

$$\Delta P_t = 160.58 - 0.02P_{t-1} \quad R^2 = 0.01$$

(134.00) (0.014)

(1)

$$\Delta DP_t = -0.97DP_{t-1} \quad R^2 = 0.487$$

(0.075)

(2)

$$\Delta VOL_t = 1.48 \cdot 10^8 - 0.144VOL_{t-1} - 0.224\Delta(VOL_{t-1}) + 91320.24t \quad R^2 = 0.14$$

(871445.3) (0.045) (0.073) (871445.3)

(3)

$$\Delta VOL_t = 1.55 \cdot 10^8 - 0.143VOL_{t-1} - 0.224\Delta(VOL_{t-1}) \quad R^2 = 0.14$$

(65210866) (0.044) (0.073)

(4)

problem 10:

(b) $T(\hat{\beta}_2 - 1)$

\uparrow \uparrow est. coef before y_{t-1} from DF regression
 \uparrow # of obs.

if $|\beta_2| < 1$ then $\sqrt{T}(\hat{\beta}_2 - \beta_2) \sim N(0, 1)$

But: if $\beta_2 = 1$ then $\sqrt{T}(\hat{\beta}_2 - 1) \not\sim N(0, 1)$



Hence $T(\hat{\beta}_2 - 1) \sim \underbrace{N(0, 1)}$

\downarrow
DF-scaled tables

for (a) $T = 183 \quad \Delta P_t = \beta_1 + (\beta_2 - 1)P_{t-1} + u_t$

$W_{obs} = T(\hat{\beta}_2 - 1) = 183(-0.02) = -3.66$

$DF_{crit} = -13.72$

$-3.66 > -13.72 \Rightarrow P_t = \text{non-stationary}$

(c)

$$P_t = \beta_1 + \beta_2 P_{t-1} + u_t$$

$$H_0: \beta_1 = 0, \beta_2 - 1 = 0$$

(if P_t - RW w.o. drift)

$$F_{\text{obs}} = 1$$

$$F_{\text{crit}} = 4.67$$

$$1 < 4.67 \Rightarrow P_t - \text{non-stationary}$$

Cointegration

$$I(1) : \Delta X_t = \varepsilon_t \quad \text{RW}$$

Problem 2:

$$X_t = \alpha_0 + \alpha_1 t + u_t$$

$$\text{Differencing: } Z_t = X_t - \alpha_1 t = \alpha_0 + u_t$$

$$E(Z_t) = E(\alpha_0 + u_t) = \alpha_0$$

$$\text{Var}(Z_t) = \text{Var}(\alpha_0 + u_t) = \sigma_u^2$$

$$\text{Cov}(Z_t, Z_{t-s}) = 0$$

Problem 3. Consider a time series process

$$\ln Y_t = \alpha + \beta t + u_t; \quad t = 1, 2, \dots, T$$

Examine the order of integration of $\ln Y_t$.

$$E(\ln Y_t) = \alpha + \beta t \Rightarrow \ln Y_t - \text{non-stationary}$$

$$\begin{aligned} \Delta \ln Y_t &= \alpha + \beta t + u_t - \alpha - \beta(t-1) - u_{t-1} \\ &= \beta + u_t - u_{t-1} \end{aligned}$$

$$E(\Delta \ln Y_t) = \beta$$

$$\text{Var}(\Delta \ln Y_t) = 2\sigma_u^2$$

$$\text{Cov}(\Delta \ln Y_t, \Delta \ln Y_{t-s}) = \begin{cases} \sigma_u^2 & s=1 \\ 0 & s>1 \end{cases}$$

Problem 4. What time series are called cointegrated?

1) same order of cointegration

2) \exists lin. comb. of these t.s.

s.t. it is stationary

\Leftrightarrow lin. reg.: $y_1 \mid y_2, y_3$

\downarrow

resid - stationary