} = 1.96;$$
$$\alpha = 10\% \Rightarrow c = z_{0.10/2=} z_{0.05} = 1.645$$

Also, $pvalue = \mathrm{P}(\mathrm{t}(60) > |0.269532|) = 0.7884$

Conclusion:

For $\alpha = 1\%$ $5\%, 10\%$, $|\ t_{obs}| < c \Rightarrow$ Do not reject H_0.

Alternatively $pvalue = 0.7884 > \ \alpha \Rightarrow$ Do not reject H_0: $\beta_5 = 0$. There is enough evidence to assume that the coefficient on $assassinations$ is not statistically significant and so it is assumed to be statistically equal zero, at a significance level of 1%, 5% and 10%.

e) Regarding that all other factors remain fixed, the effect of $tradeshare$ on $Growth$ is given by $\Delta\widehat{Growth} \approx \left[\widehat{\beta_1} + 2 \times \widehat{\beta_2} tradeshare\right]\Delta tradeshare.$

Hence, if $\Delta tradeshare = 1 - 0.5 = 0.5$ and $\widehat{\beta_1} = -2.887517$, $\widehat{\beta_2} = 3.303345$ then the predicted change in $Growth\ is$ (-2.887517+2x3.303345x0.5)x0.5= 0.207914 percentage points.

f) Testing is there is any statistical evidence of a quadratic effect of $tradeshare$ on $Growth$ is the same has testing the following hypothesis.

Test of hypothesis:

$\mathrm{H}_0: \beta_2 = 0 \quad \mathrm{vs} \quad \mathrm{H}_1: \beta_2 \neq 0$

Test statistic:

$t = \frac{\widehat{\beta_2} - \beta_2}{se(\widehat{\beta_2})} \sim t_{(n-k-1)}$ (Under H_0) since the sample is large is it possible to write

$t = \frac{\widehat{\beta_2} - \beta_2}{se(\widehat{\beta_2})} \sim N(0,1)$ (Under H_0)

Observed value of the Test Statistic:

$t_{obs} = 1.375210$

Rejection Rule:

Reject H_0 if $|t_{obs}| > c$, where c is the critical value.

$$\alpha = 1\% \Rightarrow c = z_{\frac{0.01}{2}} = 2.576;$$

$$\alpha = 5\% \Rightarrow c = z_{0.05/2} = 1.96;$$
$$\alpha = 10\% \Rightarrow c = z_{0.10/2=} z_{0.05} = 1.645$$

Also, $pvalue = 0.1742$

Conclusion:

For $\alpha = 1\%\ 5\%, 10\%$, $|\ t_{obs}| < c$ ⇒ Do not reject H_0.
Alternatively $pvalue = 0.1742 > \alpha$ ⇒ Do not reject H_0: $\beta_2 = 0$. There is enough evidence to assume that the coefficient on $tradeshare^2$ is not statistically significant and so it is assumed to be statistically equal zero, at a significance level of 1%, 5% and 10%. Therefore there is no statistical evidence of a quadratic effect of $tradeshare$ on $Growth$.

g) No, the test used in the previous question is only for the quadratic effect of $tradeshare$ on $Growth$. ie, is a individual test for the coefficient β_2.

In order to test if the variable $tradeshare$ is statistically significant a test of joint significance must be performed.

Test of hypothesis:

$$H_0: \beta_1 = \beta_2 = 0 \quad vs \quad H_1: \exists \beta_1, \beta_2 \neq 0$$

Number of restrictions: $q = 2$.
In Eview's the output for this test is:

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.883939	(2, 60)	0.1609
Chi-square	3.767878	2	0.1520

Null Hypothesis: C(2)=C(3)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	-2.887517	3.009213
C(3)	3.303345	2.402065

Restrictions are linear in coefficients.

F statistic:

$F = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-k-1)} \sim F_{(q,n-k-1)}$ (Under H_0), in this case $F \sim F_{(2,60)}$

Observed value of the F Statistic:

$F_{obs} = 1.883939$

Rejection Rule

~~Reject H_0 if $F_{obs} > c$, where c is the critical value.~~

$$\alpha = 1\% \Rightarrow c = 4.977432;\ \alpha = 5\% \Rightarrow c = 3.150411;\ \alpha = 10\% \Rightarrow c = 2.393255$$

Also, p-value= P ($F > F_{obs}$) =0.160871≈ 0.1609 (same value given in the output)

Conclusion:

For $\alpha = 1\%$, 5% and 10%, $F_{obs} < c$ $\Rightarrow$ Do not reject H_0

Alternatively $pvalue = 0.16091 > \alpha \Rightarrow$ Do not reject $H_0: \beta_1 = \beta_2 = 0$. There is enough evidence to assume that the coefficients on $tradeshare$ and $tradeshare^2$ are not jointly significant and so, statistically equal zero, at a significance level of 1%, 5% and 10%. Therefore, it is possible to assume that the effect of $Tradeshare$ is not statistically significant.