1. C. The assumption TS.2 is not verified because there is perfect collinearity.
2. C. $\widehat{\delta_0} = -0.82, \widehat{\delta_1} = 1.70 \; and \; \widehat{\delta_2} = 0.05$
3. C. Assuming contemporaneous exogeneity it is possible that $corr(x_t, u_{t-20}) \neq 0$
4. D. The estimated long-run elasticity is 0.02% and the estimated impact elasticity is 0.02%.

5. $\log(m_t) = \alpha_0 + \alpha_1 t + \delta_1 Q1_t + \delta_2 Q2_t + \delta_3 Q3_t + \beta_1 p_t + \beta_2 r_t + \beta_3 \log(y_t) + \beta_4 \log(y_{t-1}) + u_t$

$$\widehat{\log(m_t)} = 4.210499 + 0.028269t - 0.185685Q1_t - 0.0907590Q2_t - 0.114333Q3_t + 0.231249p_t - 0.421893r_t + 8.349787\log(y_t) - 0.8539909\log(y_{t-1})$$

EVIEW'S OUTPUT

Dependent Variable: LOG(M)
Method: Least Squares
Date: 11/29/16 Time: 16:56
Sample (adjusted): 1977Q2 1995Q4
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.210499	2.991367	1.407550	0.1640
T	0.028269	0.002707	10.44195	0.0000
Q1	-0.185685	0.021126	-8.789540	0.0000
Q2	-0.090759	0.018732	-4.845250	0.0000
Q3	-0.114333	0.018531	-6.169755	0.0000
PI	0.231249	0.059951	3.857303	0.0003
R	-0.421893	0.206536	-2.042708	0.0451
LOG(Y)	8.349787	2.485762	3.359046	0.0013
LOG(Y(-1))	-8.539909	2.448752	-3.487454	0.0009

R-squared	0.995616	Mean dependent var	5.914121
Adjusted R-squared	0.995085	S.D. dependent var	0.810617
S.E. of regression	0.056830	Akaike info criterion	-2.785337
Sum squared resid	0.213157	Schwarz criterion	-2.507239
Log likelihood	113.4501	Hannan-Quinn criter.	-2.674296
F-statistic	1873.739	Durbin-Watson stat	2.009461
Prob(F-statistic)	0.000000		

a) The impact multiplier of GNP is given by $\beta_{3,}$ therefore the estimated value is equal to 8.349787. The impact multiplier measures the immediate percentage change in quarterly money supply of a given country, m, given a temporary 1% increase in *GNP*, y. So, regarding all other factor fixed, for a temporarily 1% increase on the variable y the dependent variable m increases 8.349787 %.

The long-run multiplier is given by $\beta_3 + \beta_4$.
Therefore the estimate is equal to $8.349787 - 8.539909 = -0.190122$. The long run multiplier measures the percentage increase in the variable m in the long run, given a permanent 1% increase in *GNP.* So, regarding all other factors fixed, 1% permanent increase in GNP, implies in the long run a decrease in m of 0.19122%.

b) $Long\ run\ multiplier: \beta_3 + \beta_4 = 0$

Test of hypothesis:
$H_0: \beta_3 + \beta_4 = 0\ vs\ \ H_1: \beta_3 + \beta_4 \neq 0$

Eview's output:

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-0.127463	66	0.8990
F-statistic	0.016247	(1, 66)	0.8990
Chi-square	0.016247	1	0.8986

Null Hypothesis: C(8)+C(9)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(8) + C(9)	-0.190122	1.491590

Restrictions are linear in coefficients.

Test statistic:

$t = \frac{\widehat{\beta_3} + \widehat{\beta_4} - 0}{se\left(\widehat{\beta_3 + \beta_4}\right)} \sim t_{(75-8-1)}$ (Under H_0) since the sample is large is it possible to write

$t = \frac{\widehat{\beta_3} + \widehat{\beta_4} - 0}{se\left(\widehat{\beta_3 + \beta_4}\right)} \sim N(0,1)$ (Under H_0).

Observed value of the Test Statistic:

$$t_{obs} = \frac{8.349787 + (-8.539909) - 0}{1.491590} = \frac{-0.190122}{1.491590} = -0.127463$$

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, $pvalue = 0.8990$

<u>Conclusion:</u>

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

Alternatively $pvalue = 0.899 > \ \alpha \Rightarrow$ Do not Reject H_0: $\beta_3 + \beta_4 = 0$. There is not enough evidence to assume that the long run multiplier is statistically significant and so it is possible to conclude it is statistically equal to zero, at a significance level of 1%, 5% and 10%.

c) The coefficient of the time trend is $\alpha_1 = 0.028269$. (Exponential trend).Holding all other factor fixed, α_1 measures the average change rate in the variable m per period. Therefore, m_t grows, on average, 2.8% per quarter.

Note that the time trend is statistically significant at a level of 1%, 5% and 10%.

It is possible to find a spurious relationship between m_t and one or more explanatory variables if we ignore the fact that unobserved trending factors that affect m_t might also be correlated with the explanatory variables. Adding a time trend to this model eliminates the possibility of a spurious regression problem. Also, allowing for the trend in this model recognizes that m_t may be growing over time for reasons essentially unrelated to the other explanatory variables.

d) Q1, Q2 and Q3 are seasonal dummy variables.

This means that

$$Q1_t = \begin{cases} 1, & if\ t\ corresponds\ to\ 1st\ quarter \\ 0, & otherwise \end{cases}$$

$$Q2_t = \begin{cases} 1, & if\ t\ corresponds\ to\ 2nd\ quarter \\ 0, & otherwise \end{cases}$$

$$Q3_t = \begin{cases} 1, & if\ t\ corresponds\ to\ 3rd\ quarter \\ 0, & otherwise \end{cases}$$

So, with this formulation, the fourth quarter is the "base quarter" (when Q1=Q2=Q3=0).

The coefficient of Q2 is $\widehat{\delta_2} = -0.090759$.

This means that for the Second Quarter (Q2) and regarding all other factors fixed (*ceteris paribus*), m_t is on average, 9.0759% lower than for the last Quarter (Q4- base group).

e) To check if there is any evidence of seasonality on the variable m_t a F test must be performed, that is:

Joint Hypothesis Test

Test of hypothesis:

$H_0: \delta_1 = \delta_2 = \delta_3 = 0 \; vs \; H_1: \exists \delta_1, \delta_2, \delta_3 \neq 0$

Number of restrictions: $q = 3$.

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 $F \sim F_{(3,66)}$

In Eview's the output for this test is:

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	27.65073	(3, 66)	0.0000
Chi-square	82.95218	3	0.0000

Null Hypothesis: C(3)=C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3)	-0.185685	0.021126
C(4)	-0.090759	0.018732
C(5)	-0.114333	0.018531

Restrictions are linear in coefficients.

Observed value of the F Statistic:

$F_{obs} = 27.65073$

Rejection Rule

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

$\alpha = 1\% \Rightarrow c = 4.09303; \; \alpha = 5\% \Rightarrow c = 2.743711; \; \alpha = 10\% \Rightarrow c = 2.168697$

Also, p-value=0

Conclusion:

For $\alpha = 1\%, 5\% \; and \; 10\%$, $F_{obs} > c \Rightarrow$ Reject H_0

Alternatively $p - value = 0 < \alpha, \forall \alpha \Rightarrow$ Reject $H_0: \delta_1 = \delta_2 = \delta_3 = 0$. There is enough evidence to assume that the coefficients of the different Quarterly Dummy variables are jointly significant and statistically different from zero, at a significance level of 1%, 5% and 10%.

This means that it is possible to conclude that there is evidence of seasonality on the quarterly money supply.