Tutorial, Part 7

Model diagnostics, ctd.

Example

c) Jarque-Bera test

H_0: Residuals (variable u) are normally distributed.
H_1: —— // —— NOT —— // ——

$S = -0.119$ $K = 3.034$ $n = 96$

$$JB = n \cdot \left(\frac{S^2}{6} + \frac{(K-3)^2}{24} \right) = 96 \cdot \left(\frac{(-0.119)^2}{6} + \frac{(3.034-3)^2}{24} \right) =$$
$$= 0.231 \sim \chi^2_{(2)}$$

$\chi^2_{c\,(m=2,\ \alpha=0.05)} = 5.997$
$JB < \chi^2_c \implies$ cannot reject H_0 (at $\alpha = 0.05$)

(Stata: jb 6 $\longrightarrow$ $p = 0.8909 > \alpha = 0.05$)

d) Multicollinearity caused by variable PPR

$\boxed{M_{AR}:}$ $\widehat{PPR}_t = b_1 + b_2 RVP_t + b_3 RVV_t + b_4 CZP_t$
$\hookrightarrow R^2_{PPR} = 0.8847$

$$VIF_{PPR} = \frac{1}{1-R^2_{PPR}} = \frac{1}{1-0.8847} = 8.676 \overset{?}{\lessapprox} 10$$

e) White test

$$\boxed{M_B:}\quad HM1_t = b_1 + b_2 PPR_t + b_3 RVP_t + b_4 RW_t + b_5 CZP_t + e_t$$

Assume: $\sigma_t^2 = \alpha_1 + \alpha_2 PPR_t + \alpha_3 RVP_t + \alpha_4 RW_t + \alpha_5 CZP_t +$
$+ \alpha_6 PPR_t^2 + \alpha_7 RVP_t^2 + \alpha_8 RVV_t^2 + \alpha_9 CZP_t^2 +$
$+ \alpha_{10} PPR_t \cdot RVP_t + \alpha_{11} PPR_t \cdot RVV_t + \alpha_{12} PPR_t \cdot CZP_t +$
$+ \alpha_{13} RVP_t RW_t + \alpha_{14} RVP_t CZP_t + \alpha_{15} RVV_t CZP_t$

$H_0: \alpha_j = 0 \quad ; \quad \forall j = 2, \dots, 15$ (homoscedasticity)
$H_1: \alpha_j \neq 0 \quad ; \quad \exists j = 2, \dots, 15$ (heteroscedesticity)

$$\boxed{M_{AR}:}\quad \hat{e}_t^2 = a_1 + a_2 PPR_t + a_3 RVP_t + a_4 RVV_t + a_5 CZP_t +$$
$+ a_6 PPR_t^2 + a_7 RVP_t^2 + a_8 RW_t^2 + a_9 CZP_t^2 +$
$+ a_{10} PPR_t RVP_t + a_{11} PPR_t RVV_t + a_{12} PPR_t CZP_t +$
$+ a_{13} RVP_t RVV_t + a_{14} RVP_t CZP_t + a_{15} RVV_t CZP_t$

$\hookrightarrow R_{AR}^2 = 0.5607$

$15 = k \rightarrow$ # par. in M_{AR}

(LM)
$$Q = n \cdot R_{AR}^2 = 96 \cdot 0.5607 = 53.83 \sim \chi^2_{k-1}$$

$\chi^2_c (m = k-1 = 14, \alpha = 0.05) = 23.685$

$Q > \chi^2_c \Rightarrow$ reject H_0 at $\alpha = 0.05$ and conclude from $H_1 \Rightarrow$ there is heteroscedesticity problem in the model

(state: p-value $= 0.0000 < \alpha = 0.05$)

Solution: robust estimator
(HC - heteroscedesticity consistent estimator) $\rightarrow$ ~~B~~LUE

f) Breusch – Godfrey test
(e.g. for AC of order up to $p = 4$)

Assume: $u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \rho_3 u_{t-3} + \rho_4 u_{t-4} + \varepsilon_t$

$H_0: \rho_j = 0 \quad ; \quad \forall j = 1, \ldots, \overset{(p)}{4}$ (no AC of order up to $\overset{(p)}{4}$)
$H_1: \rho_j \neq 0 \quad ; \quad \exists j = 1, \ldots, 4$ (there is AC of order up to 4)

$\boxed{M_{AR}:}$ $\hat{e}_t = b_1 + b_2 PPR_t + b_3 RVP_t + b_4 RW_t + b_5 CZP_t +$
$+ \hat{\rho}_1 e_{t-1} + \hat{\rho}_2 e_{t-2} + \hat{\rho}_3 e_{t-3} + \hat{\rho}_4 e_{t-4}$
$\hookrightarrow R^2 = 0.7446$

$LM = (n-p) \cdot R^2_{AR} = (96-4) \cdot 0.7446 = 68.50$
$\sim \chi^2_p$

$\chi^2_c (m = p = 4, \alpha = 0.05) = 9.4877$
$LM > \chi^2_c \Rightarrow$ reject H_0 at $\alpha = 0.05$ and conclude from $H_1 \Rightarrow$ there is AC of order up to 4 present in the model

(Stata: p-value $= 0.0000$
$< \alpha = 0.05$)

Solution: robust estimator
(HAC - heteroscedasticity & AutoCorrelation consistent estimator) $\rightarrow$ ~~B~~LUE

(Max lag: $n - 1 - k = 96 - 1 - 5 = 90$)

Tutorial, Part 8 Dummy expl. vars

Example 1

$\boxed{M_B:}$ $\hat{PROFIT}_t = b_1 + b_2\, SALES_t$

quarterly data → likely presence of seasonal component

SEASON (q) : quarter 1, quarter 2, quarter 3, quarter 4

Generate DUMMY VARIABLES :

m categories → $m-1$ dummies (one category is base/reference)

Let quarter 1 be BASE category:

$$D_2 = \begin{cases} 1 & ; \text{quarter 2} \\ 0 & ; \text{else} \end{cases}$$

$$D_3 = \begin{cases} 1 & ; \text{quarter 3} \\ 0 & ; \text{else} \end{cases}$$

$$D_4 = \begin{cases} 1 & ; \text{quarter 4} \\ 0 & ; \text{else} \end{cases}$$

$\boxed{M_S:}$ $\hat{PROFIT}_t = b_1 + b_2\, SALES_t + b_3 D_{2t} + b_4 D_{3t} + b_5 D_{4t}$

↳ model with seasonal component

D_j : differential intercept coefficient

If D_j insignificant ($\forall j$) → M_S same as M_B

Stata: D_3 and D_4 insignificant?

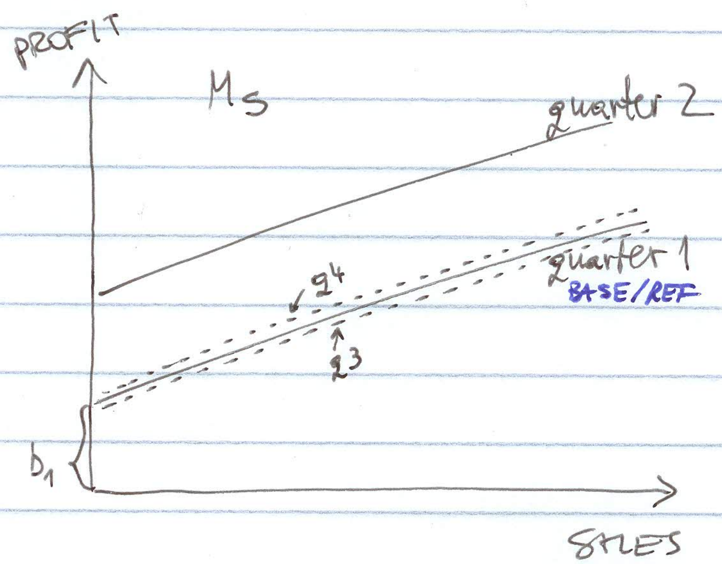
$H_0: \beta_4 = \beta_5 = 0$

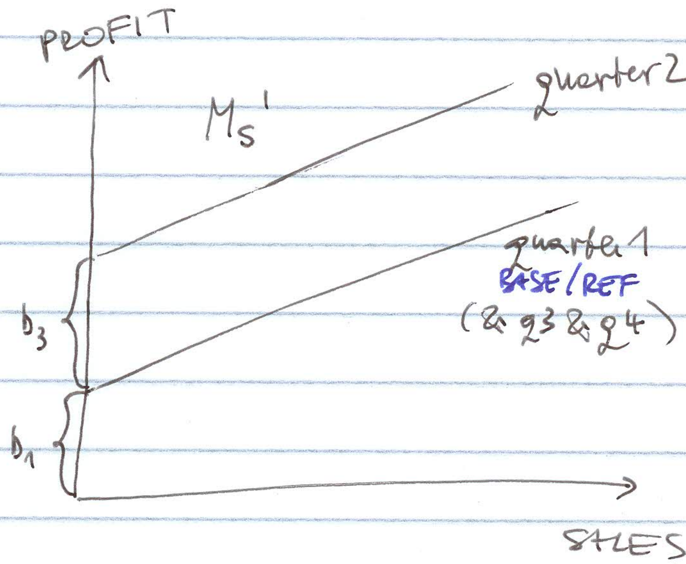
$H_1: \beta_j \neq 0 \; ; \; \exists \; j = 4, 5$

$F = 0.20$ p-value $= 0.8197 > \alpha = 0.05$

↳ cannot rejet H_0

$\boxed{M_5' :}$ $\widehat{PROFIT}_t = b_1 + b_2 \, SALES + b_3 \, D_{2t}$





Interpretation of partial regression coefficients:

$b_2 = 0.039$: If sales increase by 1 billion (10^9) USD the profits increase on average by 39 million (10^6) USD, controlling for the seasonal effect

$b_3 = 1.33$: The profits in the 2^{nd} quarter are on average by 1.33 billion USD higher compared to the 1^{st} quarter BASE CATEGORY (as well as compared to the 3^{rd} and 4^{th}).

↑ implicitly