PROBLEM 1

Due to the independent variable "$\bar{p}_t$", there is a multicollinearity problem in the estimation.

$$\bar{p}_t = \frac{\sum_{i=1}^{k} p_{ti}}{k}$$

$\bar{p}_t$ is a linear function of p_{ti} $\forall i \in \{1, 2, \ldots, k\}$

(For the consequences of multicollinearity, see the lecture notes.)

PROBLEM 2

The independent variable, "Δi_t" causes multicollinearity in the regression.

$$\Delta i_t = i_t - i_{t-1}$$

Δi_t is a linear function of "i_t" and "i_{t-1}" which are also independent variables in the model.

PROBLEM 3

a) To check that whether there is multicollinearity, or not, we need to look at the results of significance tests (both Q and t-test).

$H_0: \beta_0 = \beta_1 = \beta_2 = \beta_3 = 0$

H_A: at least one of them is non-zero.

$$Q = \frac{(0.989-0)/4}{(1-0.989)/30-3-1} = 584.40$$

$$F_{crit} = F^{0.05}_{4,26} = 2.74$$

$Q > F_{crit} \Rightarrow RH_0$

$\Rightarrow$ All coeffficents are jointly significant

Now, checking individually;

$H_0: \beta_0 = 0$	$H_0: \beta_1 = 0$	$H_0: \beta_2 = 0$	$H_0: \beta_3 = 0$
$H_A: \beta_0 \neq 0$	$H_A: \beta_1 \neq 0$	$H_A: \beta_2 \neq 0$	$H_A: \beta_3 \neq 0$
$t_{calc} = -0.69$	$t_{calc} = 3.49$	$t_{calc} = 1.02$	$t_{calc} = 1.73$

$t_{crit} = t_{0.05/2,\,30-3-1} = t_{0.025,26} = 2.055$

For $\beta_0, \beta_2, \beta_3$; $|t_{calc}| < t_{crit} \Rightarrow$ Do not RH_0

$\Rightarrow$ For $\alpha = 0.05$ significance level, β_0, β_2 and β_3 are insignificant

For β_1; $|t_{calc}| > t_{crit} \Rightarrow R H_0$
$\Rightarrow \beta_1$ is significant.

As a result; when we test jointly, all terms are resulted as jointly significant. But, in individual test β_0, β_2 and β_3 came up as insignificant. This is a symptom of multicollinearity.

b) $$VIF_1 = \frac{1}{1-R_1^2} = \frac{1}{1-0.991} = 111.11$$

$$VIF_2 = \frac{1}{1-R_2^2} = \frac{1}{1-0.993} = 142.85$$

$$VIF_3 = \frac{1}{1-R_3^2} = \frac{1}{1-0.961} = 25.64$$

We can answer part (a), from these results, too. All VIF values are greater than 10, this indicates that there is serious MC in the model.

Also, Y_{t-1} contributes most to the MC, since it increases the variance more than the other variables.

c) There are some "proposed" solutions to the MC, but none of them solves this problem, precisely.

Solutions:

1) We can divide the variables each other and use this transformed variable. " $\frac{Y_t}{Y_{t-1}}$ or $\frac{Y_{t-1}}{L_t}$ or .... "

2) We can use "changes" instead of "levels".

For example;

$$\Delta C_t = k_0 + k_1 \Delta Y_t + k_2 \Delta Y_{t-1} + k_3 \Delta L_t$$

or

$$C_t = m_0 + m_1 \Delta Y_t + \ldots$$

or

$$\Delta C_t = n_0 + n_1 Y_t \ldots$$

3) We can try to increase sample size or try to obtain completely another sample. (If possible)

4) Combine cross-section and time-series data, namely work on panel data.

5) Using prior information (If available)

6) Omitting some veribles "Y_{t-1} or Y_t or L_t", but this is not recommanded since omission leads to bias and any other problems.

PROBLEM 4

a) $H_0: \beta_0 = \beta_1 = \beta_2 = \beta_3 = 0$

H_A: at least one of them is non-zero

$$Q = \frac{(0.97)/4}{((1-0.97)/34-3-1} = 242.5$$

$$F_{crit} = F^{0.05}_{4,30} = 2.68$$

$Q > F_{crit} \Rightarrow RH_0$

$\Rightarrow$ Both intercept and slope terms are significant.

$H_0: \beta_0 = 0$	$H_0: \beta_1 = 0$	$H_0: \beta_2 = 0$	$H_0: \beta_3 = 0$
$H_A: \beta_0 \neq 0$	$H_A: \beta_1 \neq 0$	$H_A: \beta_2 \neq 0$	$H_A: \beta_3 \neq 0$
$t_{calc} = \frac{2.81}{1.38}$	$t_{calc} = \frac{-0.53}{0.34}$	$t_{calc} = \frac{0.21}{0.14}$	$t_{calc} = \frac{0.047}{0.021}$
$= 2.03$	$= -1.55$	$= 1.5$	$= 2.23$

$t_{crit} = t_{0.05/2,\, 34-3-1} = t_{0.025,\, 30} = 2.04$

$\beta_0 \Rightarrow |t_{calc}| \cong t_{crit} \Rightarrow$ For $\underline{\alpha = 0.10}$, β_0 is significant.

β_1 and $\beta_2 \Rightarrow |t_{calc}| < t_{crit} \Rightarrow$ Do not $RH_0 \Rightarrow$ For $\alpha = 0.05$, β_1 and β_2 insignificant

$\beta_3 \Rightarrow |t_{calc}| > t_{crit} \Rightarrow RH_0$

$\Rightarrow \beta_3$ is significant.

The results of joint test indicates that all terms are jointly significant. But, in individual testing β_1 and β_2 came up as insignificant.

b) The aim is to get rid of multicollinearity, by manipulating the variables. (See, problem 3, part (c), first solution)

c) $$Q = \frac{(0.65)/3}{(1-0.65)/34-2-1} = 19.190$$

$H_0: \beta_0 = \beta_1 = \beta_2 = 0$

H_A: at least one of them is non-zero

$$F_{crit} = F^{0.05}_{3,31} = 2.911$$

$Q > F_{crit} \Rightarrow RH_0 \Rightarrow$ All terms are jointly significant.

$H_0: \beta_0 = 0$ $\quad$ $H_0: \beta_1 = 0$ $\quad$ $H_0: \beta_2 = 0$

$H_A: \beta_0 \neq 0$ $\quad$ $H_A: \beta_1 \neq 0$ $\quad$ $H_A: \beta_2 \neq 0$

$t_{calc} = \frac{-0.11}{0.03} = -3.66$ $\quad$ $t_{calc} = \frac{0.91}{0.15} = 6.06$ $\quad$ $t_{calc} = \frac{0.06}{0.006} = 10$

$t_{crit} = t_{0.05/2,\, 34-2-1} = 2.039$

$\beta_0, \beta_1, \beta_2 \Rightarrow |t_{calc}| > t_{crit} \Rightarrow RH_0$

$\Rightarrow \beta_0, \beta_1$ and β_2 are <u>individually</u> significant.

Unlike part (a), F-test and t-test results supports each other, so we can conclude that MC problem is reduced.